

# Risk and Protective Factors Associated Mental Health among Female Military Veterans: Results from the Veterans' Health Study

**Richard Adams**

Kent State University <https://orcid.org/0000-0002-3372-7922>

**Yirui Hu**

Geisinger Medical Center

**Charles R. Figley**

Tulane University

**Thomas G. Urosevich**

Geisinger Medical Center

**Stuart N. Hoffman**

Geisinger Medical Center

**H. Lester Kirchner**

Geisinger Medical Center

**Ryan J. Dugan**

Geisinger Medical Center

**Joseph J. Boscarino**

William James College

**Carrie A. Withey**

Geisinger Medical Center

**Joseph A. Boscarino** (✉ [jaboscarino@geisinger.edu](mailto:jaboscarino@geisinger.edu))

<https://orcid.org/0000-0002-9965-6805>

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## Research article

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## Abstract

**Background:** This study focuses on factors that may affect female veterans' mental health, compared to men, and is part of a large study assessing the prevalence of mental health disorders and treatment seeking among formerly deployed US military service members.

**Methods:** We surveyed a random sample of 1,730 veterans who were patients in a large non-VA hospital system in the US. Based on previous research, women were hypothesized to be at higher risk for psychological problems. We adjusted our models for confounding factors, including history of childhood abuse, combat exposure, stressful life events, alcohol misuse, psychological resources, and social support.

**Results:** Among the veterans studied, 5% (N=85) were female, 96% were White, 22.9% were Iraq/Afghanistan veterans, and the mean age was 59 years old. Compared to males, female veterans were younger, unmarried, college graduates, have less combat exposure, but more likely to have lifetime PTSD (29% vs. 12%), lifetime depression (46% vs. 21%), lifetime suicide ideation (27% vs. 11%), to have ever used psychological services (67 vs. 47%). Females were more likely to have low psychological resilience and use psychotropic medicines. Using multivariate logistic regression analyses that controlled for risk and protective factors, female veterans had greater risk for lifetime PTSD, lifetime depression, and lifetime suicidal thoughts, compared to males. Since 95% of the population in this study were male and these results may have been statistically biased, we reran our analyses using propensity score matching. The results were consistent.

**Conclusion:** Using a sample of post-deployment veterans receiving services from a non-VA healthcare system, we find that female veterans are at greater risk for lifetime psychological problems, compared to male veterans. We discuss these findings and their implications for service providers.

## Background

Currently, women are one of the fastest growing demographic groups in the military, and the proportion of female military service members and veterans is at its highest level ever in the United States and other industrialized countries.<sup>1,2</sup> Although women currently comprise only 17% of US active duty forces, and about 10.5% of current veterans, this percentage is expected to grow. Growth is even greater in the National Guard/Reserve component of the US military. Given current trends, by 2042, women veterans in the US will comprise over 16% of the total veteran population.<sup>1</sup> These trends are even more pronounced in other advanced industrial countries.<sup>3,4</sup> Thus, it is critical that we conduct research on factors affecting the well-being of women serving in the armed forces. The goal of this research project is to assess both military deployment factors and post-deployment experiences that may contribute to lifetime psychological disorders, especially Posttraumatic Stress Disorder (PTSD), in female veterans, post-deployment, compared to their male counterparts, in order to plan better interventions.

Based on previous research, we hypothesize that female veterans receiving healthcare will have higher rates of PTSD and other mental health problems, compared to male veterans. This hypothesis is tentative, however, as research on sex differences in psychological problems among veterans is inconsistent. Some research reports similar combat experiences and stress exposures for men and women among active duty military personnel and few sex differences in rates of mental health problems.<sup>5,6</sup> Other research shows that women's military experiences and their response to those experiences are often different from men's, placing them at higher risk for psychological problems.<sup>3,7-9</sup> For example, women experience significantly more sexual harassment and sexual assault prior to and during military service.<sup>3,10</sup> Finally, some research finds that male veterans are at greater psychological risk for mental health problems.<sup>11</sup> Possible reasons for these sex differences include exposure to different types of trauma, genetics, emotional learning, gender socialization, and memory processing.<sup>2</sup> Our analysis examines if (1) trauma experiences (both military and non-military) and psychological well-being differ between male and female veterans, (2) if we can explain the well-being differences using multivariate statistical analysis controlling for confounding and other risk factors, and (3) examines sex differences in treatment seeking.

Many of the inconsistent results related to sex differences found in empirical studies of US veterans are also seen in studies of veterans from other industrialized countries. In their study of Canadian veterans, Brunet et al. (2015) report that females were less likely to experience combat related traumas, but more likely to suffer from sexual assaults compared to male Canadian veterans.<sup>3</sup> Like some US studies,<sup>7</sup> female Canadian veterans were also more likely to meet criteria for PTSD than male Canadian veterans. Woodhead et al., in contrast, report few mental health differences between male and female UK veterans, although these results may be due to the relatively few women in the sample.<sup>4</sup>

Much of the previous research on deployment and veteran well-being analyze data from veterans seeking services from the US Veterans Administration (VA),<sup>11-13</sup> or other government funded healthcare systems.<sup>4</sup> Our sample, in contrast, comes from a community population of veterans receiving healthcare from a large non-VA system, since many veterans in the US do not use VA healthcare services and recent policy changes will likely increase the number of veterans seeking care from other providers in the future.<sup>14-16</sup> It should be noted, however, that many participants in our study also receive healthcare from the VA. Thus, this study provides insight into a population of veterans that may overlap with VA-based samples, but is different from those used in previous studies. Seeking treatment outside of traditional military healthcare systems may also inform policy planning in other countries to the extent that their military institutions are undergoing change and veterans are seeking care in the civilian healthcare system.

## Methods

### Procedure

Data were collected via a telephone survey from a sample of community-based U.S. military veterans recruited to assess the health effects of military service.<sup>15</sup> All participants were outpatients of Geisinger Clinic, the largest multi-hospital system in central and northeastern Pennsylvania (see:

[www.geisinger.org](http://www.geisinger.org)), serving more than 3 million residents. Starting in 2007, Geisinger Clinic began to keep records on veteran status and patients were asked to complete a military history questionnaire. Participants were randomly selected using Geisinger's Electronic Health Record (EHR) system. We used screener questions at the beginning of the survey to exclude potential participants who were institutionalized or incapable of completing a 60-minute interview due to physical, language, or cognitive impairment. Screener questions were also used to identify participants who met our inclusion criteria: being able to complete the survey in English, being between 18 and 75 years old, and having at least one warzone deployment. After obtaining informed consent, trained interviewers administered a structured diagnostic interview which took place between February 2016 and February 2017. The final sample size was 1,730, and the survey cooperation rate was estimated to be approximately 55%.<sup>17</sup> The average time for participants to complete the survey was about 65 minutes and participants were offered a \$30 incentive for participation. The Institutional Review Boards of Geisinger (IRB #2015-0441) and the US Department of Defense (IRB #A-18989) reviewed and approved the study protocols.

## Dependent Variables

The study focused on four outcome variables: PTSD, depression, suicide ideation, and use of mental health services. To assess lifetime and past year PTSD, we used a diagnostic instrument and the PTSD Checklist,<sup>18</sup> based on the Association's *Diagnostic and Statistical Manual of Mental Disorders*, 5<sup>th</sup> Edition (DSM-5). To receive a diagnosis of PTSD, veterans had to meet the DSM-5 diagnostic criteria A through G: trauma exposure (criterion A), intrusive symptoms (criterion B), persistent avoidance (criterion C), negative alterations in cognitions/mood (criterion D), increased arousal (criterion E), and reported impairment/distress related to these symptoms (criterion G). Almost 80% of the veterans in the current study reported that the most significant lifetime stressor they experienced was warzone or combat exposure. Lifetime and past year depression were measured using a 10-item (coded no/yes) version of the Structured Clinical Interview for DSM (SCID) Major Depressive Disorder used in previous studies.<sup>15</sup> Consistent with DSM-IV, respondents met criteria for depression (Cronbach's alpha = 0.87), if they had 5 or more depression symptoms for at least 2-weeks.<sup>19,20</sup> We also used one item from the DSM-IV depression scale to measure Lifetime Suicide Ideation to focus more specifically on this important health outcome. Specifically, the item asked if respondents had ever had thoughts for two weeks or longer about how they would be better off dead or "of hurting yourself in some way" (no vs. yes). Lastly, the survey inquired about the use of eight different mental health services (psychiatrist, general practitioner or other counseling, psychologist, counselor, spiritual advisor, priest, minister, rabbi, etc., social worker, or other types of health professionals or self-help groups) for problems with emotions, nerves, or use of alcohol or drugs (n/y). Use of any of these services over the past year was coded yes (1), otherwise no (0). As with many of our measures, these were used in a number of previous studies.<sup>15,16</sup>

## Independent Variables

Our survey included demographic, military experiences, recent stressors, social connections, and psychological resource independent variables known to affect mental health. Demographic variables were sex, age, race, marital status, and education, which were coded such that female, older (65+), White, married or living together as married, and college graduate were coded as the indicator variable. Our military experience variables included deployment era (Iraq/Afghanistan vs. other eras), multiple combat zone tours (coded two or more vs. one) and deployed as National Guard/Reserve (no vs. yes). We measured combat exposure based on eight items from the Combat Experiences Scale.<sup>16,21-22</sup> A number of military health studies used versions of this scale since the Vietnam war period.<sup>23</sup> The 8 items (rated 1 to 4) asked about encountering dead bodies, being wounded by hostile fire, killing enemy combatants, and other combat related events (Cronbach's alpha = 0.84). We coded the sample into high combat exposure ( $\geq 75$ th percentile) versus lower exposure. Unit support/morale was the mean of six items from the Deployment Risk and Resilience Inventory that inquired about a sense of camaraderie in the unit, trust of other unit members, commanding officers being interested in how they felt, feeling like efforts counted in the military, during deployment, etc.<sup>24,25</sup> (Cronbach's alpha = 0.78). We coded respondents into those who felt a high sense of support and unit morale versus those who did not using the scale's 25th percentile. These measures were updated to reflect current conflicts.<sup>15</sup> Lastly, concussion history was assessed based on reported concussions experienced during military service (no/yes). We note that all of these measures are important dimensions of military service in combat zones.

The analysis included three measures of stress based on previous work.<sup>14,16</sup> Stressful events in the past year was the sum of 8 experiences (e.g., spouse/mate die, serious injury, problems at work, etc.), which has been used in past research.<sup>16</sup> Lifetime trauma was the sum of 12 experiences (e.g., natural disaster; being attacked with gun, knife, weapon; situation where you were seriously injured or suffered physical damage; forced sexual contact, etc.) that could have happened to the respondent in their lifetime. Finally, the Adverse Childhood Experiences measure was the sum of 9 events (e.g., parent swear or insult you; parent push, grab, slap, or push you) that could have happened to the participant before they were 18.<sup>26</sup> This measure of childhood abuse and neglect has been used in many studies, showing good validity and reliability.<sup>26,27</sup> For all three of these measures, we divided the sample into low vs high exposure (high = 2+ events).

Lastly, the analyses included several psychological, social, and physical health factors that could help explain sex differences in well-being. Psychological resilience was assessed by the 5-item version of the Connor-Davidson Resilience Scale,<sup>28</sup> with respondents who fell below the 25th percentile defined as having low resilience.<sup>15</sup> The Cronbach's alpha for this scale was 0.99. The social support scale (e.g., someone available to help you if you were confined to bed) used in this study was based on four questions (Cronbach's alpha = 0.84) that inquired about emotional, informational, and instrumental support, coded 1-4 ("none of the time" to "all the time").<sup>29</sup> This scale has been used in previous trauma studies and is considered a reliable and valid measure of current social support.<sup>15,30-32</sup> Low social support was defined as cases falling at or below the 25th percentile.<sup>30</sup> Self-rated physical health was assessed using one item (fair/poor vs. good to excellent). The survey inquired about past year heavy drinking, which we operationalized as 40 or more drinks per month (coded 1), and self-esteem, using 5-items from Rosenberg's Self-Esteem scale (Cronbach's alpha = .87), which we divided into low vs. high categories, using the 75th percentile as the cut-point. These measures have been used in other studies and show good validity.<sup>15-16</sup>

Finally, we assessed several variables related to health services use. VA service use was assessed using single item questions inquiring about current and lifetime use of VA healthcare services. We also used a single item to ask about current VA disability status. In addition, the survey asked about the use of psychotropic medications in the past year. More specifically, the survey inquired about anti-depressants, tranquilizers, sleeping pills or other medicines for problems with emotions, nerves, concentrating, sleeping or coping with stress over the past 12 months. All these measures were used in previous studies.<sup>15, 16</sup>

### Analytic Strategy

We present descriptive statistics and bivariate differences between male and female veterans (Table 1). Given the low number of females in our sample, we conducted preliminary analyses focused on lifetime disorders and retained variables that predicted these outcomes using multivariate logistic regression (Table 2). All variables in the multivariate models had complete data, except for age which had two missing values. We dropped these cases from the analyses. To further examine the relationship between gender and our outcomes, we performed propensity score matching at 1:1, 1:3, and 1:5 ratio of female to male using nearest neighbors and compared these results from propensity matched cohorts to conventional multivariate logistic regression.<sup>33</sup>

Table 1: Demographic, Deployment, and Well-Being Measures for Total Sample and by Sex (N=1727-1730)

Study Variables	(N)	% Total	Sex		p-value
			%Male	%Female <sup>χ<sup>2</sup></sup>	
Age: 18-64	(751)	43.5	40.8	95.3	97.75 <0.001
White Race	(1655)	95.7	95.9	90.6	5.56 0.018
Married	(1340)	77.5	78.8	50.6	36.96 <0.001
College Graduate or Higher	(429)	24.8	23.6	47.1	23.56 <0.001
Iraq/Afghanistan Veteran	(396)	22.9	21.3	54.1	49.39 <0.001
Multiple Tours	(686)	39.7	40.3	29.4	3.97 0.046
Deployed Guard/Reserve	(665)	38.4	37.0	65.9	28.45 <0.001
High Childhood Abuse/Neglect	(288)	16.6	16.5	20.0	0.72 0.395
High Combat Exposure	(408)	23.6	24.7	2.4	22.36 <0.001
Low Unit Support	(364)	21.0	20.5	31.8	6.19 0.013
High Stressful Events Past Yr.	(375)	21.7	21.3	29.4	3.15 0.080
High Lifetime Trauma	(357)	20.6	20.6	21.2	0.90 0.891
Low Psych Resilience	(439)	25.4	24.3	45.9	19.85 <0.001
Low Current Social Support	(314)	18.2	17.9	23.5	1.74 0.187
Fair/Poor Current Health	(633)	36.7	37.2	26.2	4.16 0.041
Concussion in Service	(491)	28.4	29.1	14.1	8.95 0.003
Heavy Drinking Past 30 Days	(208)	12.0	12.5	2.4	7.90 0.005
Low Self-Esteem	(400)	23.1	22.7	30.6	2.80 0.094
PTSD Past Year	(132)	7.6	7.3	14.1	5.34 0.021
PTSD Lifetime	(216)	12.5	11.6	29.4	23.44 <0.001
Current Depression Disorder	(143)	8.3	7.8	17.6	10.38 0.001
Lifetime Depression Disorder	(381)	22.0	20.8	45.9	29.63 <0.001
Recent Suicidal Thoughts	(94)	5.2	5.2	9.4	2.75 0.133
Ever Suicidal Thoughts	(196)	11.3	10.5	27.1	22.02 <0.001
Currently Using VA Service	(864)	49.9	50.3	43.5	1.47 0.225
Current VA Disability	(629)	36.4	37.0	24.7	5.25 0.022
Use Psych Services Past Yr.	(406)	23.5	22.4	43.5	20.03 <0.001
Ever use of Psych Services	(832)	48.1	47.1	67.1	12.88 <0.001
Use Psychotropics Past Yr.	(384)	22.2	21.4	37.6	12.36 <0.001
N (%)			1645(95.1)	85(4.9)	

Table 2: Odds Ratios and 95% Confidence Intervals for Mental Health Outcomes Regressed on Demographic, Deployment, Drinking, and Psychological Resource Variables (N=1728)

Independent Variables	Lifetime PTSD OR (95% CI)	Lifetime Depression OR (95% CI)	Ever Suicidal Thoughts OR (95% CI)	Lifetime Psych Services OR (95% CI)
Sex (Female)	5.16 (2.61-10.20)***	3.06 (1.74-5.49)***	2.62 (1.40-4.93)***	1.68 (0.98-2.87)
Age (65+)	0.71 (0.48-1.03)	0.50 (0.38-0.67)***	0.72 (0.51-1.03)	0.52 (0.41-0.66)***
College Graduate or Higher	0.83 (0.54-1.26)	0.81 (0.58-1.13)	1.00 (0.68-1.49)	0.95 (0.74-1.22)
Married	1.41 (0.92-2.14)	1.05 (0.75-1.45)	1.21 (0.81-1.81)	0.66 (0.51-0.87)**
High Child, Abuse/Neglect	1.64 (1.10-2.43)*	2.13 (1.54-2.95)***	2.25 (1.56-3.24)***	1.87 (1.38-2.55)***
High Stress past Yr.	3.29 (2.28-4.77)***	2.27 (1.67-3.08)***	1.23 (0.84-1.79)	2.05 (1.54-2.74)***
High Lifetime Trauma	2.38 (1.64-3.45)***	1.64 (1.20-2.25)**	1.20 (0.82-1.76)	1.55 (1.16-2.05)***
High Combat Exposure	3.00 (2.03-4.44)***	1.86 (1.34-2.58)***	1.20 (0.81-1.79)	1.69 (1.29-2.22)***
Concussion in Service	2.27 (1.56-3.31)***	1.50 (1.10-2.04)**	1.13 (0.77-1.64)	2.05 (1.59-2.66)***
Heavy Drinking	1.66 (1.01-2.72)*	1.09 (0.71-1.64)	1.17 (0.72-1.91)	0.89 (0.64-1.24)
Low Self-Esteem	3.06 (2.09-4.49)***	3.41 (2.51-4.63)***	4.27 (2.95-6.18)***	2.37 (1.77-3.18)***
Low Resilience	2.26 (1.54-3.31)***	2.33 (1.72-3.15)***	1.95 (1.35-2.81)***	2.03 (1.54-2.67)***
Low Current Social Support	1.69 (1.12-2.54)*	1.62 (1.16-2.27)**	1.34 (0.91-1.98)	0.95 (0.70-1.27)
Constant	0.011***	0.076***	0.034***	0.11***

Logistic Regression: OR-Odds Ratio CI-Confidence Interval

Significance levels: \* p < .05 \* p < .01 \*\*\* p < .001

### Propensity score matching

For propensity score matching we first included the confounding covariates listed in Table 2, including age, college graduate, married status, anti-social disorder, high combat exposure, serving on multiple tours, ever used mental health services, low psychological resilience, high neglect/abuse history, high current life stress, high lifetime trauma, history of concussion, low self-esteem, and low social support. In addition to these variables, we also added history of ADHD (doctor told respondents they had this health problem, no vs. yes), Iraq/Afghanistan service, low unit support during deployment, military rank (officer vs. enlisted), white race, assessment of stable emotions, based on the 5-factor personality scale<sup>34</sup>, and current reported VA service use to estimate the propensity score for the variable, female sex. Then our matching procedure, was executed using 1:1 nearest neighbor matching without replacement where a single female participant was matched to a single male participant who had the most similar estimated propensity score with a caliper of 0.2. In addition, as the sample sizes of the female and male participants vary greatly, we performed the one to many matchings where a single female participant was matched to more than one male participant (such as 1: 3 and 1: 5 matching) using nearest neighbor based on propensity scores.<sup>33</sup> There were 85 females and 1644 males in original dataset. After propensity score matching, there were 85 females and 85 males selected for the 1: 1 matching; 85 females and 255 males selected for the 1: 3 matching; 85 females and 425 males selected for the 1: 5 matching. Multivariate logistic regression models were then conducted for the 1: 1, 1: 3 and 1: 5 nearest neighbor matching to evaluate the sex differences in predicting lifetime PTSD, lifetime depression, suicidal thoughts, and use of psychological services (Table 3). The propensity scores matching procedures were conducted in RStudio Version 1.2.1335, the "MatchIt" package.<sup>35,36</sup> As a further test of model adequacy, we performed a sensitivity analysis using the Wilcoxon Signed Rank Test, where the value of Gamma can be interpreted as the odds of the model suffering from hidden bias due to omitted (unmeasured) variables.<sup>37</sup>

Table 3: Multivariate Logistic Regression Results using Propensity Score Matching for Lifetime PTSD, Depression, Suicide Ideation, and Psychological Services

Dependent Variable	OR	(95% CI)	Pr(> z )
Matching: PTSD			
1 to 5 female vs. male	5.19	(2.43 11.09)	0.00002***
1 to 3 female vs. male	5.13	(2.32 11.34)	0.000523***
1 to 1 female vs. male	11.55	(3.06 43.63)	0.000309***
Matching: Major Depression			
1 to 5 female vs. male	3.27	(1.77 6.06)	0.000162***
1 to 3 female vs. male	3.04	(1.61 5.74)	0.000635***
1 to 1 female vs. male	2.64	(1.19 5.84)	0.0171*
Matching: Suicide Ideation			
1 to 5 female vs. male	2.48	(1.30 4.75)	0.006106**
1 to 3 female vs. male	2.82	(1.41 5.63)	0.003367**
1 to 1 female vs. male	3.99	(1.53 10.37)	0.004533**
Matching: Psych Services			
1 to 5 female vs. male	1.91	(1.09 3.38)	0.024818*
1 to 3 female vs. male	1.96	(1.08 3.57)	0.027033**
1 to 1 female vs. male	1.46	(0.71 2.99)	0.299672

Significance levels: \*\*\* <0.001 \*\* <0.01 \* <0.05.

## Results

The basic characteristics of the sample (Table 1) show that 5% (n=85) were female. Other features of the sample show numerous large differences between male and female veterans. For example, about 95% of the females were less than 65, but only 40% of the male veterans were in that age range. About half the women were married, but almost 80% of the men were, and female veterans were also more likely to be college graduates, compared to their male counterparts (47% vs. 24%). Women veterans were more likely to see service during the Afghanistan/Iraq War (54% vs. 21%), be deployed as National Guard/Reserve units (66% vs. 37%), and were much less likely to report high combat exposure (2% vs. 25%), compared to men. The sample shows smaller, but statistically significant differences for race, multiple tours, and unit support, with women being more racially diverse, fewer reporting multiple tours, and higher percentages scoring low on unit support. Data also revealed psychological and health differences between female and male veterans. Women were more likely to score low on psychological resilience, less likely to report service-related concussions, less likely to be classified as a heavy drinker, and more likely to report poor health.

Female veterans in our study were more likely to meet criteria for lifetime and past year PTSD, meet criteria for lifetime and past year depression, and have suicidal thoughts. Health service results show no sex differences in the use of VA services, but women were less likely to report a current VA disability, and more likely to have used psychological services and psychotropic medication in the past year.

Multivariate logistic regression results (Table 2) reveal that women are more significantly more likely to meet study criteria for lifetime PTSD (OR = 5.16), lifetime depression (OR = 3.09), suicidal thoughts (OR = 2.62), but not for lifetime use of psychological services, after adjusting for other demographic factors, stressful events, alcohol use, psychological resources, and social support. For lifetime PTSD, childhood adversities (OR = 1.64), past year stressors (OR = 3.29), lifetime trauma (OR = 2.38), combat exposure (OR = 3.00), concussion history (OR = 2.27), heavy drinking (OR = 1.66), low self-esteem (OR = 3.06), low psychological resilience (OR = 2.26), and low social support (OR = 1.69) also predict this outcome.

In addition to sex, age is statistically related to lifetime depression (OR = 0.50), as are childhood adversities (OR = 2.13), stressful events (OR = 2.27), lifetime trauma (OR = 1.64), combat exposure (OR = 1.86), concussion history (OR = 1.50), low self-esteem (OR = 3.41), low resilience (2.33), and low social support (OR = 1.62). The model for lifetime suicidal thoughts shows that childhood adversities (OR = 2.25), low self-esteem (OR = 4.27), and low resilience (OR = 1.95), along with sex, are statistically related to this psychological problem. Finally, although there were no statistically significant differences by sex, the regression for lifetime psychological service use showed that child abuse (OR = 1.87), high stress in the past year (OR = 2.05), high lifetime trauma (OR = 1.55), high combat exposure (OR = 1.69), service-related concussion (OR = 2.05), low self-esteem (OR = 2.37), and low resilience (OR = 2.03) were associated with higher service use, while being over 65 (OR = 0.52) was related to lower service use.

As an additional check on sex differences in well-being among our sample of veterans, we replaced lifetime outcomes with current measures of each variable. That is, we replaced lifetime PTSD, depression, suicidal thoughts, and use of psychological services, with PTSD past year, current depression, recent suicidal thoughts, and use of services in past year. As shown in Table 1, statistically significant sex differences were found for PTSD past year, current depression, and service use past year, with female veterans more likely to suffer from these mental health problems and to use psychological services. When we controlled for the same factors in multivariate models shown in Table 2, sex differences remained for PTSD (OR = 2.52, p = .037) and for use of

psychological services (OR = 2.39,  $p = .002$ ), but not for current depression (OR = 1.56,  $p = .234$ ) or suicide ideation (OR = 1.08,  $p = .865$ ). We also estimated multivariate models with interaction terms for gender and the stress variables (i.e., child abuse, stress past year, lifetime trauma, and combat exposure) to see if women responded differently to these life events relative to men, some have suggested.<sup>2</sup> None of these interaction terms were statistically significant. (Results are available from the corresponding author.)

In Table 3, multivariate logistic regression results were presented for the 1 : 1 matching, 1 : 3 and 1 : 5 propensity score matched cohorts using nearest neighbor, as discussed above, to evaluate the odds ratio of sex differences in predicting lifetime PTSD, lifetime depression, and suicidal thoughts. As can be seen, these are all statistically significant, except for 1 : 1 matching for lifetime use of psychological services. The differences in the number of cases used in the across the matching ratios is probably the main reason for the different significant levels reported in the Table. Nevertheless, these results add strength to your conclusions about the differences between male and female veterans for our four outcomes. That is, matching male and female veterans using propensity scores shows that female are five times more likely to meet criteria for PTSD, and two and a half times at greater risk for major depression and suicide ideation, and most likely greater users of psychological services compared to male veterans. As a further test of our model, we conducted a sensitivity analysis. We make a note of caution in our results, as this sensitivity analysis results showed that the values of Gamma is close to 1 lead to changes in significance, which indicated that the lifetime models for PTSD, depression, and suicidal ideation may suffer from unmeasured confounders.<sup>37</sup> (Results available from the corresponding author.) We discuss the limitation in the Conclusion.

## Discussion

Our study is consistent with earlier research which finds female veterans at greater risk for lifetime PTSD and other mental health problems, and higher users of psychological services,<sup>9,38</sup> even after controlling for several risk and protective factors. Our results also match results from non-US countries.<sup>3</sup> More specifically, this study is consistent with other studies,<sup>2,5,6,9,11</sup> even controlling for key psychological/cognitive risk factors (e.g., self-esteem, psych resilience, social support, concussion history, alcohol misuse) there is still an association with adverse deployment outcomes (PTSD, Depression, Suicidality, Service Use) and female sex. For example, Lehavot et al. analyzed data from a national survey on alcohol and, like our findings, report that women veterans have the highest rates of lifetime and past year PTSD and treatment utilization, compared to male veterans,<sup>2</sup> and that controlling for different types of trauma (e.g., early childhood abuse, interpersonal violence, and recent stressful events) reduced sex differences, but did not eliminate them.<sup>39</sup> Using VA administrative data, Haskell and her colleagues find that female veterans have greater mental health problems, such as depression and adjustment disorder, and service use, compared to men, but, in contrast to our study, male veterans had higher rates of PTSD, after adjusting for demographic differences.<sup>11</sup>

These findings are especially important in that women are at greater risk for lifetime suicide ideation and for the use of psychological services in the past year. Again in line with other research, women in our study were different from male veterans in that they were younger, more educated, less likely to be married, and more likely to be deployed as part of the National Guard/Reserve component of the military, consistent with other studies of US veterans,<sup>6,7,11</sup> as well as studies of veterans who served in other countries.<sup>4</sup> Moreover, in their study of women who use the VA for mental health care, Kimerling et al. report that only half of the female veterans found that the VA met their needs.<sup>40</sup> More research on unmet need among female veterans using non-VA facilities like Geisinger is needed to ensure that this population does not suffer from the lack of appropriate care. To our knowledge, this is one of the first studies to report these findings for female veterans seen in non-VA hospitals. Clinicians in both VA and Non-VA facilities need to be aware of these demographic, pre- and post-deployment experiences, and the specific needs of female veterans.

We make a final comment on the propensity score and sensitivity analyses. The models for our four outcomes included demographic, military experiences, and non-military experiences variables. Nevertheless, three of the four models continued to show sex differences. The propensity score analysis confirmed these results, but the sensitivity analysis indicated the possibility of omitted factors in the models for PTSD, depression, and suicidal thoughts. From a social science perspective, categorical variables like sex, marital status, race/ethnicity, and religious affiliation are crude measures of complex social psychological processes. Research shows that female veterans not only have different backgrounds (e.g., are more educated and less likely to be married), but also different experiences (e.g., more likely to be sexually harassed) than male veterans.<sup>2,5,6,9,41</sup> One result of failing to capture these differences in our models is that we continue to see statistically significant differences in sex. A model that adequately assess the complexity of these experiences should show no statistically significant sex differences. Future researchers should conduct studies that carefully consider how pre-military experiences, self-perceptions, interactions with others, and social situations affects men and women differently, especially with military context.

In terms of study limitations, our data were cross-sectional, which precludes assessment of causality. Second, we only were able to successfully recruit 85 female veterans. As noted earlier, this may have biased our results in that we may have randomly selected female veterans who, by chance, do not accurately represent the larger population of female veterans receiving care in facilities like Geisinger Clinic. Although our propensity score analysis confirmed the multivariate analyses, it is possible that unmeasured variables, such as a more detailed history of sexual assault, might change our results if they were included in the model. It is also possible that only certain types of female veterans seek healthcare in non-VA facilities, and we have not included this factor in our models. Future research should sample veterans receiving care from both VA and non-VA facilities to broaden generalizations for this population. Third, the current study only included previously deployed U.S. veterans seen at a large non-VA multihospital system in Pennsylvania and our results may not generalize to all combat veterans, veterans from other sections of the country, or veterans from other countries. Research which includes veterans from both VA and non-VA systems can clarify gaps in care within each, as can studies that examine the role of culture in how veterans respond to their military experience. Fourth, the findings may not generalize to non-White US veterans because over 90% of our sample was White. Additionally, our alcohol misuse and suicidality measures were limited. Finally, we did not ask about gender identity, sexual assault/harassment in the military, or sexual orientation. Future studies should explore these issues in more detail as gender identity for both men and women, sexual harassment, and sexual orientation have been related to poor mental and physical outcomes among veterans.<sup>41</sup> Many of these limitations are also found in other studies, especially for those of veterans who

served in industrialized countries other than the US.<sup>4-7,38-40</sup> Future research examining sex differences needs to have much larger numbers of female veterans so that we can have more accurate estimates of their mental health problems and treatment needs.

## Conclusions

Despite these limitations, our findings support the case for more gender-informed planning, given the projected increase in female veterans in both the US and other industrial countries. Consistent with other researchers,<sup>1,39,40</sup> we find female veterans have high levels of need for mental health care, relative to male veterans and access psychiatric services in the past year at higher levels, too. In the Kimerling et al. study,<sup>40</sup> results suggest that female veterans reported lower use of VA healthcare because there were fewer women doctors and women-only healthcare settings. Our findings, along with other studies on female veterans, need to be used to better inform changes in the provision of healthcare to US veterans, since they are likely to receive services from non-VA facilities.<sup>15</sup> Studies of non-VA healthcare delivery to veterans will be important to develop public-private partnerships, which are especially important so medical and mental health facilities for veterans can better address gender differences, as the healthcare needs of male and female veteran are often different.<sup>40</sup> In this regard, we plan to disseminate our study finding to Veterans' Service Organizations, as well as the US Department of Defense – the sponsor for the current study. We also state the necessity of studies that compare healthcare systems outside of the United States with the US system, and what we can learn about how they address the healthcare needs of female veterans.

## Abbreviations

PTSD = Posttraumatic Stress Disorder

VA = Veterans Administration

DSM-5 = Diagnostic and Statistical Manual, Version 5

SCID = Structured Clinical Interview for DSM

DSM-IV = Diagnostic and Statistical Manual, Version IV

## Declarations

### Availability of data and Material:

The data and material used in the current study are not available.

### Corresponding author:

Correspondence to Joseph A. Boscarino, PhD, MPH.

### Ethics approval and consent to participate:

All participating men and women in this study provided written informed consent, and the Institutional Review Board (IRB) of Geisinger Clinic (IRB #2015-0441) and the US Department of Defense (IRB #A-18989) reviewed and approved the study protocols.

### Consent for publication:

Not applicable.

### Competing interests:

The authors declare that they have no competing interests.

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### Author Contributions:

JAB: Secured research funding, designed the study, directed study execution, managed study staff, reviewed and approved final draft of the manuscript.

REA: Provided study consultations, conducted data analysis, wrote first draft of manuscript, reviewed and approved final draft of the manuscript.

YH: Provided study consultations, conducted data analysis, reviewed and approved final draft of the manuscript.

CRF: Provided study consultations, reviewed and approved final draft of the manuscript.

TGU: Provided study consultations, reviewed and approved final draft of the manuscript.

SNH: Provided study consultations, reviewed and approved final draft of the manuscript.

HLK: Provided study consultations, reviewed and approved final draft of the manuscript.

RJD: Proofed the manuscript, developed study tables, reviewed and approved final draft of the manuscript.

JJB: Proofed the manuscript, reviewed and approved final draft of the manuscript.

CAW: Provided study management, reviewed and approved final draft of the manuscript.

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