



## Posttraumatic stress disorder and traumatic brain Injury: Sex differences in veterans

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### ABSTRACT

Around half of Iraq and Afghanistan war veterans with traumatic brain injury (TBI) have co-occurring post-traumatic stress disorder (PTSD). Research on the differences between male and female veterans with co-occurring PTSD/TBI is sparse. This study evaluated behavioral health differences between sexes with these conditions. Veterans ( $N = 1577$ ) completed a structured psychiatric interview, TBI interview, and self-report interviews assessing sleep quality, alcohol use, substance use, pain, depression symptoms, PTSD symptoms, and combat exposure. Groups depended on the presence/absence of a lifetime PTSD diagnosis and history of TBI. Among veterans with PTSD and TBI, males and females were equally likely to meet criteria for current PTSD, and in the PTSD only group, male veterans were more likely to have current PTSD. Male veterans with PTSD were also more likely to meet criteria for lifetime alcohol and substance use disorders (AUD and SUD), and mild TBI. Although TBI severity did not differ between sexes in the TBI only group, female veterans were more likely to have a moderate/severe TBI among veterans with co-occurring PTSD. Female veterans without PTSD and TBI were more likely to have major depressive disorder (MDD). Significant sex differences were found for AUD, MDD, current PTSD, and TBI severity.

### 1. Introduction

Over the past 50 years, the majority of women in the military have served during peacetime (McSally, 2011). However, the role of female servicemembers has transformed dramatically over time, and since the ban on women serving in direct combat roles was lifted in 2013, this role continues to evolve (Harris, 2013). The shift in roles has also been accompanied by a rise in the number of women serving in the military (National Center for Veterans Analysis and Statistics, 2016). Currently, women represent the subpopulation with the greatest growth in the military (National Center for Veterans Analysis and Statistics, 2016). Increased growth and access to combat roles means that female veterans will experience greater combat exposure than in past conflicts. Although combat support roles and indirect combat are not new for women in the military, men historically reported higher combat exposure (Street et al., 2009). The potential effect of combat exposure on the female veteran is an area of growing interest and importance. Current research on combat exposure has been found to be associated with worse health status in both men and women (Wang et al., 2015).

Given the growing projections for female veterans and combat exposure roles, it can be predicted that mental health care needs for female veterans may rise as well.

The most commonly diagnosed mental health condition among combat veterans is posttraumatic stress disorder (PTSD) (Ramsey et al., 2017), which has made PTSD among the chief treatment concerns for veterans. The focus of PTSD treatment has primarily been on military sexual trauma (MST) for female veterans (Bean-Mayberry et al., 2011). However, the increase in combat roles now puts women at higher risk for combat-specific trauma and combat-related injuries, such as traumatic brain injury (TBI), that may complicate trauma diagnosis. Evaluating combat experience holistically aides in understanding patients on a comprehensive level and improves development of effective treatment.

In order to develop a comprehensive picture, one of the most co-occurring conditions for Iraq and Afghanistan veterans should also be considered; traumatic brain injury (TBI). The leading cause of TBI in the military is falls, followed by motor vehicle accidents (DVBIC, 2018). It is not uncommon to experience a TBI in garrison or during daily

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activities (DVBIC, 2018). However, a combat zone includes additional risks for TBI. Explosive mechanisms have been found to account for about 78% of combat injuries in recent conflicts (Owens et al., 2008). Increased use of improvised explosive devices (IED) and advancements in protective gear, which has aided in survivability of blasts, has led to a growing concern for TBI in service members and veterans (Bagalman, 2013). TBI is considered by many to be the “signature injury” of Operations Enduring Freedom, Iraqi Freedom, and New Dawn (OEF/OIF/OND), and research has found that experiencing a TBI during deployment was the strongest predictor of developing PTSD (DePalma and Hoffman, 2018; Hoge and Castro, 2014). Recent numbers indicate that male veterans between the ages of 18 and 24 are at the greatest risk for TBI (DVBIC, 2018), but as the role of the female veteran continues to evolve, so too must the research on the female veteran's treatment needs.

### 1.1. Sex differences in PTSD and TBI

In the civilian population, women are more likely to meet diagnostic criteria for PTSD, though men have a higher risk of exposure to traumatic events across the lifespan (American Psychiatric Association, 2013; Silove et al., 2017; Tolin and Foa, 2006). This contrasts with research demonstrating that male veterans are more likely to be diagnosed with PTSD than female veterans (American Psychiatric Association, 2013; Maguen et al., 2010). This might reflect under-diagnosis of PTSD in female veterans, an over-diagnosis in the civilian population, or an artifact of historically limited combat exposure in this population. Alternatively, it may suggest that the female civilian population is not representative of the female veteran population. However, recent research supports no sex differences in PTSD and anxiety disorder diagnoses in veterans (Street et al., 2013). This change in PTSD diagnostic rates between male and female veterans may reflect growing changes of the female veteran/service member, such that female veterans may be more exposed to traumatizing events or that PTSD may now be better understood in the female veteran.

There is limited research evaluating veteran sex differences in TBI. Approximately 22% of OEF/OIF/OND combat veterans screened positive for a TBI by the Veteran Health Administration, with more male than female veterans diagnosed (Hendricks et al., 2013). However, this statistic may be influenced by sex differences in combat exposure. TBI is often associated with greater rates of mental health diagnoses, such as alcohol use disorder and depression. However, research on veterans with TBI has indicated that men and women do not differ on the number of mental health diagnoses, but may differ on type. Female veterans with a history of TBI are less likely to meet criteria for alcohol use disorder (AUD) and PTSD than male veterans with a history of TBI (Maguen et al., 2010; Street et al., 2013). On the other hand, female veterans are more likely to meet criteria for depression and anxiety disorders (Iverson et al., 2011; Iverson et al., 2013).

### 1.2. Sex differences in co-occurring PTSD and TBI

In the veteran population, it is not uncommon to have co-occurring diagnoses of PTSD and TBI. Studies have estimated that 33–67% of OEF/OIF/OND veterans with TBI also meet criteria for PTSD (Carlson et al., 2011; Iverson et al., 2011). However, there are many overlapping symptoms (e.g., trouble concentrating, memory problems, irritability) between PTSD and TBI that can make accurate diagnosis challenging. Differentiating between PTSD and TBI is made additionally difficult by co-occurring psychiatric and physiological conditions. Depression and anxiety often accompany both PTSD and TBI (Hoge et al., 2008; Iverson et al., 2011; Skopp et al., 2011; Vogt et al., 2011). Substance abuse and chronic pain are also common confounding factors for symptom expression in PTSD and following a TBI (Capehart and Bass, 2012; Hoge et al., 2008; Iverson et al., 2011; Lew et al., 2008; Skopp et al., 2011; Vogt et al., 2011).

There is a paucity of research on sex differences in veterans with co-occurring PTSD and TBI. Most research on co-occurring PTSD and TBI among veterans is limited by small samples of female veterans, which is congruent with the current ratio of male to female veterans in the US military. Due to the change in the female veteran's role, growing numbers of female veterans will experience deployments to warzones, and it is likely that the number of female veterans with co-occurring PTSD and TBI will increase.

The present study expands the extant literature on co-occurring PTSD and TBI for female veterans. Occurrence of PTSD and TBI were evaluated separately to assess sex differences in related groups. We hypothesized that there would be behavioral health sex differences between male and female veterans with: 1) neither a lifetime history of TBI nor PTSD (No PTSD/No TBI); 2) a lifetime diagnosis of PTSD and no history of TBI (PTSD/No TBI); 3) a history of TBI and no lifetime PTSD diagnosis (TBI/No PTSD), and; 4) co-occurring lifetime PTSD and TBI (PTSD/TBI).

## 2. Methods

### 2.1. Procedures

Data was obtained from the VA Mid-Atlantic Mental Illness Research, Education and Clinical Center (MA-MIRECC) Post-Deployment Mental Health (PDMH) study (Brancu et al., 2017), which is an ongoing, cross-sectional, multi-site study conducted across four Veterans Affairs Medical Centers. An inclusion criterion for the parent study was service in the military (including Reserves and National Guard) since September 11, 2001. The parent study had no exclusion criteria. Participants from the full PDMH sample ( $N = 3247$ ) were included in the present analyses if they completed the MA-MIRECC TBI Interview ( $N = 1577$ ). All veterans in this sample served in support of OEF/OIF/OND after September 11, 2001.

The TBI interview was internally developed for the MA-MIRECC PDMH study to assess TBI history. The comprehensive, lifetime TBI interview evaluates events that may have led to a TBI before, during, and after military service. Questions on this interview evaluate the cause, loss of consciousness, alteration of consciousness, posttraumatic amnesia, any alterations in duty, and postconcussive symptoms immediately following the injury event. The American Congress of Rehabilitation Medicine criteria were used to determine TBI severity (Kay et al., 1993).

### 2.2. Measures

The Structured Clinical Interview for DSM-IV Disorders (SCID-IV; First et al., 1996) was administered to assess for current and lifetime history of psychiatric diagnoses. All labels of “current” and “lifetime” disorders were given in accordance with the SCID-IV scoring parameters. Current refers to meeting current DSM-IV criteria at the time of evaluation. Lifetime refers to meeting criteria for a diagnosis at any time and includes current diagnoses.

In addition to completing the MA-MIRECC TBI Interview mentioned above, participants also completed measures evaluating alcohol use problems (Alcohol Use Disorders Identification Test; AUDIT; Babor et al., 2001), substance use problems (Drug Abuse Screening Test; DAST; Skinner, 1982), depressive symptoms (Beck Depression Inventory, Second Edition; BDI-II; Beck et al., 1996), posttraumatic stress symptoms (Davidson Trauma Scale; DTS; Davidson et al., 1997), sleep quality (Pittsburgh Sleep Quality Index; PSQI; Buysse et al., 1989), pain (Brief Pain Inventory; BPI; Cleeland, 2009), and combat exposure (Combat Exposure Scale; CES; Lund et al., 1984).

### 2.3. Data analysis

The total sample ( $N = 1577$ ; male  $n = 1248$ , female  $n = 329$ ), ages

21–69 ( $M = 37.71, SD = 10.55$ ), was divided into mutually exclusive subgroups for analyses: 1) No PTSD/TBI ( $N = 531$ ; male  $n = 398$ ; female  $n = 133$ ), 2) PTSD only ( $N = 270$ ; male  $n = 175$ , female  $n = 95$ ), which excluded veterans with a TBI; 3) TBI only ( $N = 383$ ; male  $n = 337$ , female  $n = 46$ ), which excluded veterans with a diagnosis of PTSD, and; 4) PTSD/TBI ( $N = 393$ ; male  $n = 338$ , female  $n = 55$ ), which included veterans with co-occurring diagnoses of PTSD and TBI. Group comparisons between sexes and descriptive statistics were conducted for all four subgroups (No PTSD/TBI, PTSD only, TBI only, and PTSD/TBI) to allow for contrast of results, adjusting for diagnoses of interest. Differences between male and female veterans were compared within groups; however, differences between female veterans were not compared between groups. This was done to remain consistent with the proposed research question regarding sex differences.

Chi-square analyses were conducted to evaluate differences in diagnostic outcomes between male and female veterans in each group. Odds ratios (OR) are provided as a measure of association for significant results. Fisher's Exact Test results are reported where expected cell sizes are  $< 5$  and are indicated in tables. Independent samples  $t$ -tests were conducted to evaluate outcomes on symptom measures between sexes within each subgroup. Cohen's  $d$  ( $d$ ) is provided for significant outcomes. Significance level was set to an alpha of 0.05. To adjust for multiple comparisons, false discovery rate was used to determine significance of results (Benjamini and Hochberg, 2000).

### 3. Results

#### 3.1. Sample characteristics

Participant characteristics are presented in Table 1 by analytic group. There were no significant differences for age between men and women within any subgroup. Significant differences between men and women were found within each subgroup for education and tours served. Women reported more years of education than men across all subgroups: No PTSD/TBI,  $p = .001$ ; PTSD only,  $p < .001$ ; TBI only,  $p = .029$ , and; PTSD/TBI,  $p < .001$ . Men reported more tours of duty

across all subgroups,  $p = .001$ ;  $p = .002$ ;  $p = .013$ , and;  $p = .001$ , respectively.

TBI history and mental health characteristics are provided in Table 2, and symptom differences are reported in Table 3. In the full sample, about half of male participants met diagnostic criteria for TBI, which was significantly higher than female participants,  $\chi^2(1, N = 1577) = 56.98, p < .001$ . Most TBI diagnoses were mild, based on ACRM criteria, for both male ( $n = 548, 81.80\%$ ) and female ( $n = 75, 74.25\%$ ) participants. Among veterans with a TBI, there were no significant sex differences among TBI severities,  $\chi^2(1, N = 623) = 2.66, p = .103$ . However, in the total sample and co-occurring PTSD/TBI subgroup, men were more likely to meet criteria for a mild TBI than women,  $\chi^2(1, N = 1577) = 48.57, p < .001$ , (men = 43.91%; women = 22.79%);  $\chi^2(1, N = 393) = 6.85, p = .009$ , (men = 78.11%; women = 61.82%). In the co-occurring PTSD/TBI sample, there were sex differences among TBI severities such that women were more likely to meet criteria for a moderate/severe TBI,  $\chi^2(1, N = 393) = 6.85, p = .009$ , (men = 21.89%; women = 38.18%). In the full sample, there were no significant sex differences for current,  $\chi^2(1, N = 1577) = 2.276, p = .131$ , (men = 31.35%; women = 27.05%), or lifetime PTSD,  $\chi^2(1, N = 1577) = 2.151, p = .142$ , (men = 41.10%; women = 45.59%).

#### 3.2. Differences in diagnoses

Group characteristics for chi-square analyses are presented in Table 2. There were significant differences between male and female veterans across all subgroups. All groups are mutually exclusive.

**No PTSD/TBI ( $N = 531$ ).** Veterans were included in this subgroup if they had no history of TBI and no lifetime or current PTSD. Chi-square analysis indicated that the frequency of lifetime,  $\chi^2(1, N = 531) = 4.21, p = .040$ , (men = 21.36%; women = 30.08%), and current,  $\chi^2(1, N = 531) = 9.99, p = .002$ , (men = 5.28%; women = 13.53%), major depressive disorder (MDD) among women was significant in proportion to men. Lifetime AUD,  $\chi^2(1, N = 531) = 6.69, p = .009$ , (men = 17.59%; women = 8.27%), and

**Table 1**  
Sample characteristics.

Demographic	No PTSD/TBI <i>m</i> ( <i>n</i> = 398)	<i>f</i> ( <i>n</i> = 133)	PTSD only <i>m</i> ( <i>n</i> = 175)	<i>f</i> ( <i>n</i> = 95)	TBI only <i>m</i> ( <i>n</i> = 337)	<i>f</i> ( <i>n</i> = 46)	PTSD/TBI <i>m</i> ( <i>n</i> = 338)	<i>f</i> ( <i>n</i> = 55)
	<i>M</i> ( <i>SD</i> ) or <i>n</i> (%)	<i>M</i> ( <i>SD</i> ) or <i>n</i> (%)	<i>M</i> ( <i>SD</i> ) or <i>n</i> (%)	<i>M</i> ( <i>SD</i> ) or <i>n</i> (%)	<i>M</i> ( <i>SD</i> ) or <i>n</i> (%)	<i>M</i> ( <i>SD</i> ) or <i>n</i> (%)	<i>M</i> ( <i>SD</i> ) or <i>n</i> (%)	<i>M</i> ( <i>SD</i> ) or <i>n</i> (%)
Age	38.61 (10.93)	37.38 (11.00)	38.07 (10.19)	37.14 (9.66)	38.65 (11.06)	38.17(11.07)	35.54 (9.47)	35.62 (7.67)
Education	<b>13.23 (4.10)</b>	<b>13.88 (4.11)</b>	<b>13.32 (3.87)</b>	<b>13.66 (4.38)</b>	<b>13.90 (4.12)</b>	<b>14.64 (3.42)</b>	<b>13.07 (3.56)</b>	<b>14.07 (4.05)</b>
Tours Served	<b>1.52 (1.33)</b>	<b>1.13 (1.00)</b>	<b>1.73 (1.38)</b>	<b>1.22 (1.10)</b>	<b>1.60 (1.15)</b>	<b>1.15 (1.03)</b>	<b>1.89 (1.35)</b>	<b>1.40 (0.93)</b>
Ethnicity								
Hispanic	21 (5.29)	4 (3.01)	19 (10.92)	5 (5.26)	17 (5.04)	4 (8.70)	24 (7.10)	4 (7.30)
Race <sup>a</sup>								
Caucasian	194 (48.74)	37 (27.82)	71 (40.57)	42 (44.21)	223 (66.17)	21 (45.65)	199 (58.90)	28 (50.90)
African American	193 (48.49)	95 (71.43)	104 (59.43)	55 (57.89)	110 (32.64)	25 (54.35)	137 (40.50)	26 (47.30)
Other	18 (4.52)	5 (3.75)	6 (3.43)	4 (4.21)	3 (0.89)	0 (0.00)	8 (2.40)	2 (3.60)
Branch of Service								
Army	211 (53.01)	82 (61.65)	124 (70.86)	64 (67.36)	199 (59.04)	31 (67.40)	232 (68.70)	35 (63.60)
Navy	106 (26.64)	38 (28.57)	24(13.71)	19 (20.00)	62 (18.4)	7 (15.21)	82 (11.30)	13 (23.60)
Air Force	43 (10.61)	10 (7.00)	13 (7.43)	11 (11.58)	33 (9.79)	6 (13.04)	13 (3.90)	6 (10.9)
Marine Corps	37 (9.30)	3 (1.25)	13 (7.43)	1 (1.05)	39 (11.58)	2 (4.34)	55 (16.3)	1 (1.80)
Coast Guard	1 (0.25)	0 (0.00)	1 (0.57)	0 (0.00)	4 (1.19)	0 (0.00)	0 (0.00)	0 (0.00)
Deployed	217 (54.80)	48 (36.09)	125 (71.43)	52 (54.74)	205 (61.19)	25 (54.35)	265 (78.40)	33 (60.0)
Deployment <sup>a</sup>								
Iraq	191 (47.99)	55 (41.35)	130 (74.29)	50 (52.63)	184 (54.60)	15 (32.61)	254 (75.10)	30 (54.50)
Afghanistan	78 (19.60)	6 (4.51)	31 (17.71)	14 (14.74)	75 (22.26)	10 (21.74)	115 (34.00)	8 (14.50)
Kuwait	76 (19.10)	25 (18.80)	44 (25.14)	27 (28.42)	104 (30.86)	6 (13.04)	101 (29.90)	10 (18.20)
Gulf War	56 (14.07)	11 (8.27)	31 (17.71)	12 (12.63)	42 (12.46)	4 (8.70)	37 (10.9)	2 (13.4)

Note.  $m$  = male,  $f$  = female. Education is the highest education completed at the time of participation. Tours served are the number of warzone deployments. Race "Other" is collapsed due to small sample sizes and includes Native American/Alaska Native, Asian, Native Hawaiian/Pacific Islander. Branch of Service is the most recent branch of service. Branches of Service are collapsed to include respective Guard and Reserve units. Deployed indicates that a participant was deployed to a warzone. Deployment is the location of OEF/OIF/OND deployment, except for the Gulf War.

<sup>a</sup> Categories are not mutually exclusive. Significant differences ( $p < .05$ ), are indicated in bold for age, education, and tours served.

**Table 2**  
Mental health diagnoses and traumatic brain injury.

Diagnosis	No PTSD/TBI (N = 531)		p	OR	PTSD only (N = 270)		p	OR
	Male (n = 398) n (%)	Female (n = 133) n (%)			Male (n = 175) n (%)	Female (n = 95) n (%)		
PTSD lifetime	–	–			175 (100.00)	95 (100.00)		
PTSD current	–	–			<b>135 (77.14)</b>	<b>53 (55.79)</b>	<b>0.000</b>	<b>0.37</b>
MDD lifetime	<b>85 (21.36)</b>	<b>40 (30.08)</b>	<b>0.040</b>	<b>1.58</b>	108 (61.71)	61 (64.21)	0.686	
MDD current	<b>21 (5.28)</b>	<b>18 (13.53)</b>	<b>0.002</b>	<b>2.81</b>	60 (34.28)	34 (35.79)	0.829	
AUD lifetime	<b>70 (17.59)</b>	<b>11 (8.27)</b>	<b>0.009</b>	<b>0.42</b>	<b>70 (40.00)</b>	<b>25 (26.32)</b>	<b>0.025</b>	<b>0.54</b>
AUD current <sup>a</sup>	16 (4.02)	6 (4.51)	0.803		22 (12.57)	5 (5.26)	0.057	
SUD lifetime <sup>a</sup>	<b>32 (8.04)</b>	<b>2 (1.50)</b>	<b>0.006</b>	<b>0.18</b>	17 (9.71)	9 (9.47)	0.949	
SUD current <sup>a</sup>	5 (1.26)	0 (0.00)	0.337		5 (2.85)	4 (4.21)	0.572	
TBI	–	–			–	–		
Mild	–	–			–	–		
Moderate/Severe	–	–			–	–		

  

Diagnosis	TBI only (N = 383)		p	OR	PTSD/TBI (N = 393)		p	OR
	Male (n = 337) n (%)	Female (n = 46) n (%)			Male (n = 338) n (%)	Female (n = 55) n (%)		
PTSD lifetime	–	–			383 (100.00)	55 (100.00)		
PTSD current	–	–			256 (75.74)	36 (65.45)	0.105	
MDD lifetime	<b>92 (27.30)</b>	<b>21 (45.65)</b>	<b>0.011</b>	<b>2.24</b>	228 (67.46)	41 (74.55)	0.294	
MDD current	33 (9.79)	5 (10.87)	0.818		126 (37.28)	24 (43.64)	0.368	
AUD lifetime	<b>84 (24.93)</b>	<b>3 (6.52)</b>	<b>0.005</b>	<b>0.21</b>	<b>151 (44.67)</b>	<b>10 (18.18)</b>	<b>0.000</b>	<b>0.28</b>
AUD current <sup>a</sup>	24 (7.12)	1 (2.17)	0.337		36 (10.65)	3 (5.45)	0.331	
SUD lifetime <sup>a</sup>	36 (10.68)	3 (6.52)	0.601		<b>60 (17.75)</b>	<b>1 (1.81)</b>	<b>0.001</b>	<b>0.09</b>
SUD current <sup>a</sup>	6 (1.78)	1 (2.17)	0.594		13 (3.85)	0 (0.00)	0.229	
TBI	–	–			–	–		
Mild	284 (84.27)	41 (89.13)	0.388		<b>264 (78.11)</b>	<b>34 (61.82)</b>	<b>0.009</b>	<b>0.45</b>
Moderate/Severe <sup>a</sup>	53 (15.73)	5 (10.87)	0.388		<b>74 (21.89)</b>	<b>21 (38.18)</b>	<b>0.009</b>	<b>2.20</b>

Note. Diagnoses were determined with the Structured Clinical Interview for DSM-IV. PTSD = posttraumatic stress disorder; MDD = major depressive disorder; AUD = alcohol use disorder; SUD = non-alcohol substance use disorder; TBI = traumatic brain injury. Significant differences between Male and Female groups are indicated in bold, and to adjust for multiple comparisons, false discovery rate was used to determine significance of results. Odds ratios (OR) reflect the absence/presence of a diagnosis, with males set as the reference level. OR is provided for significant results.

<sup>a</sup> Fisher's exact test *p*-values reported due to some cell sizes < 5.

**Table 3**  
Outcome descriptive measures.

Measure	No PTSD/TBI (N = 531)		p	d	PTSD only (N = 270)		p	d
	Male (n = 398) M (SD)	Female (n = 133) M (SD)			Male (n = 175) M (SD)	Female (n = 95) M (SD)		
BDI-II	7.95 (9.72)	9.12 (11.38)	0.531	–0.12	19.26 (12.29)	20.57 (14.07)	0.429	–0.10
DTS	15.06 (23.77)	16.56 (24.61)	0.511	0.06	64.36 (35.72)	55.51 (42.67)	0.071	0.23
PSQI	6.90 (4.25)	7.59 (4.32)	0.680	–0.16	11.21 (4.50)	11.52 (4.32)	0.587	–0.07
AUDIT	<b>3.76 (4.35)</b>	<b>2.39 (3.82)</b>	<b>0.001</b>	<b>0.32</b>	<b>6.45 (6.62)</b>	<b>3.81 (5.81)</b>	<b>0.001</b>	<b>0.42</b>
DAST	0.71 (2.06)	0.41 (1.26)	0.000	0.16	0.41 (3.56)	1.02 (3.02)	0.372	0.12
BPI <sup>a</sup>	2.39 (2.37)	3.07 (2.58)	0.152	–0.28	3.87 (2.64)	3.98 (2.78)	0.810	–0.04
CES	<b>6.22 (7.71)</b>	<b>2.87 (5.11)</b>	<b>0.000</b>	<b>0.47</b>	<b>15.22 (9.51)</b>	<b>7.18 (8.19)</b>	<b>0.000</b>	<b>0.89</b>

  

Measure	TBI only (N = 383)		p	d	PTSD/TBI (N = 393)		p	d
	Male (n = 337) M (SD)	Female (n = 46) M (SD)			Male (n = 338) M (SD)	Female (n = 55) M (SD)		
BDI-II	10.02 (9.99)	13.07 (10.18)	0.053	–0.31	22.51 (11.32)	23.71 (13.32)	0.531	–0.10
DTS	23.02 (28.31)	30.07 (28.17)	0.115	–0.25	71.21 (35.06)	67.35 (41.07)	0.511	0.11
PSQI	7.79 (4.43)	8.37 (4.27)	0.401	–0.13	12.72 (3.87)	12.44 (4.61)	0.680	0.07
AUDIT	<b>5.38 (5.78)</b>	<b>2.80 (2.78)</b>	<b>0.000</b>	<b>0.46</b>	<b>7.10 (7.50)</b>	<b>3.25 (4.01)</b>	<b>0.000</b>	<b>0.54</b>
DAST	<b>0.97 (2.41)</b>	<b>0.41 (1.26)</b>	<b>0.015</b>	<b>0.24</b>	<b>1.88 (3.71)</b>	<b>0.40 (1.27)</b>	<b>0.000</b>	<b>0.43</b>
BPI <sup>a</sup>	2.72 (2.27)	3.70 (2.83)	0.040	–0.42	4.42 (2.36)	3.79 (2.22)	0.152	0.27
CES	<b>9.86 (9.68)</b>	<b>4.61 (6.48)</b>	<b>0.000</b>	<b>0.56</b>	<b>19.32 (10.13)</b>	<b>11.04 (10.89)</b>	<b>0.000</b>	<b>0.81</b>

Note. Outcomes measures included the Beck Depression Inventory (BDI-II); Davidson Trauma Scale (DTS); Pittsburgh Sleep Quality Index (PSQI); Alcohol Use Disorders Identification Test (AUDIT); Drug Abuse Screening Test (DAST); Brief Pain Inventory (BPI), and; Combat Exposure Scale (CES).

<sup>a</sup> The BPI was administered to fewer participants (n = 909) in this sample. Independent samples *t*-tests were conducted report differences between male and female groups. *d* = Cohen's *d*. Significant differences (*p* < .05), are indicated in bold.

lifetime substance use disorder (SUD),  $\chi^2(1, N = 531) = 531, p = .006$ , (men = 8.04%; women = 1.50%), were more common in male than female participants. There were no sex differences for current AUD or SUD.

**PTSD only (N = 270).** All veterans in the PTSD-only subgroup had

no history of TBI and had a diagnosis of lifetime PTSD. Male participants had a higher frequency of current PTSD,  $\chi^2(1, N = 270) = 13.28, p < .001$ , (men = 77.14%; women = 55.79%), and lifetime AUD,  $\chi^2(1, N = 270) = 5.06, p = .025$ , (men = 40.00%; women = 26.32%). There were no significant differences between male and female veterans for

diagnosis of lifetime or current MDD, current AUD, or lifetime or current SUD.

**TBI only (N = 383).** All veterans in this subgroup had a history of TBI (mild and moderate/severe) and no history of PTSD. Lifetime MDD was greater in female veterans,  $\chi^2(1, N = 383) = 6.55, p = .011$ , (men = 27.30%; women = 45.65%). There were no differences between male and female veterans for current MDD. Lifetime AUD was diagnosed more frequently in male compared to female veterans,  $\chi^2(1, N = 383) = 7.81, p = .005$ , (men = 24.93%; women = 6.52%), but there were no significant differences in current AUD or current and lifetime SUD diagnosis. There were also no significant sex differences between TBI severities.

**PTSD/TBI (N = 393).** Male and female veterans with both a lifetime diagnosis of PTSD and TBI history did not significantly differ on lifetime or current MDD diagnosis or current PTSD diagnosis. Lifetime AUD,  $\chi^2(1, N = 393) = 13.73, p < .001$ , (men = 44.67%; women = 18.18%), and SUD,  $\chi^2(1, N = 393) = 9.16, p = .001$ , (men = 17.75%; women = 1.81%), were more frequently diagnosed in male veterans compared to female veterans, although there were no significant differences on current AUD or SUD diagnosis. In veterans with co-occurring PTSD and TBI, there were significant differences in TBI severity, such that men were more likely to report a mild TBI (men = 78.11%; women = 61.82%) and women were more likely to report a moderate/severe TBI,  $\chi^2(1, N = 393) = 6.85, p = .009$ , (men = 21.89%; women = 38.18%).

### 3.3. Symptom differences

Descriptive statistics for group comparisons are reported in Table 3. Independent samples *t*-tests between male and female veterans in all samples yielded significant differences between groups.

**No PTSD/TBI.** Male participants reported greater alcohol use,  $t(529) = 3.24, p = .001, d = 0.32$ , and combat exposure,  $t(343.57) = 5.71, p < .001, d = 0.47$ , compared to female veterans. There were no significant differences between male and female veterans on measures of depressive symptoms, posttraumatic stress symptoms, substance abuse problems, average pain, and sleep quality.

**PTSD only.** Male veterans reported greater alcohol use,  $t(268) = 3.26, p = .001, d = 0.42$ , and combat exposure,  $t(268) = 6.95, p < .001, d = 0.89$ , compared to female veterans. There were no significant differences between male and female veterans on measures of depressive symptoms, posttraumatic stress symptoms, substance abuse problems, average pain, and sleep quality.

**TBI only.** Male veterans reported greater alcohol use,  $t(108.7) = 4.99, p < .001, d = 0.46$ , substance abuse problems,  $t(98.05) = 2.47, p = .015, d = 0.24$ , and combat exposure,  $t(75.65) = 4.81, p < .001, d = 0.56$ , compared to female veterans. There were no significant differences between male and female veterans on measures of depressive symptoms, posttraumatic stress symptoms, sleep quality, and average pain.

**PTSD/TBI.** Male veterans reported greater alcohol use,  $t(126.45) = 5.68, p < .001, d = 0.54$ , substance abuse problems,  $t(235.14) = 5.60, p < .001, d = 0.43$ , and combat exposure,  $t(391) = 5.57, p < .001, d = 0.81$ , compared to female veterans. There were no significant differences between male and female veterans on measures of depressive symptoms, posttraumatic stress symptoms, sleep quality, and average pain.

## 4. Discussion

The present analyses evaluated sex differences in psychiatric diagnoses, TBI, and symptom severity in OEF/OIF/OND veterans. Research with civilian samples has demonstrated higher prevalence of PTSD in women than men, even though civilian men have more exposure to traumatic events. However, in the military population, men are more likely than women to be diagnosed with PTSD (Maguen et al., 2010).

Our large sample of veterans found no significant sex differences for current or lifetime PTSD diagnoses. This is consistent with other recent research (Street et al., 2013), and as previously mentioned, this may reflect growing changes in the experiences of female veterans/service members, such that female veterans may be more exposed to traumatizing events or that PTSD may now be better understood in the female veteran.

There are a number of additional potential explanations for differences in PTSD diagnostic prevalence between civilian and military female veterans. Female veterans may present with PTSD symptoms differently than women diagnosed with PTSD in the civilian population. Furthermore, clinicians in the Departments of Defense and Veteran Affairs work in a different environment and with a population that has different experiences than US civilians. Clinicians across different contexts (i.e., military, veteran, civilian) have different training and experiences, which could also lead to differences in PTSD diagnoses. In addition, a lack of sex differences in PTSD diagnostic rates may also suggest important characterological or experiential differences between female veterans and female civilians, such that findings may not generalize across populations. It is unclear if these differences between female civilian and military samples reflect differences in the type of trauma exposure or underlying differences in women themselves. That is, women who enlist in the military may have traits that reduce the likelihood for a PTSD diagnosis compared to civilian women. As female combat roles evolve, researchers will have additional opportunities to learn about sex differences and how this might guide treatment.

The most robust and consistent findings of sex differences in this sample were on alcohol, non-alcohol substance use problems, and combat exposure. Regardless of PTSD or TBI status, male veterans were more likely to have met criteria for a lifetime AUD and to endorse greater current alcohol and substance use problems. These findings are consistent with existing literature (Iverson et al., 2011). Approximately 8% of women with no TBI or PTSD history met criteria for lifetime AUD, whereas 26% with PTSD history and 18% with history of both PTSD and TBI met criteria for lifetime AUD. This is consistent with literature which has found alcohol misuse to be higher in men and women with a TBI (Grossbard et al., 2017). Although PTSD has been found to predict AUD in male veterans, research does not suggest PTSD predicts AUD in female veterans (Miles et al., 2015). This may reflect a difference in coping between men and women. Future research should evaluate sex differences in PTSD and co-occurring PTSD and TBI as potential risk factors for developing AUD. The current study was cross-sectional; therefore risk and prediction of diagnoses could not be evaluated.

Female veterans with no history of PTSD were more likely to meet criteria for lifetime MDD, regardless of TBI history. This is consistent with previous literature demonstrating higher levels of depression in women (Iverson et al., 2011). When lifetime PTSD was present, men were just as likely as women to have met lifetime criteria for MDD (62–67% compared with 64–75% of women). This may reflect generally high comorbidity rates between PTSD and MDD, or the overlap in symptoms (e.g., problems with concentration, low positive emotions, and anhedonia). Only women with no PTSD or TBI were more likely to have a current diagnosis of MDD. There were no differences in report of current depressive symptoms in this group. This may reflect that the BDI-II is a relatively nonspecific measure that may be assessing a construct of general distress rather than depression-specific symptoms (Arbisi et al., 2012; Miskey and Shura, 2017). Consistent with this interpretation, BDI-II scores for groups including PTSD diagnosis were descriptively higher. Regardless, our results highlight the importance of assessing MDD in veterans with PTSD.

Limitations of this study included evaluating TBI based on occurrence and severity as opposed to the brain injuring event (e.g., blast, interpersonal violence, vehicle accident, fall, etc.). Additionally, the cross-sectional design limited our ability to draw conclusions about the relationships among diagnoses and conditions. Future studies would

benefit from a civilian comparison group and evaluating the how the brain injuring event may yield differences.

#### 4.1. Implications for practice and/or policy

Symptom expression and the sequelae of conditions influence treatment goals and methods. The results of this study imply sex differences in PTSD and TBI may influence treatment. We did not find differences in PTSD diagnoses between male and female veterans in the overall sample. However, in a subsample of veterans with lifetime PTSD, male veterans were more likely to meet criteria for current PTSD than female veterans, which suggests that female veterans may experience a greater reduction in PTSD symptoms over time. This may be due to greater combat experiences in male veterans in this sample, as this could potentially lead to greater chronicity of PTSD symptoms. Although not measured in this study, other studies have found that the number of traumatic events predict current PTSD (Wilker et al., 2015). Future longitudinal research should explore how both number of traumatic events and general combat experience may predict PTSD diagnostic prognosis between sexes. Of note, when both TBI and PTSD were evaluated, the differences in PTSD disappeared between sexes. Potential prognostic differences between men and women with PTSD may inform session length for effective outcomes. However, differences may be due to variance in experiences (i.e., combat experience and number of traumatic events) rather than true sex differences, which is also an important consideration for PTSD treatment. As more women experience combat, there may be a greater need for PTSD treatment that targets women with combat trauma.

Findings also implicated sex differences in target areas for PTSD treatment, such as substance/alcohol use and depressive symptoms. Across all subsamples, male veterans were more likely to endorse alcohol use problems, and in subsamples without PTSD, female veterans were more likely to meet criteria for MDD. This may suggest differences in coping between men and women. Previous research has suggested that men are more likely to externalize dysfunction and distress and women are more likely to internalize dysfunction and distress (Gaudiano et al., 2014; Newman et al., 1999). However, after adjusting for PTSD and TBI, there were no sex differences in current MDD and no samples yielded differences in symptom report on the BDI-II, though differences in alcohol use remained. This may be due to an under-diagnoses of MDD or an overlap in symptoms between PTSD and MDD. Qualitatively, BDI-II symptom report was higher in the samples with PTSD and implies that, clinically, depressive symptoms should be addressed when treating PTSD for both male and female veterans. In support of this, men and women in the PTSD/TBI subgroup both had relatively high rates of MDD diagnoses (men = 67%; women = 74%).

In addition to symptom expression and mental health diagnoses, differences in TBI may affect treatment. Across the subsamples, men were more likely than women to have had a TBI and to endorse greater combat exposure. In veterans with no history of co-occurring PTSD, there were no sex differences in TBI severity. However, among veterans with both PTSD and TBI, men were more likely to meet criteria for a mild TBI whereas women were more likely to meet criteria for a moderate to severe TBI. It is unclear why women were found to be associated with higher TBI severity; however, the sample of veterans with moderate/severe TBI was small. Therefore, this finding warrants further exploration before conclusions can be drawn.

Overall, improving awareness about how potential sex differences may influence clinical care is a critical area of research. Even if studies find a lack of significant findings, this is important to note as we continue to develop effective treatment. Additionally, as clinicians we cannot assume that what is true and effective for women in one population or setting is true and effective for women in another. Future research should aim to evaluate the health care behavior of female veterans more closely.

#### 4.2. Conclusions

Significant sex differences were found for AUD, MDD, current PTSD, and TBI severity. Regardless of PTSD or TBI status, male veterans were more likely to have met criteria for a lifetime AUD and to endorse greater current alcohol and substance use problems. Additionally, only women with no PTSD/TBI were more likely to have a current diagnosis of MDD (current depressive episode); however, MDD was diagnosed in more than 50% of men and women with PTSD, which implies that depressive symptoms are important to consider for both men and women with PTSD. Contrary to general population statistics, female veterans were not more likely to have current PTSD or lifetime PTSD diagnoses. However, female veterans were more likely to have a moderate/severe TBI which may indicate differences in experiences.

#### Declarations of interest

None.

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