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BRIEF REPORT

Traumatic Brain Injury, PTSD, and Current Suicidal Ideation Among Iraq and Afghanistan U.S. Veterans

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Suicide is a prevalent problem among veterans deployed to Iraq and Afghanistan. Traumatic brain injury (TBI) and psychiatric conditions, such as posttraumatic stress disorder (PTSD), are potentially important risk factors for suicide in this population, but the literature is limited by a dearth of research on female veterans and imprecise assessment of TBI and suicidal behavior. This study examined 824 male and 825 female U.S. veterans who were enrolled in the baseline assessment of the Veterans After-Discharge Longitudinal Registry (Project VALOR), an observational registry of veterans with and without PTSD who deployed in support of the wars in Iraq and Afghanistan and were enrolled in the Veterans Affairs healthcare system. Results indicated that current depressive symptoms, PTSD, and history of prior TBI were all significantly associated with current suicidal ideation (Cohen's $d = 0.91$, Cramers' $Vs = .19$ and .08, respectively). After adding a number of variables to the model, including psychiatric comorbidity, TBI history was associated with increased risk of current suicidal ideation among male veterans only (RR = 1.55). TBI is an important variable to consider in future research on suicide among veterans of the wars in Iraq and Afghanistan, particularly among male veterans.

Suicide occurs at an alarming rate among Operation Enduring Freedom (OEF), Operation Iraqi Freedom (OIF), and Operation New Dawn (OND) veterans (LeardMann et al., 2013). Suicidal ideation is a primary target of the Department of Veterans Affairs' (VA) suicide screening efforts. A better understanding of factors associated with suicidal ideation among OEF/OIF/OND veterans accessing VA services is critically important to informing suicide prevention.

Posttraumatic stress disorder (PTSD), depression, and substance abuse are well-established risk factors for suicidal ideation among OEF/OIF veterans (Pietrzak et al., 2010). Traumatic brain injury (TBI), a "signature injury" of OEF/OIF, may confer further risk. Although small studies suggest that the association between TBI and suicidal behavior is explained by comorbid PTSD (Barnes, Walter, & Chard, 2012), a large study of veterans found that TBI predicted suicide, even after adjusting for psychiatric comorbidity (Brenner, Ignacio, & Blow, 2011).

Importantly, there is comparatively little research on suicidal behavior among women veterans, a growing yet understudied group. Female veterans are a vulnerable population who are at increased suicide risk relative to female civilians (McCarthy et al., 2009). The association between TBI and suicidal ideation may be particularly important among female veterans, as women who serve in the military are at increased risk of TBI relative to female civilians (Tanielian & Jaycox, 2008).

This study examined associations between current suicidal ideation and self-reported TBI history, lifetime PTSD, and other deployment-related factors in a large sample of male and female OEF/OIF/OND veterans accessing VA mental health care. We hypothesized that suicidal ideation would be associated with TBI history, psychiatric conditions, combat and

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postbattle experiences, and lower levels of postdeployment social support. We further hypothesized that TBI history would be related to suicidal ideation even after adjusting for psychiatric comorbidity. Finally, we predicted that similar risk and protective factors would be observed for female and male veterans.

Method

Participants and Procedure

Participants were United States Army or Marine veterans enrolled in the baseline assessment of the Veterans After-Discharge Longitudinal Registry (Project VALOR), a registry of VA mental health care users with and without PTSD who deployed in service of OEF/OIF/OND (Rosen et al., 2012). Veterans with probable PTSD according to medical records were oversampled at a 3:1 ratio to create the PTSD registry; women (underrepresented among veterans) were sampled at a 1:1 ratio.

Potential participants ($n = 4{,}391$) were contacted by phone; 2,712 (61.8%) consented to participate. Of consented participants, 1,649 completed questionnaires online or by mail and a telephone interview with a doctoral-level clinician (1,214 with probable PTSD and 436 with no PTSD, according to administrative records), yielding a response rate of 37.6%. Responders were slightly older ($M = 38.50$ years, $SD = 9.74$) than nonresponders ($M = 35.79$ years, $SD = 9.73$; $t(4{,}389) = 8.94$, $p < .001$, Cohen's $d = 0.28$) and more likely to be Caucasian (56.0% vs. 48.9%, respectively, $\chi^2(4, N = 4391) = 40.60$, $p < .001$, Cramer's $V = .09$). There was no difference in military branch, χ^2 $(1, N = 4{,}391) = 1.73$, $p = .188$, Cramer's $V = .02$). To ensure safety, 42 participants at high suicide risk (total score > 17 on measure described below) were excluded. All procedures were approved by the VA Boston Healthcare System Institutional Review Board.

Measures

Age and sex were derived from participants' medical record. Ethnicity and race were obtained by self-report. A modified Deployment Risk and Resilience Inventory (DRRI; King, King, Vogt, Knight, & Samper, 2006) was used to assess combat intensity (16-item combat experiences scale), other warzone stressors (16-item postbattle experiences scale), and social support (15-item postdeployment social support scale).

TBI history was assessed using structured interview questions reflecting current classification standards (American Congress of Rehabilitation Medicine, Head Injury Interdisciplinary Special Interest Group, 1993). Participants were asked if they ever had a head injury or blast exposure that led to altered consciousness, memory loss, seizures, or brain surgery. If so, up to five injuries were queried. For each injury, participants were asked when the injury occurred, whether it occurred during deployment, whether they were "dazed, confused, or seeing stars" (altered mental state) immediately afterwards, presence and duration of loss of consciousness, whether they could recall the event immediately afterwards, and how long after the injury they began remembering new things (posttraumatic amnesia). Participants were classified as having probable TBI if they reported at least one head injury with either altered mental state, loss of consciousness, or posttraumatic amnesia. For additional analyses, participants were further classified according to these TBI characteristics: (a) number, (b) loss of consciousness, (c) single or multiple, (d) occurred on or off deployment, and (e) the number of months since the most recent TBI. One hundred interviews were coded for interrater agreement ($\kappa = .97$).

PTSD diagnostic status for all participants was confirmed using the Structured Clinical Interview for DSM-IV, PTSD module (SCID; Spitzer, Williams, Gibbon, & First, 1992), a well-validated clinician administered interview. Interrater agreement among the three raters, based on a randomly selected subsample of 5% of interviews, was high ($\kappa s > .85$). Lifetime PTSD status (any current or past PTSD diagnosis) determined by SCID was used in all analyses.

The total score on the 8-item version of Prime-MD Patient Health Questionnaire (PHQ-8; Wells, Horton, LeardMann, Jacobson, & Boyko, 2013) was our measure of current depressive symptoms (Cronbach's $\alpha = .90$). The Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, Fuente, & Grant, 1993), a 10-item questionnaire (Cronbach's $\alpha = .87$), was used to classify participants with the suggested ranges of 8 to 16 for moderate and > 16 for high alcohol problems.

The Mini-International Neuropsychiatric Interview, English version 5.0 (M.I.N.I., Sheehan et al., 1998) is a brief structured diagnostic interview assessing suicidality within the past month. Participants who endorsed any of four items assessing suicidal ideation were classified as ideators.

Data Analysis

We conducted χ^2 analyses and *t* tests examining whether those with and without suicidal ideation differed on variables of interest. We then conducted multivariate Poisson regressions predicting suicidal ideation status using a hierarchical approach; the first multivariate model included demographics, the second model added combat and postbattle experiences, and the third model included all variables. To examine possible gender differences, these three multivariate models were conducted in the full sample and separately among males and females, yielding a total of nine analyses. As a sensitivity analysis, multivariate regressions were repeated excluding participants reporting moderate-to-severe TBI (defined as at least one TBI with loss of consciousness > 30 minutes or posttraumatic amnesia > 24 hours). Complete data were not available for all variables; analyses were completed on all available data.

Results

Bivariate analyses are provided in Table 1. Hispanic ethnicity, PTSD, high levels of alcohol problems, TBI history, more

Table 1
Characteristics of Veterans With and Without Current Suicidal Ideation

Variable	Combined		No suicidal ideation		Suicidal ideation		
	n or *M*	% or *SD*	*n* or *M*	% or *SD*	*n* or *M*	% or *SD*	*V* or *d*
Female	825	50.1	625	50.8	200	48.0	.03
Hispanic	211	13.0	141	11.6	70	17.2	.07**
Race							.07
White	1238	77.5	943	78.9	295	73.2	
Black	261	16.3	181	15.1	80	19.9	
Asian	15	0.9	11	0.9	4	1.0	
AI/AN	18	1.1	13	1.1	5	1.2	
NH/PI	5	0.3	2	0.2	3	0.7	
Multiracial	61	3.8	45	3.8	16	4.0	
Lifetime PTSD	1250	77.1	875	72.4	375	91.0	.19***
Alcohol problems							
Moderate	336	20.5	248	20.3	88	21.2	.03
High	168	10.3	104	8.5	64	15.4	.12***
TBI							
≥ 1 reported	896	55.8	643	53.5	253	62.6	.08**
No LOC	339	21.1	251	20.9	88	21.8	.05
LOC	557	34.7	392	32.6	165	40.8	.10**
Single	452	28.2	342	28.5	110	27.2	.04
Multiple	443	27.6	300	25.0	143	35.4	.12***
Off deployment	304	18.9	221	18.4	83	20.5	.07*
On deployment	390	24.3	288	24.0	102	25.2	.06
On/off deployment	201	12.5	133	11.1	68	16.8	.12***
Age	37.49	9.88	36.98	9.84	39.02	9.86	0.21***
Combat experiences	32.88	12.70	32.36	12.62	34.39	12.83	0.16**
PB experiences	33.08	13.03	32.65	12.99	34.32	13.09	0.13*
PD social support	49.57	11.23	50.91	11.06	45.61	10.81	0.48***
Current depression	20.40	6.40	19.08	6.16	24.34	5.38	0.91***
Months since last TBI	100.9	87.46	99.98	88.77	103.69	83.62	0.04

Note. AI/AN = American Indian/Alaska Native; NH/PI = Native Hawaiian/Pacific Islander; PTSD = posttraumatic stress disorder; TBI = traumatic brain injury; LOC = loss of consciousness; PB = postbattle; PD = deployment. Data on suicidal ideation were not available for two participants, who are excluded from this table. *N*s ranged from 1,598 to 1,647 for the combined sample, 1,195 to 1,230 for individuals with no suicidal ideation, and 403 to 417 for individuals with suicidal ideation. Cramer's *V* was used as the effect size index for continuous variables; Cohen's *d* was used for categorical variables. Chi−square tests for alcohol variables reflect comparisons to the no alcohol control group; χ^2 tests for the TBI variables reflect comparisons to the no TBI control group.
*$p < .05$. **$p < .01$. ***$p < .001$.

severe depressive symptoms, older age, greater exposure to combat and postbattle experiences, and lower levels of social support were associated with current suicidal ideation. There was no effect of gender on suicidal ideation. A history of multiple TBIs and TBI with loss of consciousness were more strongly associated with suicidal ideation than a history of a single TBI or TBI without loss of consciousness. Multivariate Poisson regression (Table 2) revealed that, after adjusting for effects of other variables, risk of suicidal ideation higher among veterans with more severe depressive symptoms and with PTSD diagnoses, and among veterans of Hispanic ethnicity. In follow-up multivariate models stratified by gender, TBI was associated with significantly increased risk among men but not women. PTSD, depressive symptoms, and Hispanic ethnicity were associated with increased risk of suicidal ideation for men and women. The sensitivity analysis indicated that TBI associations remained the same when participants with moderate-to-severe TBI ($n = 160$, 17.8% of participants with TBI) were excluded.

Discussion

History of TBI, a common experience of veterans deployed in service of OEF/OIF/OND, emerged as a noteworthy correlate of current suicidal ideation. Specific TBI characteristics, loss of consciousness and multiple injuries, were associated with greater suicidal ideation risk at the bivariate level. After

Table 2
Hierarchical Multivariate Models Accounting for Suicidal Ideation among Males, Females, and Full Sample

	Male		Female		Combined	
Variable	RR	95% CI	RR	95% CI	RR	95% CI
Model 1: Demographics						
Gender (male)	–		–		1.06	[0.97, 1.15]
Age	1.01	[1.00, 1.02]	1.02*	[1.01, 1.03]	1.01*	[1.01, 1.02]
Hispanic	1.43*	[1.02, 1.99]	1.77*	[1.32, 2.36]	1.59*	[1.27, 1.98]
Race						
Black	1.37	[0.98, 1.92]	1.26	[0.95, 1.68]	1.30*	[1.05, 1.61]
Other	1.14	[0.69, 1.88]	1.26	[0.82, 1.92]	1.19	[0.86, 1.64]
Model 2: Demographics and deployment-related stressors						
Gender (male)	–		–		1.01	[0.92, 1.11]
Age	1.01	[1.00, 1.02]	1.02*	[1.01, 1.03]	1.01*	[1.01, 1.02]
Hispanic	1.46*	[1.04, 2.06]	1.78*	[1.33, 2.39]	1.62*	[1.30, 2.03]
Race						
Black	1.30	[0.92, 1.84]	1.26	[0.94, 1.68]	1.27*	[1.02, 1.59]
Other	1.13	[0.67, 1.91]	1.21	[0.78, 1.90]	1.16	[0.82, 1.62]
Combat experiences	1.01	[1.00, 1.03]	1.00	[0.99, 1.02]	1.01	[1.00, 1.02]
Postbattle experiences	1.00	[0.99, 1.01]	1.00	[0.99, 1.01]	1.00	[0.99, 1.01]
Model 3: All variables						
Gender (male)	–		–		1.09	[0.99, 1.19]
Age	1.00	[0.99, 1.02]	1.01	[1.00, 1.03]	1.01	[1.00, 1.02]
Hispanic	1.45*	[1.05, 1.99]	1.56*	[1.14, 2.12]	1.52*	[1.22, 1.89]
Race						
Black	1.18	[0.84, 1.64]	1.05	[0.79, 1.40]	1.08	[0.87, 1.34]
Other	0.94	[0.58, 1.50]	1.13	[0.72, 1.78]	1.01	[0.73, 1.41]
Combat experiences	1.00	[0.99, 1.01]	0.98	[0.97, 1.00]	0.99	[0.99, 1.00]
Postbattle experiences	0.99	[0.98, 1.00]	0.98	[0.99, 1.01]	0.99	[0.98, 1.00]
Postdeployment support	0.99	[0.98, 1.00]	0.99	[0.98, 1.00]	0.99	[0.98, 1.00]
Depressive symptoms	1.10*	[1.07, 1.12]	1.09*	[1.06, 1.11]	1.09*	[1.07, 1.11]
PTSD	2.16*	[1.29, 3.61]	1.85*	[1.16, 2.94]	2.00*	[1.41, 2.83]
Alcohol problems						
Moderate	1.04	[0.79, 1.37]	1.01	[0.72,1.42]	1.02	[0.83, 1.26]
High	1.28	[0.95, 1.71]	1.19	[0.80, 1.77]	1.17	[0.98, 1.40]
TBI	1.55*	[1.16, 2.09]	0.95	[0.74, 1.22]	1.17	[0.98, 1.40]

Note. RR = relative risk; CI = confidence interval; PTSD = posttraumatic stress disorder; TBI = traumatic brain injury. Models 1, 2, and 3 were each run three times: among males only, among females only, and in the combined sample. Confidence intervals not including one indicate statistical significance at $\alpha = .05$. Age, combat experiences, postbattle experiences, postdeployment social support, and depressive symptoms were entered into the models as continuous variables. Prevalence ratios for alcohol variables reflect risk in reference to a no-alcohol control group; ratios for race reflect risk in reference to a White control group.

adjusting for covariates, TBI was significantly associated with current suicidal ideation among male, but not female veterans. Our results do not explain why suicidal ideation is higher among veterans reporting prior TBI or whether the association is due to neural causes. One possibility is that TBI leads to cognitive deficits that impair cognitive control and mood regulation, although there is little evidence of long-lasting cognitive deficits in mild TBI (Vasterling et al., 2006). Nonetheless, these results indicate that TBI assessment may be important to include in future suicide screening research, particularly in male veterans.

Consistent with prior research, depression, lifetime PTSD, high levels of alcohol problems, and low levels of social support were associated with current suicidal ideation at the bivariate level. After adjusting for covariates, depression and PTSD remained significantly associated with suicidal ideation. Key deployment-related factors (combat and postbattle experiences) were weakly related to suicidal ideation, and were not significant after adjusting for demographics. These findings suggest that assessment of combat exposure is less valuable than assessment of psychiatric conditions in determining suicide risk (LeardMann et al., 2013).

Unfortunately, due to the observational and retrospective nature of our study, we cannot determine causal relationships. The generalizability of our findings is potentially limited by aspects of our sample, which was self-selected, restricted to deployed OEF/OIF/OND veterans seeking mental healthcare within VA, and excluded participants at highest suicide risk in the interest of safety. Finally, we did not verify TBI independently with eye witnesses or medical records, a limitation common in deployed samples. Strengths include the large sample of both female and male veterans and the use of structured interviews for assessment of TBI, PTSD, and suicidal ideation.

Therefore, psychiatric disorders are important markers of suicidal ideation among both male and female OEF/OIF/OND veterans accessing VA mental health care. Among male veterans in this cohort, self-reported TBI is also an important suicidal ideation marker. Our results offer initial support for including TBI history, in addition to psychiatric history, in suicide risk assessment, especially for male veterans.

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