

# Preinjury Psychiatric Status, Injury Severity, and Postdeployment Posttraumatic Stress Disorder

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**Context:** Physical injury has been associated with the development of posttraumatic stress disorder (PTSD). Previous studies have retrospectively examined the relationship of preinjury psychiatric status and postinjury PTSD with conflicting results, but no prospective studies regarding this subject have been conducted, to our knowledge.

**Objective:** To prospectively assess the relationship of predeployment psychiatric status and injury severity with postdeployment PTSD.

**Design:** Prospective, longitudinal study.

**Setting:** United States military personnel deployed in support of the conflicts in Iraq and Afghanistan.

**Participants:** United States service member participants in the Millennium Cohort Study who completed a baseline questionnaire (from July 1, 2001, through June 30, 2003) and at least 1 follow-up questionnaire (from June 1, 2004, through February 14, 2006, and from May 15, 2007, through December 31, 2008) and who were deployed in the intervening period. Self-reported health information was used to prospectively examine the relationship between baseline psychiatric status and follow-up PTSD in injured and uninjured deployed individuals.

**Main Outcome Measures:** A positive screening result using the PTSD Checklist–Civilian Version.

**Results:** Of 22 630 eligible participants, 1840 (8.1%) screened positive for PTSD at follow-up, and 183 (0.8%) sustained a deployment-related physical injury that was documented in the Joint Theater Trauma Registry or the Navy–Marine Corps Combat Trauma Registry Expeditionary Medical Encounter Database. The odds of screening positive for PTSD symptoms were 2.52 (95% confidence interval, 2.01–3.16) times greater in those with 1 or more defined baseline mental health disorder and 16.1% (odds ratio, 1.16; 95% confidence interval, 1.01–1.34) greater for every 3-unit increase in the Injury Severity Score. Irrespective of injury severity, self-reported preinjury psychiatric status was significantly associated with PTSD at follow-up.

**Conclusions:** Baseline psychiatric status and deployment-related physical injuries were associated with screening positive for postdeployment PTSD. More vulnerable members of the deployed population might be identified and benefit from interventions targeted to prevent or to ensure early identification and treatment of postdeployment PTSD.

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**C**ONTROVERSY SURROUNDS some of the risk factors associated with posttraumatic stress disorder (PTSD) after physical trauma. The relationship between preinjury psychiatric status and postinjury PTSD is not well understood because studies<sup>1,2</sup> have used retrospective methods, which have limited ability to accurately ascertain preinjury psychiatric status. Although some of these studies<sup>3–11</sup> have found that postinjury PTSD is greater among those with preinjury psychiatric disorders, others<sup>1,2,12</sup> have suggested that the physical injury itself and peritraumatic factors are of greater importance than preinjury characteristics. Fur-

thermore, some authors<sup>13–15</sup> have reported that the severity of injury as measured by objective scoring methods is associated with PTSD, but others<sup>9,16,17</sup> have found no such relationship. In addition, the *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition)<sup>18</sup> allows specification of a delayed-onset PTSD with symptoms appearing at least 6 months after the traumatic event. However, some authors<sup>19,20</sup> have found that delayed-onset PTSD is rare. Finally, estimates of sex differences in the prevalence of PTSD in military populations varies widely, likely due to confounding variables such as combat experiences, preinjury psychiatric morbidity, and sexual harassment.<sup>21</sup>

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Using data from the Millennium Cohort,<sup>22</sup> the Joint Theater Trauma Registry (JTTR),<sup>23</sup> and the Navy–Marine Corps Combat Trauma Registry Expeditionary Medical Encounter Database (CTR EMED),<sup>24</sup> the primary objective of our study was to prospectively assess the relationship of self-reported preinjury psychiatric status and injury severity with PTSD among those deployed in support of the conflicts in Iraq and Afghanistan. A secondary aim was to prospectively identify and briefly comment on other demographic, military, and deployment-related characteristics associated with postdeployment PTSD to address some of the other aforementioned controversies.

## METHODS

### STUDY POPULATION AND DATA SOURCES

The Millennium Cohort Study was launched in 2001 to prospectively evaluate the long-term health of US military service members and experiences related to military service that may be associated with adverse health outcomes.<sup>22,25</sup> The first panel of invited participants was randomly selected from US military personnel serving in 2000. Those who had been previously deployed to Bosnia, Southwest Asia, or Kosovo between January 1, 1998, and December 31, 2000; US Reserve and National Guard members; and women were oversampled to ensure sufficient power to detect differences in smaller subgroups of the population. Baseline data collection (wave 1) from the first panel (panel 1) began July 1, 2001, before the start of the conflicts in Iraq and Afghanistan and extended through June 30, 2003. For panel 1, data for the first follow-up questionnaire (wave 2) was collected from June 1, 2004, through February 14, 2006, and for the second follow-up questionnaire (wave 3) from May 15, 2007, through December 31, 2008.

Of the 77 047 service members who enrolled in panel 1, 63 372 (82.3%) completed the baseline questionnaire and submitted at least 1 follow-up questionnaire. Of these, 37 791 were excluded because they were not deployed between baseline and the time of a follow-up questionnaire and 2423 were excluded because they were deployed before baseline. An additional 528 were excluded because they were missing specific follow-up outcome or baseline exposure data. The remaining 22 630 participants comprised the study population.

The JTTR, established in 2002, is a registry maintained by the US Army Institute of Surgical Research that contains detailed medical information regarding military personnel injured during deployment to Iraq and Afghanistan.<sup>23,26,27</sup> The CTR EMED is a Naval Health Research Center triservice research capability that uses the Military Health System to electronically assemble a longitudinal clinical history of US service members injured or sick during deployment, beginning with the tactical and clinical events at the point of injury or illness and continuing through the ultimate patient rehabilitative outcome.<sup>24,28</sup> Among the many variables collected in these 2 databases are measurements of injury severity.

### HEALTH METRICS

All participants in the study completed the baseline questionnaire (wave 1), 77.2% submitted wave 2 and wave 3 follow-up questionnaires, and 22.8% submitted only 1 of the follow-up questionnaires. All baseline measurements were assessed using data from the wave 1 questionnaire, and the repeated-measures characteristics were assessed using data from wave 2 and/or wave 3

follow-up questionnaires. Repeatedly measured characteristics were assigned a missing value at wave 2 or wave 3 if responses to that questionnaire had not been submitted.

### OUTCOME VARIABLE

The binary outcome, postdeployment PTSD, was defined at the 2 follow-ups by self-reported symptoms using the PTSD Checklist–Civilian Version, a validated, 17-item, self-report measure of PTSD symptoms that is included as part of the Millennium Cohort questionnaire.<sup>29,30</sup> Participants were identified as meeting the *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition) criteria for PTSD symptoms if they reported a moderate or higher level of at least 1 intrusion symptom, 3 avoidance symptoms, and 2 hyperarousal symptoms.<sup>18,31</sup>

### EXPOSURE VARIABLES

The exposure variable of primary interest, baseline psychiatric status, was defined at baseline using screening instruments for the following mental health disorders: depression, panic syndrome, and other anxiety syndrome. The study population was classified into 2 groups: those without and those with 1 or more psychiatric disorders. Depression, panic syndrome, and other anxiety syndrome were assessed using the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire (PHQ), which is included as part of the Millennium Cohort questionnaires. The PHQ is a validated, self-administered health questionnaire that assesses mental disorders.<sup>32–34</sup> The PHQ has demonstrated high internal consistency in this cohort as measured by the Cronbach  $\alpha$  for depressive disorder ( $\alpha = .89$ ), panic syndrome ( $\alpha = .76$ ), and other anxiety syndrome ( $\alpha = .75$ ).<sup>35</sup> Depression was assessed using the 9 standard questions from the PHQ.<sup>32,36,37</sup> Participants were defined as having depression if they responded “more than half the days” or “nearly every day” to at least 5 of the 9 depressive symptoms and 1 of the 5 items endorsed was depressed mood or anhedonia. Panic and other anxiety syndrome were assessed using the 22 items on the PHQ that measure anxiety and panic symptoms.<sup>32–34</sup> Participants were identified as having panic syndrome if they responded affirmatively to experiencing certain psychosocial conditions, including suddenly feeling fear or panic, having the feeling of fear or panic more than once, having anxiety attacks out of the blue, being bothered or worried about having another anxiety attack, and having 4 or more symptoms of an anxiety attack (shortness of breath, racing or pounding heart, chest pain or pressure, sweating, choking, hot flashes or chills, upset stomach, dizziness or feeling faint, tingling or numbness in parts of the body, trembling or shaking, and fear of dying). Other anxiety syndrome comprises a broad array of anxiety disorders, excluding anxiety related to having a panic attack (panic disorder) but including anxiety related to being publicly embarrassed (social phobia), being contaminated (obsessive-compulsive disorder), being away from home or close relatives (separation anxiety disorder), gaining weight (anorexia nervosa), having multiple physical symptoms (somatization disorder), or having a serious illness (hypochondriasis), and the anxiety and worry do not occur exclusively in relation to PTSD. On the basis of responses to questions related to depression, panic, and other anxiety, individuals were classified as having none of these defined psychiatric disorders or 1 or more of them.

Injury severity was ascertained as a repeated-measures variable between wave 1 and wave 2 and between wave 2 and wave 3 from the JTTR and CTR EMED using the assigned Injury Severity Score (ISS), one of the most widely used anatomical measures of overall injury severity.<sup>38,39</sup> It is a quantitative variable consisting of integers with a range of 1 to 75 and has been found

to correlate in the civilian population with mortality and other measures of injury severity.<sup>39</sup> The ISS was used as a continuous variable.

Combat-related exposure (yes/no) was also assessed at both follow-up periods. Participants who, during the past 3 years, self-reported personally witnessing at least 1 of the following were classified as deployed with combat exposure: death (due to war, disaster, or a tragic event), physical abuse (torture, beating, or rape), dead and/or decomposing bodies, maimed soldiers or civilians, or prisoners of war or refugees. Participants who did not report any of these experiences were classified as deployed without combat exposure.

Other repeated-measures characteristics consisted of separation status (yes/no), which indicated whether a participant had been separated from military service at the time of the follow-up questionnaire. Cumulative prior deployment at follow-up was categorized as 0 through 182 days, 183 through 365 days, or more than 365 days. Elapsed theater of war-to-survey time represented the period from the most recent date out of theater to the date of the next follow-up questionnaire and was categorized as more than 365 days, 183 through 365 days, or surveyed while deployed to 182 days.

To adjust for predeployment PTSD, PTSD symptoms were assessed at baseline using the PTSD Checklist–Civilian Version and were based on the same criteria that were used to determine postdeployment PTSD. In addition, other baseline psychiatric factors were described as follows. Psychotropic drug use (yes/no) was based on self-report of current use of medication for anxiety, depression, or stress. Psychiatric history (yes/no) was based on self-report of ever having been told by a health care professional of having any of the following conditions: depression, schizophrenia or psychosis, manic-depressive disorder, or PTSD. The life stressors item was based on the points and scoring system of the Holmes and Rahe Social Readjustment Rating Scale, in which each type of stressful event is assigned a certain number of points.<sup>40-42</sup> On the Millennium Cohort baseline questionnaire, participants were asked whether they had ever experienced the following life events: divorce or separation, major financial problems such as bankruptcy, forced sexual relations or sexual assault, sexual harassment, violent assault, severe illness or the death of a family member or loved one, or a disabling illness or injury. On the basis of the summation of scores of the above life events (using the Holmes and Rahe Social Readjustment Rating Scale), life stress was classified into 3 categories: low or mild (<200 points), moderate (200-299 points), and major ( $\geq 300$  points).

Other baseline covariates included demographic and military-specific data obtained from electronic personnel files and consisted of sex (male or female), birth year (pre-1960, 1960-1969, 1970-1979, or 1980 and after), educational level (high school diploma-equivalent, Equivalency Diploma, or less; college or bachelor's degree; or higher than bachelor's degree), marital status (not married or married), race/ethnicity (white non-Hispanic, black non-Hispanic, or other), military rank (enlisted or officer), service component (US Reserve or National Guard or active duty), branch of service (US Army, US Marine Corps, US Navy or US Coast Guard, or US Air Force), and military occupation (combat specialist, health care, service supply or functional support, or other). This research was conducted in compliance with all applicable federal regulations governing the protection of human subjects in research (protocol NHRC.2000.007).

## STATISTICAL ANALYSIS

Descriptive statistics were generated to compare all baseline and repeated-measures characteristics by baseline psychiatric sta-

tus. Univariate assessment of the relationship of each of the baseline characteristics with baseline psychiatric status was performed with a  $\chi^2$  test. Because of the repeated nature of the measurements, we chose not to perform  $\chi^2$  testing on the relationship of repeated-measures variables with baseline psychiatric status. Generalized linear model and generalized estimating equations methods were used to fit a repeated-measures logistic model for binary data.<sup>43,44</sup> Using these methods, univariate analyses were performed to assess unadjusted associations between all characteristics and postdeployment PTSD. Multivariable analysis was conducted to assess the relationship of baseline psychiatric status and ISS with postdeployment PTSD, adjusting for all other covariates in the model. Because it is plausible that the severity of injury modifies the relationship between baseline psychiatric status and PTSD symptoms at follow-up, a first-order multiplicative interaction term of baseline status by ISS was entered into the multivariable model. The interaction was nonsignificant ( $P=.13$ ), and the term was dropped from the model. Model diagnostics included examining covariates for multicollinearity (none found). All data analyses were conducted using SAS statistical software, version 9.2 (SAS Institute Inc, Cary, North Carolina).

## RESULTS

Of the 22 630 participants comprising the study sample, 739 (3.3%) had 1 or more defined baseline psychiatric disorders. Between the baseline and follow-up questionnaires, 183 participants (0.8%) sustained a battle or non-battle physical injury that was documented in the JTTR or CTR EMED, and 1840 (8.1%) had postdeployment PTSD symptoms. The distributions of baseline characteristics by levels of baseline psychiatric status are listed in **Table 1**. Each baseline characteristic demonstrated a significant association ( $P<.05$ ) with baseline psychiatric status. Repeated-measures characteristics by baseline psychiatric status at follow-up (waves 2 and 3), including the distribution statistics of the ISS, are listed in **Table 2**.

Univariate analysis revealed that postdeployment PTSD was significantly associated with the presence of 1 or more defined baseline psychiatric disorders, predeployment PTSD, increasing injury severity, psychiatric history at baseline, use of psychotropic drugs at baseline, higher number of life stressors at baseline, combat exposure, greater cumulative deployment time, greater elapsed time from date out of theater to questionnaire date, separation from military service, female sex, unmarried status, younger birth year, black non-Hispanic race/ethnicity, lower educational level, enlisted military rank, US Reserve or National Guard service component, US Army branch of service, and service supply or functional support (results of univariate analyses not shown).

**Table 3** gives the adjusted odds ratios (ORs) of postdeployment PTSD symptoms, including all variables used in the repeated-measures logistic regression model using the generalized estimating equations method. Screening positive for postdeployment PTSD was significantly associated with baseline PTSD (OR, 4.96; 95% confidence interval [CI], 4.00-6.03). In addition, after adjusting for baseline PTSD and all other exposure variables, the odds of postdeployment PTSD symptoms were 2.52 (95% CI, 2.01-3.16) times greater in those with 1 or more

**Table 1. Baseline Characteristics of Millennium Cohort Study Participants Deployed Between Baseline and Follow-up by Baseline Psychiatric Status**

Characteristic	Baseline Psychiatric Disorders, No. (%) <sup>a</sup>	
	None Defined (n=21 891)	≥1 Defined (n=739)
Baseline PTSD		
No	21 529 (98.3)	402 (54.4)
Yes	362 (1.7)	337 (45.6)
Sex		
Male	17 918 (81.9)	517 (70.0)
Female	3973 (18.1)	222 (30.0)
Year of birth		
Pre-1960	3361 (15.4)	84 (11.4)
1960-1969	9223 (42.1)	258 (34.9)
1970-1979	8186 (37.4)	311 (42.1)
1980 and after	1121 (5.1)	86 (11.6)
Race/ethnicity		
White non-Hispanic	15 063 (68.8)	511 (69.1)
Black non-Hispanic	2537 (11.6)	112 (15.2)
Other	4291 (19.6)	116 (15.7)
Marital status		
Not married	7595 (34.7)	336 (45.5)
Married	14 296 (65.3)	403 (54.5)
Educational level		
High school diploma/equivalent, or less	10 305 (47.1)	494 (66.8)
College or bachelor's degree	9828 (44.9)	225 (30.4)
Higher than bachelor's degree	1758 (8.0)	20 (2.7)
Military rank		
Enlisted	16 087 (73.5)	665 (90.0)
Officer	5804 (26.5)	74 (10.0)
Service component		
US Reserve or National Guard	8652 (39.5)	251 (34.0)
Active duty	13 239 (60.5)	488 (66.0)
Branch of service		
US Army	11 307 (51.7)	451 (61.0)
US Marine Corps	1177 (5.4)	33 (4.5)
US Navy or US Coast Guard	2943 (13.4)	117 (15.8)
US Air Force	6464 (29.5)	138 (18.7)
Occupational category		
Combat specialist	5367 (24.5)	147 (19.9)
Health care	1712 (7.8)	48 (6.5)
Service supply or functional support	5537 (25.3)	221 (29.9)
Other	9275 (42.4)	323 (43.7)
Life stressor score <sup>b</sup>		
Low or mild	19 332 (88.3)	522 (70.6)
Moderate	2210 (10.1)	160 (21.7)
Major	349 (1.6)	57 (7.7)
Psychiatric history <sup>c</sup>		
No	20 971 (95.8)	509 (68.9)
Yes	920 (4.2)	230 (31.1)
Use of psychotropic drugs <sup>d</sup>		
No	21 535 (98.4)	636 (86.1)
Yes	356 (1.6)	103 (13.9)

Abbreviation: PTSD, posttraumatic stress disorder.

<sup>a</sup>Baseline psychiatric disorders defined by screening positive for 1 or more of the following at baseline: major depression, panic, or other anxiety syndrome based on the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire criteria. All baseline characteristics were significantly associated with baseline psychiatric status at the .05 significance level using the  $\chi^2$  test.

<sup>b</sup>Assessed using scoring mechanisms from the Holmes and Rahe Social Readjustment Rating Scale,<sup>41</sup> which includes items such as divorce, major financial problems, sexual trauma, and disabling illness.

<sup>c</sup>Based on self-report of ever being diagnosed as having depression, schizophrenia or psychosis, manic-depressive disorder, or PTSD.

<sup>d</sup>Based on self-report of current use of such drugs for anxiety, depression, or stress.

defined baseline psychiatric disorders. Furthermore, pre-deployment characteristics suggesting baseline psychiatric difficulties, such as psychiatric history, use of psy-

**Table 2. Repeated Measurements of Follow-up Characteristics of Millennium Cohort Study Participants Deployed Between Baseline and Follow-up by Baseline Psychiatric Status<sup>a</sup>**

Characteristic	Baseline Psychiatric Disorders <sup>b</sup>	
	None Defined (n=21 891)	≥1 Defined (n=739)
ISS between wave 1 and wave 2		
Injured	74 (0.33)	1 (0.13)
Mean (SD)	5.65 (5.78)	10 (NA)
ISS between wave 2 and wave 3		
Injured	102 (0.46)	6 (0.81)
Mean (SD)	5.45 (7.88)	2.5 (2.07)
Separated from military in wave 2		
No	21 448 (98.0)	712 (96.3)
Yes	443 (2.0)	27 (3.7)
Missing	0	0
Separated from military in wave 3		
No	19 677 (89.9)	619 (83.8)
Yes	2214 (10.1)	120 (16.2)
Missing	0	0
Combat exposure in wave 2 <sup>c</sup>		
No	10 976 (50.1)	293 (39.6)
Yes	7758 (35.4)	322 (43.6)
Missing	3157 (14.4)	124 (16.8)
Combat exposure in wave 3 <sup>c</sup>		
No	11 026 (50.4)	288 (39.0)
Yes	8772 (40.1)	357 (48.3)
Missing	2093 (9.6)	94 (12.7)
Cumulative days deployed in wave 2 <sup>d</sup>		
0-182	12 794 (58.4)	387 (52.4)
183-365	4944 (22.6)	188 (25.4)
>365	1183 (5.4)	44 (6.0)
Missing	2970 (13.6)	120 (16.2)
Cumulative days deployed in wave 3 <sup>d</sup>		
0-182	7016 (32.0)	215 (29.1)
183-365	7957 (36.3)	259 (35.0)
>365	4886 (22.3)	177 (24.0)
Missing	2032 (9.3)	88 (11.9)
Date out of theater of war to wave 2 <sup>e</sup>		
>365	10 197 (46.6)	313 (42.4)
183-365	2885 (13.2)	94 (12.7)
0-182	5860 (26.8)	212 (28.7)
Missing	2949 (13.5)	120 (16.2)
Date out of theater of war to wave 3 <sup>e</sup>		
>365	13 380 (61.1)	468 (63.3)
183-365	2092 (9.6)	57 (7.7)
0-182	4387 (20.0)	126 (17.1)
Missing	2032 (9.3)	88 (11.9)

Abbreviations: ISS, Injury Severity Score; NA, not applicable.

<sup>a</sup>Values are given as number (percentage) unless otherwise indicated.

<sup>b</sup>Defined by screening positive for 1 or more of the following at baseline: major depression, panic, or other anxiety syndrome, based on the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire criteria. Missing values make up the difference of percentage column totals that do not sum to 100%. Percentages are rounded to nearest tenth of a percent.

<sup>c</sup>Included combat exposure self-report of having witnessed physical abuse, dead and/or decomposing bodies, maimed soldiers or civilians, and prisoners of war or refugees.

<sup>d</sup>Cumulative days deployed until the date of the follow-up questionnaires.

<sup>e</sup>Number of days from the most recent date out of theater of war through the date of the next follow-up questionnaire.

chotropic drugs, and stressful life events, were all significantly associated with postdeployment PTSD symptoms. In addition, the severity of physical injury as as-

**Table 3. Adjusted ORs of Postdeployment PTSD Symptoms Generated by a Repeated-Measures Logistic Regression Model Using the Generalized Estimating Equations Method: the Millennium Cohort Study**

Variable	OR (95% CI) <sup>a</sup>	P Value
Psychiatric status, No. of defined psychiatric disorders <sup>b,c</sup>		
0	1.00 [Reference]	<.001
≥1	2.52 (2.01-3.16)	
PTSD <sup>c</sup>		
No	1.00 [Reference]	<.001
Yes	4.96 (4.00-6.13)	
Injury severity <sup>d,e</sup>		
Every 3-unit increase in ISS	1.16 (1.01-1.34)	.04
Separated from military <sup>d</sup>		
No	1.00 [Reference]	<.001
Yes	2.18 (1.87-2.54)	
Combat exposure <sup>d,f</sup>		
No	1.00 [Reference]	<.001
Yes	2.64 (2.35-2.95)	
Cumulative days deployed <sup>d,g</sup>		
0-182	1.00 [Reference]	<.001
183-365	1.13 (1.00-1.28)	
>365	1.38 (1.20-1.59)	
Date out of theater of war through survey date <sup>d,h</sup>		
>365	1.00 [Reference]	<.001
183-365	0.70 (0.60-0.81)	
0-182	0.69 (0.62-0.77)	
Sex <sup>c</sup>		
Male	1.00 [Reference]	<.001
Female	1.28 (1.10-1.47)	
Year of birth <sup>c</sup>		
Pre-1960	1.00 [Reference]	.24
1960-1969	0.85 (0.72-1.01)	
1970-1979	0.89 (0.74-1.06)	
1980 and after	0.97 (0.74-1.27)	
Race/ethnicity <sup>c</sup>		
White non-Hispanic	1.00 [Reference]	<.001
Black non-Hispanic	1.20 (1.02-1.41)	
Other	1.39 (1.21-1.61)	
Marital status <sup>c</sup>		
Not married	1.00 [Reference]	.86
Married	1.01 (0.89-1.14)	
Educational level <sup>c</sup>		
High school diploma/equivalent or less	1.00 [Reference]	<.001
College or bachelor's degree	0.75 (0.64-0.88)	
Higher than bachelor's degree	0.67 (0.48-0.93)	

(continued)

sessed by the ISS was significantly associated with postdeployment PTSD symptoms. After adjusting for baseline PTSD symptoms and other covariates, the odds of postdeployment PTSD symptoms were 16.1% (OR, 1.16; 95% CI, 1.01-1.34) greater for every 3-unit increase in the ISS.

Deployment-related variables, including combat exposure, cumulative deployment time, and greater elapsed time from date out of theater to questionnaire date, as well as separation from military service, were significantly associated with postdeployment PTSD symptoms. Other characteristics associated with postdeployment PTSD symptoms included female sex, black non-Hispanic and other race/ethnicity, lower educational level, US Reserve or National Guard service component, enlisted pay grade, and US Army branch of service. Occupation was marginally associated ( $P = .05$ ) with postdeployment PTSD symptoms. A major effect was seen with health care workers in whom the odds of postdeployment PTSD symptoms were 27.9% (OR,

**Table 3. Adjusted ORs of Postdeployment PTSD Symptoms Generated by a Repeated-Measures Logistic Regression Model Using the Generalized Estimating Equations Method: the Millennium Cohort Study (continued)**

Variable	OR (95% CI) <sup>a</sup>	P Value
Military rank <sup>c</sup>		
Enlisted	1.00 [Reference]	<.001
Officer	0.59 (0.48-0.72)	
Service component <sup>c</sup>		
US Reserve or National Guard	1.00 [Reference]	<.001
Active duty	0.71 (0.63-0.80)	
Branch of service <sup>c</sup>		
US Army	1.00 [Reference]	<.001
US Marine Corps	0.56 (0.43-0.73)	
US Navy or US Coast Guard	0.76 (0.63-0.92)	
US Air Force	0.43 (0.36-0.52)	
Occupational category <sup>c</sup>		
Combat specialist	1.00 [Reference]	.05
Health care	0.72 (0.57-0.92)	
Service supply or functional support	0.98 (0.83-1.15)	
Other	0.97 (0.84-1.12)	
Life stressor score <sup>c,i</sup>		
Low or mild	1.00 [Reference]	<.001
Moderate	1.66 (1.43-1.93)	
Major	2.78 (2.14-3.62)	
Psychiatric history <sup>c,j</sup>		
No	1.00 [Reference]	<.001
Yes	1.76 (1.42-2.17)	
Use of psychotropic drugs <sup>c,k</sup>		
No	1.00 [Reference]	.02
Yes	1.47 (1.06-2.02)	

Abbreviations: CI, confidence interval; ISS, Injury Severity Score; OR, odds ratio; PTSD, posttraumatic stress disorder.

<sup>a</sup>Adjusted for all other variables in the table.

<sup>b</sup>Psychiatric disorders were defined as follows: major depression, panic, or other anxiety syndrome based on the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire criteria; PTSD symptoms were based on the PTSD Checklist–Civilian Version using the *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition) criteria.

<sup>c</sup>Assessed at baseline.

<sup>d</sup>Assessed at follow-up.

<sup>e</sup>Per Injury Severity Score assigned in the Joint Theater Trauma Registry or Navy–Marine Corps Combat Trauma Registry Expeditionary Medical Encounter Database.

<sup>f</sup>Included self-report of having witnessed death, physical abuse, dead and/or decomposing bodies, maimed soldiers or civilians, or prisoners of war or refugees.

<sup>g</sup>Cumulative days deployed until the date of the follow-up questionnaires.

<sup>h</sup>Number of days from the most recent date out of theater through the date of the next follow-up questionnaire.

<sup>i</sup>Assessed using scoring mechanisms from the Holmes and Rahe Social Readjustment Rating Scale,<sup>41</sup> which includes items such as divorce, major financial problems, sexual trauma, and disabling illness.

<sup>j</sup>Based on self-report of ever being diagnosed as having depression, schizophrenia or psychosis, manic-depressive disorder, or PTSD.

<sup>k</sup>Based on self-report of current use of such drugs for anxiety, depression, or stress.

0.72; 95% CI, 0.57-0.92) less than those of combat specialists. Characteristics showing no significant association with postdeployment PTSD symptoms were birth year and marital status.

## COMMENT

Our study provides new insights into whether preexisting characteristics, including psychiatric status, are important risk factors for the occurrence of PTSD when the precipitating event is physical injury. The literature presents conflicting results regarding this issue, likely due

to retrospective assessment of preinjury psychiatric status and differences in injury severity.<sup>1,2,4,5,8,10,11,45-49</sup> This prospective, longitudinal study is the first, to our knowledge, to directly measure preinjury psychiatric status through a survey, and it suggests that, irrespective of injury severity, preinjury psychiatric disorders and other baseline characteristics are significant risk factors for postdeployment PTSD. Other variables suggesting predeployment psychiatric distress, such as psychiatric history, use of psychotropic drugs, and the presence of life stressors, were also significantly associated with screening positive for postdeployment PTSD.

Our study also finds a marginally significant association of postdeployment PTSD symptoms with severity of injury as measured by the ISS. The significance of this association ( $P = .04$ ) is much weaker than the significance of the association with baseline psychiatric status ( $P < .001$ ). Some studies have found that the ISS is not associated with PTSD.<sup>9,16,17</sup> An explanation may be provided by research that indicates the subjective perception of threat to life at the time of injury is of importance in the genesis of PTSD.<sup>6,13,50,51</sup> Supporting this view, military personnel administered morphine shortly after injury were at less risk for PTSD, irrespective of the severity of injury.<sup>52</sup> In addition, other authors propose that comprehensive rehabilitation<sup>17</sup> and early social support<sup>2,53</sup> might protect against PTSD. These studies suggest the hypothesis that rapid relief of pain and anxiety at the time of injury combined with medical, rehabilitative, and social and emotional support beginning as soon as appropriate might reduce the risk of postinjury PTSD, irrespective of the severity of injury.

The occurrence of the onset of PTSD developing more than 6 months after experiencing the inciting traumatic event (delayed-onset PTSD) is controversial.<sup>19,20</sup> We found that postdeployment PTSD symptoms are significantly associated with greater number of months after leaving a theater of war, supporting the recommendations of other authors<sup>54</sup> who have suggested the need to identify late-onset PTSD months beyond the immediate postdeployment period. Furthermore, studies<sup>21,55-58</sup> have shown inconsistent results regarding the effect of sex on the risk of deployment-related PTSD, likely due to confounding variables, such as combat experiences, preinjury psychiatric morbidity, occupation, and sexual harassment. After adjusting for baseline psychiatric status, cumulative days deployed, combat exposure, injury status, and other model covariates, our prospective analysis found the odds of postdeployment PTSD symptoms to be 27.6% (OR, 1.28; 95% CI, 1.10-1.47;  $P < .001$ ) greater in women than men, a percentage substantially lower than the 100% to 200% frequently quoted in the civilian population.<sup>59,60</sup> In addition, our prospective analysis supports earlier cross-sectional and retrospective studies<sup>61-64</sup> suggesting that length of deployment and separation from military service are associated with PTSD.

Our study has some limitations. Although 82.3% of panel 1 members completed at least 1 follow-up questionnaire and, of the study population, 77.2% submitted both follow-up questionnaires, data showed a small, albeit significant, association of baseline psychiatric status and injury with missing follow-up questionnaires. Seventy-two percent of deployed

participants with 1 or more defined baseline psychiatric disorders submitted all 3 questionnaires, but 77.4% of deployed participants with no defined baseline psychiatric disorders submitted all 3 questionnaires. Seventy-three percent of injured participants submitted the 3 questionnaires, but 77.2% of deployed uninjured participants submitted the 3 questionnaires. Whether missing data from our study participants resulted in bias in our results is not known.

The prevalence of injury in our study is lower than the 2% to 3% reported for military personnel deployed to Iraq and Afghanistan.<sup>65</sup> We attribute this finding to the likelihood that some of our participants were misclassified as uninjured because the JTTR and the CTR EMED were not fully functional for several years after the start of the Iraq and Afghanistan conflicts. Furthermore, the few participants who sustained injury after the end of the follow-up period were classified as uninjured, and injury was classified as missing if it occurred after the first follow-up in the small number of participants who failed to submit a second follow-up questionnaire. If injury was positively associated with postdeployment PTSD among those lost to follow-up or misclassified as uninjured, the magnitude of our measure of effect was reduced toward the null. In addition, it is possible that the inability to detect an interaction of relatively small magnitude between baseline psychiatric status and the ISS is due to lack of power, resulting from a relatively small number of injured participants.

The study population consisted of a sample of responders to the Millennium Cohort questionnaire and may not be representative of the military population of all combat deployers. However, previous investigations of potential biases in the Millennium Cohort have shown a well-representative military cohort characterized by reliable reporting of information and no association between poor health before enrollment and participation in the study.<sup>22,35,66-74</sup> Self-reported data are inherently subject to recall and reporting biases, and the questions used to identify combat exposures were self-reported and not specific to deployment; therefore, participants may have experienced these exposures at times other than during their deployment. Although the PTSD Checklist–Civilian Version and the PHQ used to assess psychiatric symptoms and conditions are standardized and validated instruments,<sup>31,35</sup> they are surrogates for actual clinical diagnoses and may not accurately reflect the true clinical status, thus leading to misclassification for some participants. On the other hand, the questionnaire data may more accurately identify those with psychiatric symptoms compared with ambulatory or hospitalization data because many with symptoms may not seek treatment for fear of stigma or other barriers or from lack of awareness that they have a health condition for which effective treatments may be available.<sup>75</sup>

Despite these limitations, this study has many important strengths. It is the first, to our knowledge, to prospectively investigate baseline mental health status in individuals developing postdeployment PTSD symptoms. The ability to repeatedly measure postdeployment PTSD over time provided the opportunity for a longitudinal analysis that added additional information and statistical power to the assessment.

The combination of self-reported data from the Millennium Cohort Study with information from the JTTR and CTR EMED allowed prospective assessment of psychiatric status and injuries in a robust study population with many variables available to address possible confounding. Access to the ISS in trauma registries provided an objective and widely used measure of injury severity. In addition, inclusion of US Reserve and National Guard members in our study is a strength, for this subgroup is often excluded from postdeployment health investigations because their medical care generally occurs in the private sector. Finally, the large sample size of women, frequently absent from deployment-related health studies, permitted the prospective analysis of postdeployment PTSD symptoms by sex.

In conclusion, a screening result positive for a baseline psychiatric disorder and deployment-related physical injuries is associated with postdeployment PTSD. Our findings suggest that, irrespective of the severity of injury, baseline psychiatric status is significantly associated with postdeployment PTSD. Our findings also suggest that the Millennium Cohort or similar questionnaires completed before deployment might be useful to identify a combination of characteristics of deployed military personnel that could predict those most vulnerable or, conversely, those most resilient to postdeployment PTSD, thereby providing an opportunity for the development of predeployment interventions that may mitigate postdeployment mental health morbidity.

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### Correction

**Error in Figure Citations and Legend.** In the Original Article "Reduced Acetylcholinesterase Activity in the Fusiform Gyrus in Adults With Autism Spectrum Disorders" by Suzuki et al, published in the March 2011 issue of the *Archives* (2011;68(3):306-313), some figure citations and some parts of the legend are incorrect. Though the first figure citations (those in boldface) are correct, all subsequent ones are incorrect. Thus, Figure 1 should be Figure 2 and Figure 2 should be Figure 1 in these citations. Also, in the legend of Figure 1, lines 11 and 12, (A) and (B) should be (B) and (C), respectively. The Suzuki et al article was corrected online.