Relationship of Psychiatric Status to Gulf War Veterans' Health Problems

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Objective: A growing body of research has shown that there are important links between certain psychiatric disorders and health symptom reporting. Two disorders in particular (posttraumatic stress disorder (PTSD) and major depression) have been the most widely implicated to date, and this association has sometimes been used to explain the occurrence of ill-defined medical problems and increased somatic symptoms in certain groups, most recently Gulf War veterans. **Methods:** Structured psychiatric diagnostic interviews were used to examine the presence of major psychiatric (axis I) disorders and their relation to health symptom reporting in a well-characterized, stratified subset of Gulf War veterans and a non-Gulf-deployed veteran comparison group. **Results:** Rates of most psychiatric disorders were substantially lower than national comorbidity estimates, consistent with prior studies showing heightened physical and emotional well-being among active-duty military personnel. Rates of PTSD and major depression, however, were significantly elevated relative to the veteran comparison group. The diagnosis of PTSD showed a small but significant association with increased health symptom reports. However, nearly two-thirds of Gulf participants reporting moderate to high health symptoms had no axis I psychiatric diagnosis. **Conclusions:** Results suggest that rates of psychiatric illness were generally low with the exception of PTSD and major depression. Although PTSD was associated with higher rates of reported health problems, this disorder did not entirely account for symptoms reported by participants. Factors other than psychiatric status may play a role in Gulf War health problems. **Key words:** Gulf War veterans, health symptoms, posttraumatic stress disorder, major depressive disorder.

BSS = body-system symptom; CAPS = Clinician-Administered PTSD Scale; HSC = Health Symptom Checklist; MDD = major depressive disorder; PTSD = posttraumatic stress disorder; SCID = structured clinical interview for DSM-III-R; VA = Veterans Administration.

INTRODUCTION

There is growing evidence that psychiatric illness is a significant risk factor for medical illness (1). Research shows that there is a higher prevalence of adverse health outcomes in individuals with PTSD and MDD than in individuals without these diagnoses (2, 3). This finding is important because health impairments are often associated with diminished functional status, poorer quality of life, and decreased individual productivity. As such, individuals with PTSD or MDD might suffer excess illness burden. Recent epidemiological research has confirmed that both PTSD and MDD occur with considerable frequency in the general population (4, 5). Furthermore, alterations in behavior, as well as certain physiological and neurobiological systems in PTSD and MDD, could increase vulnerability to particular types of medical problems. If individuals with these disorders are at increased risk for health problems based on their psychiatric status (6), then studies on this topic could potentially improve diagnostic and treatment resources available for these conditions.

Studying the association of certain psychiatric conditions and health may have particular utility in situations where troubling medical problems have been reported but no explanation is available (7). Such a case exists for US veterans of the 1990–1991 Gulf War. Gulf War veterans, based on their eligibility for wartime service, can be expected to represent a cohort of psychologically and physically healthy individuals at the time of their deployment. Although the war ended more than 7 years ago, large numbers of returned soldiers continue to express problems related to adverse health effects. The most commonly reported problems include headache, joint pain, fatigue, and problems with memory and concentration (8, 9). Several national panels have concluded that, although exogenous hazards in the Gulf could have played a role, no single environmental hazard has been definitively linked to the reported health problems (10, 11). Instead, psychiatric disorders like PTSD have been proposed as an explanation for veterans' health concerns. Prior research on Vietnam War veterans provides considerable support for this hypothesis (12). Similar as-

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sociations between combat stress and reported physical effects have been observed after a number of wars, lending additional support for a psychiatric etiology (13, 14).

Although psychiatric conditions have been proposed as a major source of Gulf War illnesses, data on psychiatric rates from this war vary widely. One large population-based study of Gulf War veterans (15) found that several psychiatric illnesses (eg, PTSD) were higher in deployed Gulf War veterans than in an activated but not deployed comparison group. Still, rates of PTSD were well below national estimates (ie, 1.9% in Gulf War veterans vs. 7.8% in national samples) (5). Although this study used a large, representative sample, the investigators relied on self-report test instruments for determining estimates of PTSD and other psychiatric disorders. Hence, diagnostic-level data based on structured interviews were not available. Some other studies of psychiatric outcomes after the war have reported notable increases in disorders like PTSD (16, 17). These studies, however, have often focused on single units or small groups of veterans deployed from a particular geographic area, potentially limiting their generalizability. Still, if past associations between psychiatric status and health symptom reports are reliable, these studies could support the hypothesis that a substantial portion of Gulf War veterans' health problems stems from a psychiatric component. However, the issues described, including psychiatric assessment methodology (eg, use of self-report measures), sample composition (small cohorts or single units), and sampling strategies (inclusion of VA treatment registries), make definitive conclusions about psychiatric prevalence and health effects problematic at this point.

Building on prior research, the present study sought to address issues of psychiatric status and diagnostic comorbidity by using carefully conducted, comprehensive psychiatric evaluations in conjunction with health symptom reporting. We used multivariate statistical methods to examine the unique contribution of two relevant psychiatric conditions, PTSD and MDD, to the report of these problems. We are not aware of any study to date that has assessed the contribution of these disorders to postwar health in this way. Our study included participants from a large, community-based cohort of Gulf War veterans who represent a range of demographic and military characteristics. There were two main goals: to provide more rigorous psychiatric outcome data than previously available, particularly focusing on PTSD and MDD, and to assess the association of these diagnoses with Gulf War veterans' physical health complaints. Both goals were intended to improve the understanding of Gulf War veterans' health problems. Our primary questions were (1) What are the current rates of major psychiatric disorders, particularly PTSD and MDD, after Gulf War service; (2) What is the relationship of psychiatric disorders to the report of postwar health complaints; and (3) Are any patterns discernible within health symptoms? We anticipated that overall rates of psychiatric disorders would be low given other findings that soldiers eligible for war deployment constitute an unusually "fit "cohort (18). However, we expected that rates of PTSD and MDD would be elevated relative to a comparison group and that these two disorders in particular would be strongly linked to health problems in Gulf War veterans. Finally, we anticipated that participants with no psychiatric diagnoses would report few health symptoms.

METHODS

The present study was part of a larger project conducted at the Boston VA Medical Center between 1994 and 1996 (19). The focus of the larger project was the assessment of cognitive functioning, Gulf War exposures, combat exposure, current health problems, and psychiatric status in Gulf War veterans. The current set of analyses was designed to evaluate rates of psychiatric illness in these individuals and the relationship to self-reported physical health.

Participants

Participants were recruited from two cohorts of Gulf War veterans, one based in New England (Fort Devens, MA) and the other based in New Orleans, LA. Two cohorts were used to maximize the demographic and geographic diversity of the participants and thus enhance generalizability. The New England cohort from which participants were recruited included 2949 Army members (active duty, reserve, and National Guard) deployed to the Gulf theater through Fort Devens. The New Orleans cohort included 928 deployed troops (representing all military branches) from units based in Louisiana. Both cohorts have been described in detail elsewhere (20, 21).

We used a stratified, random sampling strategy to guarantee that both high and low physical health symptom reporters were sampled and to ensure the inclusion of comparable numbers of women and men (see Ref. 19 for an overview of the sampling procedure). Based on this sampling procedure, a sample of 547 troops (353 from Fort Devens and 194 from New Orleans) was identified. For the Fort Devens cohort, 220 persons (62%) agreed to participate in the present study, representing 84% of those who could be located and contacted. Complete data were available for 148 Fort Devens participants; 72 individuals participated in portions of the protocol but were unable to provide complete data, primarily because they lived outside New England and could not take part in person. Of the 133 nonparticipants, 88 could not be located, and 45 did not participate for other reasons (eg, deceased (n = 4), did not show at scheduled appointment times, refused, or would not commit to a testing date). Examination of data from previous study phases suggests that, compared with the 148 Fort Devens participants with complete data, the nonresponders and participants without completed data (n = 205) were more likely to be African American (11 vs. 4% of participants were African American; $\chi^2(1) = 5.9$, $p < .02$), more likely to have been deployed from active duty (16 vs. 7% of participants were deployed from active duty; $\chi^2(1) = 5.9$, $p < .02$), and less symptom-

atic for PTSD (mean Mississippi score of 67.2 vs. 71.3 for participants; $t(350) = -2.1$, $p < .04$).

For the New Orleans cohort, time and budgetary constraints forced recruitment to end prematurely. As a result, 73 persons from the New Orleans cohort (37.6%) agreed to participate in the study, and complete data were available for 58 (79%) of those who participated. Compared with the 58 participants with complete data, nonresponders and participants from New Orleans without complete data ($n = 136$) were younger (mean age was 28.1 vs. 32.7 years for participants, $t(191) = -3.5$, $p < .01$) and less likely to be married (24% were married vs. 38% of participants; $\chi^2(1) = 3.7$, $p < .05$). Thus, although the response rates were somewhat low, particularly for the New Orleans sample, there are few differences between participants with complete data and others identified for recruitment.

Finally, a unit from an air ambulance company, activated and sent to Germany during the Gulf War (December 1990–August 1991), was recruited to serve as a comparison group. The unit consisted of medics, helicopter pilots, flight crews, mechanics, communications specialists, and administrative support personnel whose intended mission was the transport of wounded US soldiers evacuated from the Gulf. Because of the low number of US casualties, however, the unit assisted with German civilian evacuation and transport missions. Forty-eight veterans (85% of those who could be located and contacted and 51% of the deployed unit) completed the diagnostic interviews and questionnaires. See Table 1 for a description of the sample's characteristics.

TABLE 1. Adjusted[a] Demographic and Health Characteristics by Group

Variable	Persian Gulf		Germany
	Fort Devens ($n = 148$)	New Orleans ($n = 56$)	($n = 48$)
Mean age, years	36.1 (1.0)A	35.6 (1.7)A	40.8 (1.3)B
Mean education, years	13.3 (0.2)A	14.2 (0.4)A	13.7 (0.2)A
Combat exposure[b]	6.7 (0.4)A	6.6 (0.8)A	NA
Gender, % female	8.3A	21.2B	12.5AB
Race, % nonwhite	4.1A	44.3B	0.0C
Military rank, %			
Enlisted	34.2A	43.9A	17.4B
Noncommissioned officer	52.8A	50.6A	56.5A
Officer	13.2A	5.5A	26.1B
Prior service, %			
Any	25.0A	31.4AB	52.2B
Vietnam	17.0A	23.1AB	41.3B
Marital status, %			
Single	26.8A	30.0A	11.1A
Married	62.4A	61.9A	73.3A
Separated, divorced, widowed	10.8A	8.1A	15.6A
Military status during Gulf War, % active duty	6.5A	21.5A	0.0B
Mean self-reported health symptoms, n	3.5 (0.3)A	3.0 (0.5)A	1.0 (0.2)B

[a] Estimates are adjusted for stratification variables (ie, gender and reported health symptoms). Values are percentages for categorical variables and means with standard errors in parentheses for measurement variables. Values in the same row that do not share uppercase letters differ at $p < .05$.
[b] Combat exposure is a weighted sum of exposures with higher numbers representing greater exposure. NA = not available.

Measures

Participants provided written informed consent and completed a test battery of measures that included two questionnaires, an environmental interview, a neuropsychological test battery, and two standardized, structured psychiatric interviews. Data reported in the current set of analyses were drawn from the questionnaires and psychiatric interview.

Demographics. A number of demographic variables were measured, including gender, age, education level, race, marital status, military rank, military status, and prior military service.

Combat exposure. Combat exposure was assessed with the Laufer Combat Scale (22), augmented with items that described distinctive Gulf War experiences (eg, being on alert for SCUD missiles or biochemical attack) (23). The scale was designed to assess a range of combat experiences, from being surrounded by the enemy to handling enemy prisoners of war. The reliability and validity of the scale has been well established (22). All 33 items were summed to create a total combat exposure score.

PTSD. CAPS (24), a structured clinical interview designed to assess clinical levels of PTSD, was administered to all participants by specially trained, advanced clinicians. The psychometric properties of the scale are well established, with both high reliability and validity (25). Interrater reliability for the PTSD diagnosis on a subset of 24 interviews (17% of the sample) was excellent ($\kappa = 1.00$).

In addition to the clinical interview, all participants completed the Mississippi scale for combat-related PTSD (26), which was modified for Desert Storm personnel (27). The Mississippi scale is a 35-item, paper-and-pencil scale designed to measure PTSD symptoms. Subjects respond to each item on a five-point, Likert-style scale. The psychometric properties of the Mississippi scale are well established, and the reliability in the current sample was quite good ($\alpha = 0.92$). Each subject was assigned a PTSD symptomatology score by summing across all 35 items.

Axis I psychiatric diagnoses. In addition to the CAPS, participants were administered the SCID, nonpatient edition (28), by one of two trained clinicians. The SCID is a structured clinical interview designed to assess both current (within the last month) and lifetime (at any time, including currently) axis I disorders. Past research shows that the SCID has acceptable joint interrater reliabilities, with κ values ranging from 0.70 to 0.94 (29). For the current study, all portions of the interview were administered except the sections on substance use disorders and PTSD, because these were screened through other methods. κ values for axis I diagnostic categories on a subset of 24 interviews (17% of the sample) were all 1.00.

Health symptoms. The 52-item expanded HSC used in this study is a synthesis of several published checklists from other studies of military populations (eg, Refs. 12 and 30). The HSC measures the frequency of 52 health symptoms (eg, headaches and difficulty breathing) over the past 30 days (19). Responses are given on a five-point scale (0 = no symptom; 1 = rarely, 1–2 times in all; 2 = some, 1–2 times per week; 3 = often, several times per week; and 4 = very often, almost every day).

With the goal of developing a comprehensive scale of health symptomatology, four clinicians sorted the 52 items into nine categories (referred to as body systems) and rated them for relevance (19). Based on this, 24 items were classified into one of nine different body systems (cardiac, dermatological, gastrointestinal, genitourinary, musculoskeletal, neurological, neuropsychological, psychological, and pulmonary). For this study, which focused on physical

health, we excluded the three symptoms that comprised the psychological system score (inability to fall asleep, frequent periods of feeling depressed, and frequent feelings of anxiety or nervousness). Reporting the symptom at least once a week (score of 2 or higher) was considered endorsement of a symptom for purposes of counting the number of symptoms. BSS scores were the sum of the ordinal symptom frequency scale (0–4) for symptoms in each body system; the three psychological symptoms were again excluded. Internal consistency reliability in the present sample was quite good (α = 0.90).

Statistical Analyses

Each sample (Fort Devens and New Orleans) was weighted to account for the sampling design and response rate across sampling strata so that the adjusted samples more accurately reflect the gender and symptom distribution of the larger cohort. Adjustments were performed using the SUDAAN statistical package (31); all analyses were adjusted for sampling design when both estimates and standard errors were computed. For the comparison of demographic, health, and rates of psychiatric diagnoses by sample (Devens, New Orleans, and Germany), pairwise comparisons of means were based on a modified t test, and pairwise comparison of percentages were based on a modified χ^2 test (both controlling for sampling design). Weighted correlation coefficients were used to test for trend across number of health symptoms. A hierarchical regression relating the number of reported health symptoms to PTSD, MDD, and any other axis I disorder (controlling for covariates) was estimated. Finally, when mean BSS scores for those with and without PTSD and/or MDD were compared, regression models were estimated, controlling for the effects of age, education, gender, and duty status.

RESULTS

Table 1 presents a number of demographic characteristics separately for the three samples. As described in Methods, numbers for the Fort Devens and New Orleans samples were adjusted to reflect their respective cohorts. For example, although our Fort Devens sample includes equal numbers of men and women, the adjusted percentage of females (8.3%) reflects the overall distribution of men and women in the larger cohort.

As shown in Table 1, there were few statistically significant differences between the adjusted demographic characteristics of the Fort Devens and New Orleans samples. The New Orleans sample included a larger number of women (21.2 vs. 8.3%; $\chi^2(1) = 8.39$, $p < .01$) and ethnic minorities (44.3 vs. 4.1%; $\chi^2(1) = 21.04$, $p. < .01$). No other differences were significant.

The Germany-deployed sample showed a number of differences compared with the two Gulf-deployed samples. The Germany-deployed sample was older, exclusively comprised of white reservists, more likely to have had prior military service, had higher military rank, and reported fewer health symptoms (for all, $p < .05$).

Table 2 lists the prevalence estimates of a number of psychiatric disorders for each of the three samples.

TABLE 2. Adjusted[a] Prevalence of Psychiatric Diagnoses by Group

Variable	Persian Gulf		Germany
	Ft. Devens (n = 148)	New Orleans (n = 56)	(n = 48)
PTSD			
Current	5.4A	7.2AB	0B
Lifetime	6.5A	8.2AB	0B
MDD			
Current	6.6A	4.5AB	0B
Lifetime	22.5A	10.2B	4.2B
Dysthymia	3.6A	4.8AB	0B
Panic disorder			
Current	0.2A	0A	0A
Lifetime	1.6A	3.9A	2.1A
Agoraphobia			
Current	0A	0A	0A
Lifetime	1.2A	0A	0A
Social phobia			
Current	0A	2.8A	0A
Lifetime	0.1A	7.1A	0A
Simple phobia			
Current	0A	2.0A	0A
Lifetime	0A	2.0A	0A
Obsessive-compulsive disorder			
Current	0A	0A	0A
Lifetime	1.3A	0A	0A
Generalized anxiety disorder			
Current	0.8A	0A	0A
Somatoform disorder			
Current	0.9A	0A	0A
Undifferentiated	0A	0A	0A

[a] Prevalences are adjusted for stratification variables (ie, gender and reported health symptoms). Current somatization, hypochondria, and adjustment disorder were not present in any of the three samples. Values are percentages. Values in the same row that do not share uppercase letters differ at $p < .05$.

Although the exact rates differ somewhat, the pattern was similar for the Fort Devens and New Orleans samples. Rates of current and lifetime PTSD differed only slightly, ranging from 5.4 to 8.2%. The difference between current and lifetime MDD was larger, with the rate of lifetime MDD 2.5 to 3 times greater than current MDD. In addition, lifetime MDD was significantly higher in the Fort Devens than New Orleans sample (22.5 vs. 10.2%, respectively; $\chi^2(1) = 5.06$, $p < .05$). Rates for remaining psychiatric disorders were generally low, with no significant differences between the two Gulf-deployed samples. The Germany-deployed group had a 4.2% rate for lifetime MDD and 2.1% for panic disorder. The Germany-deployed sample had prevalence estimates of zero for all remaining psychiatric disorders.

Table 3 shows the relationship between various

TABLE 3. Adjusted[a] Demographic Characteristics by Symptom Groups in Gulf-Deployed Groups

Variable	Number of Symptoms				Trend Test r
	None	Few	Moderate	High	
	0 (n = 45)	1–5 (n = 101)	6–9 (n = 31)	10+ (n = 19)	
Cohort, %					
New Orleans	43.7A	36.9A	42.5A	34.9A	−0.06
Mean age, years	39.4 (2.1)A	34.5 (1.0)B	34.6 (2.3)AB	39.1 (2.0)AB	0.03
Mean education, years	14.0 (0.5)A	13.8 (0.3)A	13.0 (0.5)A	13.1 (0.4)A	−0.20
Combat exposure	5.6 (0.9)A	6.7 (0.5)A	7.7 (0.9)A	7.6 (0.9)A	0.13
Gender, % female	8.4A	15.7A	13.5A	19.4A	0.03
Race, % nonwhite	10.3A	24.0A	25.2A	17.3A	0.01
Military rank, %					
Enlisted	30.5A	35.1A	50.9A	40.5A	0.08
Noncommissioned officer	58.4A	54.0A	42.6A	45.9A	
Officer	11.1A	10.9A	6.5A	13.6A	
Prior service, %					
Any	33.9A	25.7A	29.6A	10.8	0.08
Vietnam	25.2A	17.7A	22.9A	6.6	0.05
Marital status, %					
Single	22.9A	32.8A	23.1A	24.6A	0.07
Married	66.5A	59.5A	61.6A	61.5A	
Separated, divorced, widowed	10.6A	7.7A	15.4A	13.9A	
Military status during war, % active duty	12.3A	12.4A	9.9A	19.5A	0.03

[a] Estimates are adjusted for stratification variables (ie, gender and reported health symptoms). Groups defined by number of symptoms reported at time 3 of the 21 nonpsychological symptoms from the body system summaries. Values are percentages for categorical variables and means with standard errors in parentheses for measurement variables. Values in the same row that do not share uppercase letters differ at $p <$ .05. Values in the last column are correlations between the number of symptoms and the row variable. None of the correlations are significant at $p <$ .05 with the exception of that for education.

background and demographic characteristics and the number of self-reported health symptoms for the Gulf-deployed samples. Because the two Gulf-deployed samples were similar on most demographic variables and had comparable rates of psychiatric disorders, the samples were subsequently combined, and all remaining analyses are reported for the Gulf-deployed sample as a whole. Population weights, however, continued to weight individuals on the basis of their respective cohort.

All but one of the demographic variables were unrelated to reported health symptoms (Table 3). Education was significantly associated with health symptoms ($r = -0.20$, $p < .05$). Examination across the range of symptoms suggested that this relationship was essentially linear, with low symptom reporters slightly more educated than high symptom reporters.

Table 4 shows the relationship between psychiatric diagnosis and reported health complaints. In general, PTSD and MDD diagnoses were associated with the reporting of higher numbers of health symptoms. However, veterans with no current PTSD or MDD comprised 67 to 73% of those reporting health symptoms in the moderate to high range. Also, nearly 40% of those reporting symptoms in the high range had no lifetime history of these disorders.

A hierarchical multiple regression was performed to examine the association between current PTSD, MDD, and any other axis I disorder (controlling for effects of covariates) on health symptom reporting. The initial step included the covariates only and accounted for 12% of the variance in health symptom reporting. Education was the sole covariate significantly associated with health symptom reporting, with higher education associated with lower symptom rates. Next, current PTSD and MDD were added to the regression. Cohort and prior military service emerged as significant, with more symptom reporting in the New Orleans cohort and among those with no prior military service. Controlling for these covariates, the effect of PTSD on symptom reporting was significant ($b = 4.7$, $p < .05$), whereas the effect of MDD on symptom reporting was not significant ($b = 4.0$, $p = .10$). Compared with those without current PTSD, those with current PTSD reported an average of 4.7 more health symptoms, controlling for covariates in the model. In the third and final step, a variable representing any other axis I disorder was entered. The regression coef-

TABLE 4. PTSD and MDD by Symptom Groups (Adjusted[a]) in Gulf-Deployed Groups

Variable	Number of Symptoms[b]				Trend Test
	None	Few	Moderate	High	
	0 (n = 45)	1–5 (n = 101)	6–9 (n = 31)	10+ (n = 19)	r
Current, %					
PTSD	0.0A	4.1B	18.8AB	13.9AB	0.28
Depression	0.0A	4.5B	14.7AB	14.8AB	0.26
Neither	100.0A	92.2B	66.5B	72.9B	0.40
Lifetime, %					
PTSD	0.0A	5.4B	19.5AB	18.6AB	0.29
Depression	4.6A	18.1B	15.8AB	61.1C	0.34
Neither	95.4A	80.2B	64.7B	38.9C	0.40

[a] All proportions and analyses are adjusted for stratification variables. Tables values are percentages. Values in the same row that do not share uppercase letters differ at $p < .05$. Values in the last column are correlations between the number of symptoms and the row diagnosis. All correlations are significant at $p < .05$, with the exception of that for current depression, with $p = .055$.
[b] Based on 21 nonpsychological symptoms from the body system summaries.

ficient associated with this variable was not significant, and the addition of this variable did not significantly increase the R^2 value over that of the previous model. In addition, the regression coefficients associated with PTSD remained significant ($b = 4.37$, $p < .05$).

To investigate whether health symptoms were localized in any particular body system, mean BSS scores were compared between the Gulf-deployed groups with and without current PTSD and/or MDD (Table 5). The BSS scores for the Germany-deployed group were included for comparison. Overall, Gulf-deployed veterans with psychiatric diagnoses reported higher mean BSS scores compared with those without any diagnosis. In addition, Gulf-deployed veterans with no psychiatric diagnosis reported significantly higher scores for the majority of body systems (except for pulmonary, genitourinary, and musculoskeletal) than the Germany group.

DISCUSSION

Our data suggest that rates of psychiatric illnesses among Gulf War veterans are low, with the exception of PTSD, MDD, and dysthymia. Although rates of most disorders were lower than those reported by the National Comorbidity Study for the general US population (4), rates of current and lifetime PTSD and lifetime MDD in Gulf-deployed veterans were comparable to national estimates. This finding seems to be consistent with the large literature on specific psychological sequelae of wartime service (12). Furthermore, when compared with a group of veterans deployed from Germany, Gulf-deployed veterans showed higher rates of the preceding disorders. This is not to say, however, that other differences may not exist. Our ability to detect differences could be influenced by the small sample size of our Germany group. Our estimated rate for most psychiatric disorders among those participants was zero; however, the 95% exact binomial confidence interval ranged from 0 to 7%. Studies with larger samples are needed to explore the possibility of increased rates of other psychiatric disorders.

Participants with war-related PTSD or MDD described significantly more health problems than veterans without these diagnoses across nearly every health symptom category. This finding is in strong agreement with a growing literature on the relationship between stress and anxiety disorders and physical health problems (32–35). Although no definitive causal relationship has been identified, several models linking psychiatric conditions to health symptoms have been proposed whereby emotional distress induces physiological changes that increase biological or immunological susceptibility to any number of external viruses or infections (36–38). Individuals with PTSD or MDD could also report health problems for a variety of behavioral reasons, including heightened sensitivity to interoceptive cues, enhanced somatic sensation, or magnified concerns with physical well-being. Both negative mood and emotional distress, common correlates of PTSD and MDD, have been shown to affect perceptions of well-being and may lead, in some cases, to symptom amplification or somatization (39, 40).

We found that, controlling for the effects of current MDD, current PTSD was associated with higher physical health symptoms. However, the reverse finding was not supported: Current major depression failed to significantly predict higher health symptoms when PTSD was included as a predictor. Although health

TABLE 5. BSS Scores by Psychiatric Diagnosis Groups[a]

BSSs	Gulf-Deployed		Germany-Deployed (n = 48)
	Current PTSD and/or MDD (n = 20)	Neither (n = 178)	
Neurological (Headaches, numbness in arms/legs, dizziness or feeling lightheaded)	3.8A	1.8B	0.8C
Pulmonary (Difficulty breathing or shortness of breath, common cold or flu, rapid breathing)	1.8A	0.9A	0.6A
Gastrointestinal (Stomach cramps or excess gas, diarrhea or constipation, nausea and/or upset stomach)	5.4A	1.7B	0.5C
Genitourinary (Frequent urination, pain during intercourse)	0.6A	0.4A	0.3A
Musculoskeletal (Joint pains, backaches, neckaches, stiffness)	5.5A	2.6B	1.9B
Cardiac (Irregular heart beat, chest pain, racing heart)	1.1A	0.6A	0.2B
Neuropsychological (Difficulty learning new material, difficulty concentrating, confusion)	5.2A	1.6B	0.4C
Dermatological (Skin rashes, eczema, skin allergies)	1.1A	0.6A	0.1B

[a] All values are adjusted for stratification variables. Means in the same row that do not share uppercase letters differ at $p < .05$. Results remain similar after controlling for age, sex, education, and active duty status in the Gulf for all the BSS scores except the dermatological score, where the PTSD/MDD Gulf-deployed vs. Germany-deployed comparison drops to $p = .066$.

effects have been described in depressed individuals (41), our finding suggests that PTSD and depression may have distinct roles in their relationship to health. Alternatively, the effects of depression may be accounted for by the larger impact of PTSD. Given the distinctive pathophysiological characteristics of traumatic stress (ie, PTSD) and depression (42), differing mechanisms or linkages to health outcomes might well be suspected.

Although PTSD and MDD emerged as significant predictors of health symptoms, more than two-thirds of the variance in health symptoms remained unaccounted for after demographic and psychiatric factors were modeled. Consequently, our results lend support to the hypothesis that psychiatric illness is associated with some Gulf War health complaints, but the findings do not fully resolve questions about Gulf War health outcomes, specifically, why veterans who appear psychologically healthy would describe the onset of health problems. One possibility is that, although psychiatric illness is a contributor, other factors are potentially implicated. In two recent publications, several Gulf-related environmental exposures were found to be associated with increased health symptomatology after controlling for traumatic stress (19, 43). Alternatively, it is possible that the health symptom increases in our participants lack clinical significance; that is, although elevated in respect to the comparison group, the symptoms of Gulf-deployed veterans' are not distinct for this age group (44) and lack medical significance, reflecting the longer readjustment process observed in some soldiers after war (45).

In terms of Gulf War illness, one hypothesis we considered is whether deployment itself constituted a sufficiently severe stressor to produce somatic symptoms. To test potential effects of deployment to the war zone, we included a unit deployed during this era but who served elsewhere (Germany). Although the latter group was not sampled on the same basis as our larger cohort, we included this unit because of its availability and geographic accessibility and the opportunity it provided to compare effects of deployment-based stress. We found, in fact, that rates of psychiatric disorders were higher in our Gulf-deployed veterans. This finding could be attributable to the direct impact of war-zone service. Pierce (46) used a similar strategy to compare Gulf-deployed personnel and troops deployed elsewhere during the war and found significant increases in adverse health reports only for participants who served directly in the Gulf theater. Like our findings, these results suggest that it is critical to search for more links between veterans' health symptoms and their possible exposure to hazards during the war.

The present study has some limitations. Our reports of physical health problems were derived from a new scale with little validation. Also, description of these problems relied exclusively on individual reports and may be subject to the usual reporting biases of recall, subjective interpretation, and mood state (47, 48). In addition, we did not have physician diagnoses or corroborative data from medical records. The symptoms we report may lack specificity and do not offer clear answers on etiology or causation (49), and, although symptom reporting might be useful in the absence of a case definition (50), we cannot rule out the effects of undetected psychological factors on reporting. Our comparison group also poses some limitations (eg, dif-

ferences on important demographics), and future studies might include more rigorously defined control groups. Finally, our participants came from a relatively healthy community sample, and the relatively low rates of psychiatric and physical symptoms potentially limit the impact of our findings.

This study also has a number of strengths, particularly a well-characterized sample derived from a large cohort. Also, comprehensive, standardized psychiatric evaluations constitute an improvement over the majority of prior studies, providing better reliability for psychiatric status and potential sequelae (51). The use of a unique comparison unit permits some inferences about possible effects of direct service in the Gulf theater. Finally, our aggregation of health symptoms by body system may help us understand the range of seemingly nonspecific health complaints and separate some symptoms with psychiatric bases from other etiologies. In the continuing absence of a case definition for Gulf War illness, this approach may have some utility (52, 53). The current data are another step toward delineating some of the factors possibly linked with Gulf War outcomes and highlight the important, although potentially limited, role that certain psychiatric disorders play in health reporting.

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