FAST TRACK ARTICLE

Health of US Veterans of 1991 Gulf War: A Follow-Up Survey in 10 Years

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Objective: *To assess periodically the health status of a cohort of 1991 Gulf War veterans by comparing various health outcomes with those of their military peers who were not deployed to the Gulf.* ***Methods:*** *We conducted a follow-up health survey to collect health information among population-based samples of 30,000 veterans (15,000 Gulf War veterans and 15,000 Gulf Era veterans) using a structured questionnaire.* ***Results:*** *Gulf veterans reported significantly higher rates of unexplained multi-symptom illness, chronic fatigue syndrome-like illness, posttraumatic stress disorder, functional impairment, health care utilization, a majority of selected physical conditions and all mental disorders queried during the survey than did Gulf Era veteran controls.* ***Conclusions:*** *Fourteen years after deployment, 1991 Gulf War veterans continue to report a higher prevalence of many adverse health outcomes, compared with Gulf Era veterans.* (J Occup Environ Med. *2009;51: 000–000*)

In 1995, the US Department of Veterans Affairs (VA) initiated a survey entitled "National Health Survey of Gulf War Era Veterans and Their Families." The survey was designed as a retrospective cohort study in which the health indicators of a population-based sample of 15,000 troops deployed to the Persian Gulf area were compared with those of 15,000 troops not deployed to the Persian Gulf area.[1]

A number of health studies including the VA's National Health Survey and expert panel reports have identified a constellation of symptoms and medical or psychological conditions associated with Gulf War service.[1–11] Congress, veterans and their families, Departments of Veterans Affairs and Defense continue to be interested in the morbidity and mortality of Gulf War veterans. However, only a few studies have followed, longitudinally, a cohort of Gulf War veterans to evaluate the long-term health consequence of deployment.[9–11] In response to an Institute of Medicine committee recommendation,[12] we designed a health survey based on the 1995 National Health Survey cohort to evaluate the health of the 1991 US Gulf War veterans 10 years after the baseline survey in 1995.

The primary objective of the study was to assess the health status of Gulf War veterans and Gulf Era veterans by comparing them for chronic medical conditions, posttraumatic stress disorder (PTSD) and other common mental disorders, unexplained multi-symptom illness (MSI), chronic fatigue syndrome (CFS)-like illness, general health

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perceptions, functional status, and health care utilization.

Materials and Methods

Study Population

Data for this study came from a follow-up survey to the 1995 National Health Survey of Gulf War Era Veterans and Their Families.[1] The study population, sampling methodology, and participation rates of the 1995 survey have been described in detail elsewhere[1] and are summarized here. The same 30,000 Gulf War era veterans (15,000 Gulf War veterans and 15,000 Gulf Era veterans) selected for the 1995 survey served as the permanent panel. In this study, the term veteran referred to any individual who served in the US military on active duty, in the reserves, or in the National Guard, irrespective of whether they remained in or were separated from the military. Gulf War veterans were sampled from 693,826 US troops who were identified by the Department of Defense (DoD) Manpower Data Center (DMDC) in Monterey, California as being deployed to the Persian Gulf area during the 1991 Gulf War. Gulf Era veterans were sampled from 800,680 individuals, approximately one half of all troops who were in the military between September 1990 and May 1991 but did not serve in the Persian Gulf theaters of operations. The population-based samples of troops represent each branch of service (Army, Navy, Air Force, and Marine Corps), unit components (active, reserve, and National Guard) and gender. To ensure that women and those who served in reserve or National Guard units were adequately represented, a stratified random sampling method was applied to each group. Among the Gulf deployed troops, one fifth of the sample were women, one third were reservists, and approximately one quarter were members of the National Guard. The proportions of these subgroups in the entire population of deployed troops were 7%, 10%, and 7%, respectively. After similar stratification of the population of 800,680 Gulf Era troops, a requisite number of troops were randomly sampled to mirror the number in the same stratum in the Gulf-deployed troops. The study protocol was approved by the Institutional Review Boards of the Washington DC VA Medical Center and DoD.

Data Collection Methods

The vital status of each of the 30,000 permanent panel members was determined through use of VA Beneficiary Identification and Records Locator Subsystem database and records of the Social Security Administration updated through December 2002. A total of 393 panel members who were identified as being deceased were deleted from the survey, leaving 29,607 living members at the start of the data collection period. Updated addresses were obtained from the Internal Revenue Service by utilization of the Taxpayer Address Retrieval System.

In phase I, in keeping with a modified Dillman's mail survey method,[13] all 29,607 living members of the panel were mailed a pre-notification letter, followed by a 20-page scannable structured health questionnaire, which included a 4-page informed consent form and a pre-addressed stamped return envelope. Two weeks after the initial questionnaire mailing, a post card was sent to thank respondents and to remind veterans who had not yet submitted the questionnaire. Ten weeks later, the second questionnaire was mailed to nonrespondents to the first mailing, followed in 2 weeks by a second reminder post card. The third wave of mailing began in October 2004 and extended over a 10-week period.

In phase II, telephone interviews using a computer-assisted telephone interviewing software were attempted on 2000 veterans who had not responded to the first two waves of phase I postal survey. During phase II, a sample of 1000 who responded to phase I and II and who had a history of clinic visit or hospitalization within past 12 months were asked to provide written authorization to retrieve the medical records to substantiate self-reported medical conditions related to the visit or hospitalization. All data collection was completed by the end of 2005 (Fig. 1).

Questionnaire Instruments

A modified version of the 1995 survey questionnaire was used to obtain information from study veterans concerning potentially confounding factors, the presence of various symptoms, functional status, activity limitations, health perceptions, chronic medical conditions, PTSD and other mental disorders, health care utilization, and use of alcohol and cigarettes. Similar to the design of the 1995 survey, in efforts to increase anticipated low response rates typically associated with postal surveys, the questionnaire was relatively short, and the questions were simple and straightforward.

Symptoms of PTSD were assessed using the PTSD Checklist (PCL).[14] The PCL is a self-report measure developed for measuring PTSD symptom severity and for estimating PTSD caseness when administration of a structured clinical interview is not feasible. The self-administered PCL has strong correlation with other measures of PTSD and clinician-administered interviews.[14–17] Respondents rate PCL items on a 5-point scale ("not at all" through "extremely") to indicate the degree to which they have been bothered by each of 17 PTSD symptoms[18] during the past month. Possible PCL scores range from 17 to 85, and the most accurate cut point for PTSD caseness has been the subject of debate, with investigators advocating cut-points from 30[19] to 50,[14,15] based on data from studies comparing PCL scores to structured clinical interviews. Telephone administration of the PCL has been commonly performed, has acceptable reliability and validity in

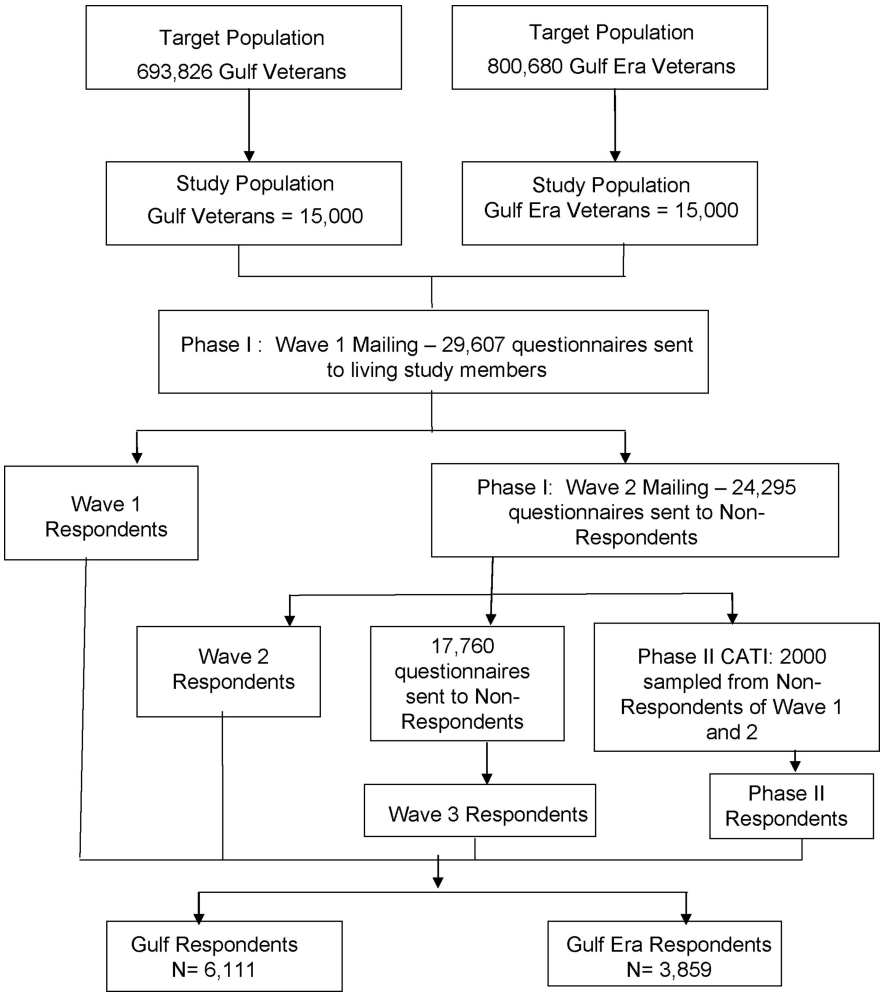

Fig. 1. Flow diagram showing participation in the 2005 follow-up of the National Health Survey of Gulf War Era Veterans and Their Families, United States. Participants were Gulf and Gulf Era US veterans of the 1991 Gulf War.

population studies[20] and is responsive to change in longitudinal studies.[21] In our study, participants with scores of 50 or higher on the PCL were considered to have met the criteria for PTSD.

The Patient Heath Questionnaire (PHQ)[22] is a brief self-report assessment of common mental disorders developed specifically for primary care. PHQ allows brief provisional primary care diagnoses of eight disorders, divided into several threshold disorders (disorders that correspond to specific DSM-IV[18] diagnoses: major depressive disorder, panic disorder, and bulimia nervosa) and subthreshold disorders (disorders for which criteria encompass fewer symptoms than are required for any specific DSM-IV diagnoses: other depressive disorder, other anxiety disorder, probable somatoform disorder, probable alcohol abuse or dependence, and binge eating disorder).[23] Other authors[22] have reported excellent correspondence of the PHQ to DSM-IV diagnostic criteria. We used the PHQ for brief assessments of depression, anxiety (panic and generalized anxiety), somatic symptoms, and probable alcohol abuse or dependence. We embedded the PHQ modules for depression, somatic symptoms, anxiety and alcohol abuse in the survey questionnaire, and applied diagnostic algorithms that are abbreviated at the bottom of each PHQ page.

Symptoms of depression were assessed using the 9-item PHQ depression scale (PHQ-9). The PHQ-9 has been evaluated as a diagnostic screen for a depressive disorder and as a measure of depression severity.[23] The PHQ-9 has been administered in studies of military personnel and veterans. Major depression is diagnosed if five or more of the nine depressive symptom criteria have been present at least "more than half the days" in the past 2 weeks, and 1 of the symptoms is anhedonia or depressed mood. Other depression is diagnosed if in the past 2 weeks, 2, 3, or 4 depressive symptoms have been present at least "more than half the days," and 1 of the symptoms is anhedonia or depressed mood.[23] One of the nine symptom criteria ("thoughts that you would be better off dead or hurting yourself in some way") confers caseness by itself.

Somatic symptoms were measured with the widely used and validated 15-item Patient Health Questionnaire (PHQ-15).[24] Symptoms were scored per established criteria[24] as 0 ("not bothered at all"), 1 ("bothered a little"), or 2 ("bothered a lot"), except for sleep disturbance and fatigue, which were scored as 0 ("not at all"), 1 ("several days"), or 2 ("more than half the days" or "nearly every day"). A total sum score of greater than or equal to 15 indicates high somatic symptom severity, based on data from primary care settings.[24]

PHQ anxiety sections include panic and generalized anxiety symptoms.[22] The anxiety symptom scales have been less well studied than the depression and somatic symptom scales, but available data support their applicability, validity and reliability in general medical and psychosomatic patients.[22,25] As with the PHQ scales for depression and somatic symptoms, the anxiety scales correspond well to symptom-based diagnostic criteria in DSM-IV. Application of coding algorithms, available in the PHQ, permits categorization of panic disorder and other anxiety disorder as case and non-case. Similarly, we applied the criteria in the PHQ to identify

veterans who have probable alcohol abuse or dependence.

The physical and mental components of a 12-item short-form health survey (SF-12)[26] were used to assess the general health and functional status of the study subjects. The SF-12 is a 12-item subset of the SF-36,[27] a well standardized and widely used instrument to assess health-related quality of life. As a brief, reliable measure of overall health status, the SF-12 is the instrument of choice in large population health surveys. Due to its brevity, it is frequently embedded in longer surveys. Responses are differentially weighted and combined to produce a "Physical Component Summary-12" score between 0 and 100 as an indicator of physical health, and a "Mental Component Summary-12" score between 0 and 100 as an indicator of mental health. The higher the score, the better the physical or mental health status. Norm based methods and T-score transformations were used to standardize the summary scores so that in the general US population the means are 50 with a standard deviation of 10.[26] As the construction of SF-12 summary scores involves 12 individual questions, scoring software was used to increase the percentage of responses scored.[28] The SF Health Outcomes™ Scoring Software uses item response theory and regression methods to improve missing data estimation.[29]

The 1994 Centers for Disease Control case definition of CFS illness[30] was modified in our study because of limited information available in the survey instrument. This modification was termed CFS-like illness. (Please refer to the Appendix 1 for a complete definition of CFS-like illness.)

Questionnaire items also included information on unexplained physical symptoms and illnesses, such as fatigue, muscle or joint pain, headaches, memory problems, respiratory problems, skin problems etc. The constellation of these symptoms defines "Unexplained Multi-symptom Illness" when they 1) persist for 6 months or longer; and 2) are not adequately explained by an established, conventional medical or mental disorder diagnosis. Appendix 2 shows the query from the survey questionnaire for presence of MSI.

Health Outcomes

In addition to PTSD, mental disorders measured by PHQ, CFS-like illness and MSI, other questionnaire items were used to evaluate functional status, activity limitations, respondent report of a provider diagnosis of one or more common chronic medical conditions, self-reported health status, and health care utilization, including physician contacts related to illness (excluding routine visits for vaccinations and physical examinations) and hospitalizations overnight.

Gulf War Deployment Status Identification

Basic demographic and military variables (Gulf War deployment status, date of birth, gender, race, marital status while deployed, branch, rank, and unit component) were retrieved from DMDC database when the panel members were selected. In both 1995 and 2005 surveys, the participants were asked to report their Gulf War deployment status and the period of their Persian Gulf service. Discrepancies were found among the DMDC records and self-reported Gulf War deployment status for the two surveys. Relevant information available from the two surveys, such as self-reported Gulf service period and exposures, was used to construct a revised deployment status for 4.1% of respondents. This revised deployment status variable was used in all subsequent statistical analyses.

Statistical Methods

Analyses measured the association between 1991 Gulf War service and the various health outcomes available in the survey instrument. Contingency table analysis was adopted to evaluate associations between 1991 Gulf War deployment and subsequent health outcomes. Unadjusted risk ratios (relative risk [RR]) were calculated directly from the raw table entries. The Mantel-Haenszel method[31] was used to compute adjusted RR with 95% confidence intervals, comparing Gulf veterans and Gulf Era veterans. RR were adjusted for age in 2005 (<46 years vs ≥ 46 years), gender, race (white vs all other), rank (enlisted vs officer or warrant), branch of service (Air Force or Navy vs Army or Marine), unit component (active vs National Guard or reserve), Body Mass Index (BMI) (underweight or normal [<25.0], overweight [25.0 to 29.9], or obese [≥ 30.0]), and current cigarette smoking, chosen because of their potential association with health outcomes. The propensity score,[32] defined as the conditional probability of being exposed given the covariates, can be used to balance the differences on the observed covariates between the two cohorts. A large set of background covariates were used to estimate the propensity score in a logistic regression model. After the estimated propensity scores were divided into quintiles, the rank was used as a stratification variable in the Mantel-Haenszel analyses. Statistical significance was ascertained by examining the coverage of 95% confidence intervals. All estimated prevalence rates presented in this manuscript are unweighted and calculated within the study samples, not for the entire Gulf War era veteran population. Missing values of covariates (primarily BMI or cigarette smoking) resulted in the loss of less than 3% (286 of 9970) of observations in formation of the propensity score. Computations were carried out with standard SAS software.[33]

Results

Survey Response Rates and Assessment of NonResponse Bias

A total of 9970 veterans (overall response rate, 34%; 6111 or 40% Gulf veterans, 3859 or 27% Gulf Era

TABLE 1
Percent Distribution of Selected Characteristics of Respondents vs NonRespondents, Stratified by Gulf Deployment Status

	Gulf (n = 15,508)[a]				Gulf Era (n = 14,494) [a]			
Characteristic	Phase I (n = 5,797)	Phase II (n = 314)	Respondents (n = 6,111)	Nonrespondents (n = 9,397)	Phase I (n = 3,679)	Phase II (n = 180)	Respondents (n = 3,859)	Nonrespondents (n = 10,635)
Sex*								
Male	79.7	84.1	79.9	81.7	78.0	82.2	78.2	79.2
Female	20.3	15.9	20.1	18.3	22.0	17.8	21.8	20.8
Age (mean age in yr in 1991)†‡	31.6	29.2	31.5	28.5	33.7	32.1	33.6	29.2
Race*§								
White	76.3	75.5	76.3	64.7	81.5	76.1	81.2	65.1
Black/African American	16.5	17.2	16.6	26.9	12.6	18.3	12.9	26.1
Other	7.2	7.3	7.1	8.4	5.9	5.6	5.9	8.8
Marital status (1991)*§								
Married	55.5	51.1	55.3	46.7	61.7	60.6	61.7	47.2
Single	39.0	44.1	39.2	48.7	32.8	35.0	32.9	48.3
Other	5.5	4.8	5.5	4.6	5.5	4.4	5.4	4.5
Rank*§								
Enlisted	84.2	86.6	84.3	90.6	75.9	84.4	76.3	87.8
Officer	14.4	12.1	14.3	8.5	21.9	14.5	21.6	11.3
Warrant	1.4	1.3	1.4	0.9	2.2	1.1	2.1	0.9
Branch*§								
Air Force	12.2	13.1	12.2	10.9	13.9	12.8	13.9	11.0
Army	64.6	61.1	64.4	62.5	64.3	65.0	64.3	65.1
Marine	10.4	12.4	10.5	12.0	9.2	11.1	9.3	11.6
Navy	12.8	13.4	12.9	14.6	12.6	11.1	12.5	12.3
Unit component*								
Active	35.6	37.6	35.7	42.3	40.2	33.3	39.9	40.5
National guard	29.2	26.1	29.0	25.7	26.3	38.9	26.9	26.1
Reserve	35.2	36.3	35.3	32.0	33.5	27.8	33.2	33.4
Current active duty[b]	13.0	11.5	12.9		12.8	8.3	12.6	
Current marital status[b]								
Married	70.7	71.3	70.7		73.1	80.9	73.5	
Separated	3.0	3.5	3.1		2.8	2.3	2.7	
Divorced	13.4	12.8	13.3		13.3	6.7	13.0	
Widowed	0.7	0.6	0.7		0.8	1.1	0.8	
Single, never married	8.6	10.5	8.7		7.0	9.0	7.1	
Single, living with partner	3.6	1.3	3.5		3.0	0.0	2.9	
Current education[b]								
<High School	1.3	0.9	1.3		1.3	0.0	1.2	
High School/GED/Equivalent	18.6	26.3	19.0		13.6	25.7	14.2	
Some College, no degree	33.5	32.7	33.5		28.2	24.0	28.0	
Associate's degree	13.4	12.2	13.3		13.7	10.6	13.5	
Bachelor's degree	20.1	18.6	20.0		23.4	27.4	23.6	
Master's/PHD/Professional degree	13.1	9.3	12.9		19.8	12.3	19.5	
Current income[b]								
<20,000	9.6	6.7	9.5		6.5	5.4	6.5	
$20,000–$34,999	16.4	17.8	16.5		14.4	12.0	14.3	
$35,000–$49,999	21.5	22.9	21.5		18.9	19.2	18.9	
$50,000–$74,999	26.7	26.6	26.7		26.2	24.5	26.1	
$75,000–$99,999	13.3	12.5	13.3		15.4	16.8	15.4	
≥$100,000	12.5	13.5	12.5		18.6	22.1	18.8	

*$P < 0.01$, P significance probability by χ^2 test of independence between characteristic and response status for Gulf veterans.
†$P < 0.01$, P significance probability by t test of equal means of respondents and nonrespondents in Gulf veterans.
‡$P < 0.01$, P significance probability by t test of equal means of respondents and nonrespondents in Gulf Era veterans.
§$P < 0.01$, P significance probability by χ^2 test of independence between characteristic and response status for Gulf Era veterans.
[a]Revised distribution of Gulf and Gulf Era veterans by revised deployment status (see "Method" section "Gulf War Deployment Status Identification" part). Two volunteered veterans were added to the panel.
[b]Active duty status, marital status, education level, income level at the time of 2005 survey.

TABLE 2
Percent Distribution of Perception of General Health Reported by Veterans in 1995 NHS Survey, Stratified by Response Status in 2005 Survey

	1995 NHS Gulf Respondents (n = 11,637)				1995 NHS Gulf Era Respondents (n = 9,280)			
Health Status in 1995	Respondents in 2005 (n = 5,469)	Nonrespondents in 2005 (n = 6,168)	χ^2 (df = 4)	P	Respondents in 2005 (n = 3,353)	Nonrespondents in 2005 (n = 5,927)	χ^2 (df = 4)	P
Excellent	16.3	15.9			30.5	30.0		
Very good	28.3	27.2			37.2	37.0		
Good	31.6	34.2			21.9	23.4		
Fair	20.5	19.0			9.2	8.4		
Poor	3.4	3.8	10.2	0.04	1.2	1.3	3.9	0.42

veterans) consented and participated in the phase I postal survey or phase II telephone survey. In both Gulf veteran and Gulf Era veteran groups, nonrespondents were more likely to be younger, non-white, single individuals who served in enlisted ranks at the time of 1991 Gulf War (Table 1, $P < 0.0001$). In addition, Gulf veteran participants were more likely on National Guard or reserve during the Gulf War service (64.3% vs 57.7%) and women (20.1% vs 18.3%) than Gulf veteran nonparticipants. To account for the differences in characteristics between Gulf veterans and Gulf Era veteran respondents, these variables (age, gender, race, rank, unit component) were included, along with branch of service, BMI and current smoking history, in the estimate of RR.

We attempted to assess, in two different ways, whether or not characteristics of respondents were significantly different than those of nonrespondents with respect to health status of individuals. First, we compared baseline self-reported health status in 1995 (from excellent to poor) between those who participated and did not participate in the 2005 survey (Table 2). Stratified by deployment status, no differences were observed. The self-reported health status in 1995 was not a good predictor of whether or not a veteran would participate in the 2005 survey.

Second, several follow-up mailings during the 2005 survey also allowed for assessment of nonresponse bias by permitting comparison of responses to the same question between a group of early respondents (phase I) and the late respondents (phase II).[34,35] Each successive group of respondents could be considered a group of nonrespondents compared with the preceding group of respondents, because they would have remained as nonrespondents without the follow-up recruitment efforts. In both the Gulf veterans and Gulf era veterans, general health status (excellent or very good or good vs fair or poor) did not differ significantly among survey respondent groups. Within Gulf veterans, 74.0% of phase I postal respondents and 75.8% of phase II telephone respondents (considered to be representative of nonrespondents) perceived that their health was excellent, very good or good ($P = 0.49$). Gulf Era respondents also reported very similar percentages of excellent to good health (87.6% for phase I and 85.0% for phase II, respectively; $P = 0.31$). The perceived health status of an individual was not a significant determinant of whether or not an individual decided to participate in the current survey.

Functional Status, Activity Limitations, Medical Care Use

Twice as high a proportion of Gulf War veterans as Gulf Era veteran respondents reported staying in bed or at home all or part of a day because of not feeling well, illness or injury within the 2 weeks before completing the questionnaire (31.6% vs 16.5%) (Table 3). The percentage distribution of number of days in bed or at home during the preceding 2 weeks was also statistically different between the two cohorts ($P < 0.001$) (Table 4). Similarly, 29.0% of Gulf veterans and 19.2% of Gulf Era veterans reported limited employment or household work activities due to physical impairment or health problems (Table 3).

A higher proportion of Gulf veterans made at least one clinic or doctor visit because of illness within the previous 12 months (56.2% vs 45.9%), after exclusion of routine visits for vaccinations and physical examinations. Among Gulf veteran respondents, 10.5% reported having been hospitalized overnight or longer for illness during the past 12 months, whereas the corresponding proportion among the Gulf Era veterans was 8.0%. Statistically significant differences were observed between Gulf and Gulf Era veterans in number of clinic visits ($P < 0.001$) and hospitalizations ($P < 0.001$) during the previous 12 months because of illness (Table 4).

Prevalence of Chronic Medical Conditions

The prevalence rates of 23 chronic medical conditions ever told to the veteran by a doctor are presented in Table 3, by descending order of ad-

TABLE 3
Frequency and Estimated Prevalence Rate of Selected Self-Reported Health Outcomes and Medical Conditions

Health Outcomes/Conditions	Gulf (*n* = 6,111) *n* (%)**	Gulf Era (*n* = 3,859) *n* (%)**	Crude RR (95% CI)	Adjusted RR* (95% CI)
Functional impairment‡	1,918 (31.6)	633 (16.5)	1.92 (1.77–2.08)	1.83 (1.69–1.98)
Limitation of activities§	1,757 (29.0)	735 (19.2)	1.52 (1.40–1.64)	1.53 (1.41–1.65)
Clinic visit‖	3,371 (56.2)	1,751 (45.9)	1.22 (1.17–1.27)	1.24 (1.19–1.29)
Hospitalization¶	633 (10.5)	306 (8.0)	1.31 (1.15–1.49)	1.31 (1.15–1.50)
Has your doctor ever told you that you have				
Chronic fatigue syndrome	1,082 (18.2)	340 (9.0)	2.03 (1.81–2.28)	1.98 (1.76–2.23)
Gastritis	1,643 (27.4)	685 (18.1)	1.52 (1.40–1.64)	1.52 (1.40–1.65)
Depression	1,866 (31.1)	777 (20.4)	1.52 (1.42–1.64)	1.50 (1.39–1.61)
Irritable bowel syndrome	1,138 (19.1)	479 (12.6)	1.51 (1.37–1.67)	1.50 (1.35–1.66)
Emphysema or chronic bronchitis	847 (14.2)	364 (9.6)	1.48 (1.32–1.66)	1.47 (1.30–1.65)
Repeated seizures	605 (10.2)	262 (6.9)	1.47 (1.28–1.69)	1.43 (1.24–1.66)
Tachycardia	849 (14.2)	380 (10.0)	1.42 (1.27–1.59)	1.42 (1.26–1.60)
Dermatitis or any other skin trouble	2,027 (34.0)	920 (24.2)	1.40 (1.31–1.50)	1.41 (1.32–1.51)
Neuralgia or neuritis	797 (13.4)	368 (9.7)	1.38 (1.23–1.55)	1.39 (1.23–1.57)
Stroke	541 (9.1)	259 (6.8)	1.33 (1.15–1.53)	1.32 (1.14–1.52)
Bladder infection	730 (12.2)	351 (9.3)	1.32 (1.17–1.49)	1.32 (1.17–1.49)
Cirrhosis of the liver	502 (8.4)	240 (6.3)	1.33 (1.15–1.54)	1.30 (1.12–1.52)
Fibromyalgia	605 (10.3)	296 (7.9)	1.31 (1.14–1.49)	1.29 (1.12–1.48)
Asthma	953 (16.0)	482 (12.7)	1.26 (1.14–1.39)	1.24 (1.12–1.38)
Other endocrine disorder	770 (12.9)	406 (10.7)	1.21 (1.08–1.35)	1.24 (1.11–1.39)
Any disease of the genital organs	797 (13.4)	408 (10.8)	1.24 (1.11–1.39)	1.23 (1.10–1.38)
Coronary heart disease	671 (11.3)	355 (9.4)	1.20 (1.06–1.36)	1.22 (1.08–1.39)
Hepatitis	651 (10.9)	339 (8.9)	1.22 (1.08–1.38)	1.20 (1.06–1.37)
Arthritis	2,206 (36.9)	1,231 (32.4)	1.14 (1.08–1.21)	1.20 (1.13–1.27)
Diabetes	742 (12.5)	427 (11.3)	1.11 (0.99–1.24)	1.11 (0.99–1.25)
Hypertension	1,811 (30.1)	1,074 (28.2)	1.07 (1.00–1.14)	1.11 (1.04–1.19)
Other cancer	621 (10.4)	369 (9.7)	1.07 (0.95–1.21)	1.09 (0.96–1.24)
Skin cancer	713 (12.0)	447 (11.8)	1.02 (0.91–1.14)	1.09 (0.97–1.22)
PTSD (past 4 wk)†	928 (15.2)	176 (4.6)	3.33 (2.85–3.89)	2.98 (2.54–3.50)
Other anxiety disorder (past 4 wk)#	675 (11.1)	142 (3.7)	3.00 (2.51–3.58)	2.67 (2.24–3.19)
High somatic symptom severity (past 4 wk)#	985 (16.1)	222 (5.8)	2.80 (2.44–3.22)	2.60 (2.25–3.00)
Major depressive disorder (past 2 wk)#	908 (14.9)	224 (5.8)	2.56 (2.22–2.95)	2.34 (2.03–2.70)
Panic disorder (past 4 wk)#	546 (9.0)	138 (3.6)	2.50 (2.08–3.00)	2.28 (1.89–2.74)
Other depressive disorder (past 2 wk)#	397 (6.5)	152 (4.0)	1.65 (1.37–1.98)	1.55 (1.28–1.86)
Probable alcohol abuse (past 6 mo)#	997 (16.4)	461 (12.0)	1.37 (1.23–1.51)	1.24 (1.11–1.37)
Taking med for anxiety/depression/stress	912 (15.0)	404 (10.5)	1.43 (1.28–1.59)	1.45 (1.30–1.63)
Multi-symptom illness (MSI)	2,180 (36.5)	446 (11.7)	3.13 (2.85–3.44)	3.05 (2.77–3.36)
CFS-like illness (past 12 mo)	574 (9.4)	132 (3.4)	2.75 (2.28–3.30)	2.38 (1.97–2.87)
	Gulf (*n* = 1,225)	**Gulf Era (*n* = 851)**		
Female only				
Serious problem with mood before period	494 (41.8)	256 (30.9)	1.35 (1.20–1.53)	1.28 (1.13–1.45)
Have you given birth within the last 6 mo	23 (2.0)	7 (0.9)	2.29 (0.99–5.30)	2.11 (0.89–5.04)
Miscarriage within the last 6 mo	6 (0.5)	9 (1.1)	0.46 (0.17–1.30)	0.42 (0.15–1.17)
Having difficulty getting pregnant	115 (9.9)	35 (4.3)	2.30 (1.59–3.32)	2.20 (1.50–3.22)

*Adjusted for age, gender, race, body mass index, current cigarette smoking, rank, branch of service, and unit component (active duty, National Guard, or reserve).

†Caseness was coded from the PTSD checklist—civilian version (PCL-C).

‡Positive response to the question, "Thinking back over the past 2 wk, did you stay in bed or at home all or part of any day because you did not feel well or as a result of illness or injury?"

§Positive response to the question, "Are you limited in your employment or the kind of work you can do around the house because of any impairment or health problem?"

‖Clinic visit because of illness within the previous 1 yr, exclude routine visits for vaccinations, physical examinations, etc.

¶Hospitalization because of illness within the previous 1 yr.

#Caseness was coded from the Patient Health Questionnaire (PHQ).

**Each percentage % is based on number of respondents for specific health outcome/condition.

RR indicates risk ratio; CI, confidence interval.

justed RR. All except three of the listed conditions showed significantly higher rates among the Gulf veteran group. Skin cancer, other cancer and diabetes were reported at the same rates.

Prevalence of Mental Disorders

Table 3 shows that statistically significant associations exist between Gulf War deployment and all the seven mental disorders (including PTSD), after adjustment for covariates. PTSD was almost three times more common in Gulf veterans than it was in Gulf Era veterans (adjusted RR: 2.98, 95% CI: 2.54 to 3.50). Adjusted RR for the mental disorders ranged

TABLE 4
Percent Distribution of Number of Bed Days, Clinic Visits, and Hospitalizations

Condition	Gulf (n = 6,111)	Gulf Era (n = 3,859)	χ^2 (df = 3)	P*
Bed days†				
0	69.1	84.1		
1–2	16.2	8.5		
3–4	7.4	3.5		
≥5	7.3	3.9	281.5	<.0001
Clinic visit‡				
0	43.9	54.2		
1–3	26.7	25.4		
4–6	15.1	11.4		
≥7	14.3	9.0	129.1	<.0001
Hospitalizations§				
0	90.0	92.2		
1	6.8	5.7		
2	1.7	1.3		
≥3	1.5	0.7	17.8	0.0005

*Probability value from χ^2 test.

†Response to the question, "How many days did you stay in bed or at home more than half of the day because of illness or injury during the past 2 wk?" Percentages are different than those in Table 3 due to values unanswered.

‡Response to the question, "During the past 12 mo how many clinic or doctor visits have you made because you were sick?" Percentages are different than those in Table 3 due to values unanswered.

§Response to the question, "During the past 12 mo how many times have you been hospitalized overnight or longer?" Percentages are different than those in Table 3 due to values unanswered.

TABLE 5
Percent Distribution of Perception of General Health Reported by Veterans*

Health Status	Gulf (n = 6,111)	Gulf Era (n = 3,859)
Excellent	9.1	15.8
Very good	26.0	37.7
Good	39.0	34.0
Fair	20.6	10.6
Poor	5.3	2.0

*$P < 0.0001$, P significance probability by χ^2 test of independence between Gulf/Gulf Era deployment status.

from 1.24 (probable alcohol abuse) to 2.98 (PTSD). Gulf veterans reported taking more medicine for anxiety, depression or stress at the time of the survey than did Gulf Era veterans (adjusted RR: 1.45, 95% CI: 1.30 to 1.63).

Prevalence of Unexplained Multi-Symptom Illness and CFS-Like Illness

Table 3 shows that about 25% more Gulf War veterans reported suffering from MSI compared with their Gulf Era military peers (36.5% vs 11.7%). After adjustment for covariates through the propensity score, the risk ratio of MSI is 3.05 (95% CI: 2.77 to 3.36), which is the highest of all physical conditions and mental disorders listed in Table 3.

Among Gulf veterans with MSI, about three quarters first experienced the illness between 1991 and 1995. The proportions who had a recent clinic visit or hospitalization were significantly higher among Gulf MSI veterans than Gulf non-MSI veterans (clinic visit: 74% vs 46% [$P < 0.0001$]; hospitalization: 16% versus 7% [$P < 0.0001$]). To describe functional status as a correlate of MSI, we used measures of health-related quality of life (SF-12) and found that Gulf veterans with MSI have significantly lower SF-12 summary physical and mental health scores than Gulf veterans without MSI.

More Gulf veterans were classified as having CFS-like illness than Gulf Era veterans (9.4% vs 3.4%), with an adjusted risk ratio of 2.38 (95% CI: 1.97 to 2.87).

Female Only Questions

About 20% of Gulf and 22% of Gulf Era respondents were females (n = 1225 and 851, respectively), consistent with the sampling proportion. The case numbers and prevalence rates of four common reproductive outcomes self-reported by female participants were shown at the bottom of Table 3. Higher percentages of Gulf women veterans reported serious premenstrual mood changes and difficulty conceiving, compared with Gulf Era women controls.

Perception of General Health

A substantially lower proportion of Gulf veterans than Gulf Era veterans reported that their health was excellent or very good (Table 5: 35.1% vs 53.5%, $P < 0.0001$).

The SF-12 physical and mental component summary scales demonstrated lower mean scores for both scales in Gulf compared to Gulf Era veterans (46.9 vs 50.1, 45.8 vs 50.4, respectively, $P < 0.0001$), indicating poorer health for Gulf respondents (Table 6). The distributions of both scales in the Gulf Era group were very similar to those of the general U.S. population (mean = 50, SD = 10).[26]

Validation of Self-Reported Reasons for Clinic Visits and Hospitalization

A total of 572 (303 from Gulf, 269 from Gulf Era) records were released from health facilities, with signed consent forms by veterans. Self-reported reasons for clinic visits or hospitalization were documented in the records for 93% of those received. Similar confirmation rates between self-report and medical record were found for Gulf veterans and Gulf Era veterans (Gulf, 93.1%; Gulf Era, 93.7%).

Discussion

Fourteen years after the 1991 Gulf War, a population-based sample of 6111 Gulf veterans reported signifi-

TABLE 6
SF-12 Scores and Standard Deviation

Summary Score	Gulf (n = 6,111)	Gulf Era (n = 3,859)	P*
Physical	46.9 (11.4)	50.1 (10.1)	<0.0001
Mental	45.8 (12.4)	50.4 (10.2)	<0.0001

*Probability value from 2-sample t test.

cantly higher rates for 20 of 23 physical conditions and all seven mental disorders assessed in the survey compared to 3859 Gulf Era veteran controls, both before or after adjustment for explanatory demographic and military factors. Moreover, deployed veterans reported almost two times more functional impairment, a 50% higher rate of health-related activity limitation, and more clinic, doctors' offices visits, and inpatient hospital health care than the Gulf Era veterans. These results are similar to those observed in the 1995 National Health Survey of Gulf War Era Veterans and Their Families.[1] Thus, military service in the 1991 Gulf War appears to be continuing to affect the health status of veterans, which may impact future use of physical and mental health care services.

Survey information collected to estimate prevalence of MSI permits quantification of the clinical significance of MSI among veterans as well as the health care burden. Veterans with MSI had significantly poorer physical health and mental health summary scores, more clinic visits, and hospitalizations.

We found that 1991 Gulf deployment still influenced health care utilization and measures of physical and mental health 14 years after return. The magnitudes of adjusted RR for depression, anxiety, PTSD, and panic syndrome range from 2.0 to 3.0, indicative of strong association between Gulf War deployment status and mental health problems 14 years later.

The low response rate of 34% gave rise to concern of possibility of participation bias. In terms of the demographic and military characteristics, the differences between respondents and nonrespondents are non-differential by deployment status (Table 1) and the differences in demographic characteristics were taken into consideration by including these variables in the analyses through the propensity score.

We also examined the perceived health status reported by veterans in the 1995 survey (Table 2) and found no significant difference between 2005 survey respondents and nonrespondents in reporting their baseline health perception in 1995. In addition, the perceived health status reported during the 2005 survey general health status (excellent, very good, good vs fair or poor) did not differ significantly between those who responded in phase I and those who responded in phase II. These two assessments suggest that the health status of individuals was not a significant determinant of a decision to participate in the survey. Thus, lack of participation was unrelated to health status, making it less likely that nonresponse was responsible for the relatively large adjusted RR observed for the various health conditions between deployed and Gulf Era veterans. If the participation rates differ with respect to exposure (deployment) only or disease (health status of veterans) only, then the effects of non-response bias could be considered minimal. The type of non-response bias having the most serious impact on study results is seen when the participation rates vary according to specific combination of exposure and disease. The available data, however, suggest that this type of response bias was unlikely to have occurred in the current survey.

As in any health survey, a potential limitation of the study could be the fact that outcomes are based on self-reported data, which can be subject to reporting or recall bias. However, the results of our medical records validation study indicated high agreement rate of 93% between the self-reported health conditions and the conditions documented in health care providers' records. The satisfactory agreement rate of 93% was observed within each cohort, which indicates that the reporting error is not differential by deployment status. The results suggest that bias due to reporting errors is very little in our study. With the low response rate, not-atypical in many current epidemiology studies, resources could be spent better on improving the data quality, rather than on efforts to increase the response rate.[35]

In summary, 14 years after deployment, 1991 Gulf War veterans continue to report a higher prevalence of many adverse health outcomes, both physical and mental, compared with Gulf Era veterans.

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Appendix 1

Chronic Fatigue Syndrome-Like Illness

In past 12 months, persistent problems with fatigue lasting >24 hours after exertion and persistent problems with at least three of the following seven symptoms:

Headaches, sore throat, tender lymph nodes, muscle aches or cramps, joint aches or pain, awaken feeling tired or worn out after a full night of sleep, and difficulty concentrating or reasoning or memory loss

AND

None of the following medical conditions:

Arthritis, skin cancer, any other cancer, cirrhosis of liver, hepatitis, diabetes, other endocrine disorder, repeated seizures or convulsions or blackouts, neuralgia or neuritis, disease of genital organs, coronary heart disease, stroke or cerebral vascular accident, tachycardia or rapid heart, asthma, emphysema or chronic bronchitis, and repeated bladder infections.

Appendix 2

Unexplained Multi-Symptom Illness

- Unexplained multi-symptom illness is defined as having several different symptoms together that persist for 6 months or longer and are not adequately explained by conventional medical or psychiatric diagnoses.
- Unexplained multi-symptom illness might include things like fatigue, muscle or joint pain, headaches, memory problems, digestive problems, respiratory problems, skin problems, or any other unexplained symptoms. These problems are often not labeled at all, but may sometimes be diagnosed as chronic fatigue syndrome, fibromyalgia, irritable bowel syndrome, or multiple chemical sensitivity.