

1. [Br J Psychiatry](#). 2007 May;190:385-93. [Links](#)

Mental health of US Gulf War veterans 10 years after the war.

[Toomey R](#), [Kang HK](#), [Karlinsky J](#), [Baker DG](#), [Vasterling JJ](#), [Alpern R](#), [Reda DJ](#), [Henderson WG](#), [Murphy FM](#), [Eisen SA](#).

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BACKGROUND: Gulf War veterans reported multiple psychological symptoms immediately after the war; the temporal course of these symptoms remains unclear. AIMS: To assess the prevalence of war era onset mental disorders in US veterans deployed to the Gulf War and in non-deployed veterans 10 years after the war. METHOD: Mental disorders were diagnosed using structured clinical interviews. Standard questionnaires assessed symptoms and quality of life. RESULTS: Gulf War-era onset mental disorders were more prevalent in deployed veterans (18.1%, n=1061) compared with non-deployed veterans (8.9%, n=1128). The prevalence of depression and anxiety declined 10 years later in both groups, but remained higher in the deployed group, who also reported more symptoms and a lower quality of life than the non-deployed group. Remission of depression may be related to the presence of comorbid psychiatric disorders and level of education. Remission of anxiety was related to treatment with medication. CONCLUSIONS: Gulf War deployment was associated with an increased prevalence of mental disorders, psychological symptoms and a lower quality of life beginning during the war and persisting at a lower rate 10 years later.

PMID: 17470952 [PubMed - indexed for MEDLINE]

2. [Arch Environ Occup Health](#). 2006 Nov-Dec;61(6):271-8.

A study of Gulf War veterans with a possible deployment-related syndrome.

[Levine PH](#), [Richardson PK](#), [Zolfaghari L](#), [Cleary SD](#), [Geist CE](#), [Potolicchio S](#), [Young HA](#), [Simmens SJ](#), [Schessel D](#), [Williams K](#), [Mahan CM](#), [Kang HK](#).

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A previous symptom-based survey of veterans of the 1990-1991 Persian Gulf War suggested a neurological syndrome (blurred vision, loss of balance/dizziness, tremors/shaking, and speech difficulty). The authors conducted the present study to determine whether specific findings could indicate an organic basis for this possible syndrome. They completed an extensive clinical and laboratory evaluation on Gulf War veterans with all 4 symptoms, using 3 comparison groups. A single clinically based neurological syndrome could not be identified. No deployment-related exposure appeared to explain the pattern of symptoms, but this evaluation suggested

comorbidities and possibly multiple vaccines as important contributors. Many of the neurological symptoms reported by the studied veterans appear to have an organic basis, but comorbidities must be excluded before researchers can conclude that a definitive syndrome exists.

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3. Healthcare utilization and mortality among veterans of the Gulf War

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The authors conducted an extensive search for published works concerning healthcare utilization and mortality among Gulf War veterans of the Coalition forces who served during the 1990–1991 Gulf War. Reports concerning the health experience of US, UK, Canadian, Saudi and Australian veterans were reviewed. This report summarizes 15 years of observations and research in four categories: Gulf War veteran healthcare registry studies, hospitalization studies, outpatient studies and mortality studies. A total of 149 728 (19.8%) of 756 373 US, UK, Canadian and Australian Gulf War veterans received health registry evaluations revealing a vast number of symptoms and clinical conditions but no suggestion that a new unique illness was associated with service during the Gulf War. Additionally, no Gulf War exposure was uniquely implicated as a cause for post-war morbidity. Numerous large, controlled studies of US Gulf War veterans' hospitalizations, often involving more than a million veterans, have been conducted. They revealed an increased post-war risk for mental health diagnoses, multi-symptom conditions and musculoskeletal disorders. Again, these data failed to demonstrate that Gulf War veterans suffered from a unique Gulf War-related illness. The sparsely available ambulatory care reports documented that respiratory and gastrointestinal complaints were quite common during deployment. Using perhaps the most reliable data, controlled mortality studies have revealed that Gulf War veterans were at increased risk of injuries, especially those due to vehicular accidents. In general, healthcare utilization data are now exhausted. These findings have now been incorporated into preventive measures in support of current military forces. With a few diagnostic exceptions such as amyotrophic lateral sclerosis, mental disorders and cancer, it now seems time to cease examining Gulf War veteran morbidity and to direct future research efforts to preventing illness among current and future military personnel.

4. [Am J Ind Med. 2006 Apr;49\(4\):261-70.](#)

Fatal motor vehicle crashes among veterans of the 1991 Gulf War and exposure to munitions demolitions at Khamisiyah: a nested case-control study.

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BACKGROUND: A proposed explanation for the observed higher risk of fatal motor vehicle crashes (MVC) among 1991 Gulf War-deployed veterans is neurocognitive deficits resulting from nerve agent exposure at Khamisiyah, Iraq. Our objective was to assess any association between postwar fatal MVC and possible nerve agent exposure based on 2000 modeled plume data.

METHODS: Cases were defined as MVC deaths with a record in the Department of Transportation Fatality Analysis Reporting System through 1995. Cases (n = 282) and controls (n = 3,131) were derived from a larger nested case-control study of Gulf War-era veterans and limited to Army, male, deployed personnel. Exposure and cumulative dose by case-control status were analyzed using multivariate techniques. **RESULTS:** Exposure status was not associated with fatal MVC (OR 0.96, 95% CI 0.72-1.26), nor were tertiles of cumulative dose.

CONCLUSIONS: Findings do not support an association between possible exposures at Khamisiyah and postwar fatal MVC among Gulf War veterans.

PMID: 16550564 [PubMed - indexed for MEDLINE]

5. **Accident Analysis & Prevention. 38(3):518-25, 2006 May.**

Understanding the effect of deployment on the risk of fatal motor vehicle crashes: a nested case-control study of fatalities in Gulf War era veterans, 1991-1995.

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Motor vehicle crashes (MVCs) are an important cause of morbidity and premature loss of life among military personnel during peacetime and particularly following combat. A nested case-control study of fatal MVC occurring between 1991 and 1995 was conducted in a cohort of Gulf War era veterans. Cases were validated MVC deaths in the Fatality Analysis Reporting System. Controls were selected using risk set sampling by gender and year of case ascertainment in a 10:1 ratio. Preliminary results, consistent with previous reports of increased fatal MVC risk among returning combat veterans, showed a crude odds ratio of 1.45 (95% confidence interval 1.27-1.65). Multivariable logistic regression modeling was used to identify important independent predictors, as well as to quantify the influence of deployment on a risk profile for fatal MVC. Because of significant interaction between deployment and inpatient diagnosis of substance abuse, the final model was stratified by deployment status. Results suggest that demographic, military, and behavioral characteristics of deployed healthy warriors are similar to the risk profile for fatal MVC. In addition to young, single, high school-educated, enlisted male personnel, those who served during times of ground combat, particularly in infantry, gun crews, or seamanship occupations, should be targeted for preventive interventions.

6. [Traffic Inj Prev.](#) 2006 Mar;7(1):31-7.

Motor vehicle fatalities among Gulf War era veterans: characteristics, mechanisms, and circumstances.

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OBJECTIVES: Our objective was to describe fatal motor vehicle crashes (MVC) among veterans of the 1991 Gulf War era and to compare the distribution of crash and individual characteristics between those deployed to the Gulf War (GWV) and those not deployed (NDV). **METHODS:** We compared individual characteristics, crash mechanisms, and crash circumstances between 765 GWV and 553 NDV who died from MVC within the first five years of the war, between May 1991 and December 1995. **RESULTS:** Overall, GWV and NDV who died from a MVC were more likely to be enlisted males (97%), 21-30 years old (72%), have a high school education or less (91%), drive a passenger car (52%), and not use restraints (60%). The overall annual rate of motor vehicle fatalities for GWV (23.6 per 100,000; 95% confidence interval: 21.9-25.3) was significantly greater than the rate for NDV (15.9, 95% CI: 14.6-17.3). GWV with the highest motor vehicle fatality rates include males (24.8, 95% CI: 23.0-26.6), 17-20 year olds (105.0, 95% CI: 78.2-138.1), and those not married (27.3, 95% CI: 25.1-30.1). Adjusting for differences in age distribution across GWV and NDV did not account for the difference in rates. Characteristics of MVC fatalities that were over-represented among GWV include serving as regular active duty ($p = 0.001$), having a high school education or less ($p = 0.01$), being involved in a single-vehicle crash ($p = 0.008$), and dying within the first hour following the crash ($p = 0.004$). Also, we identified a greater proportion of alcohol-related crashes among GWV during the late night and early morning hours. **CONCLUSIONS:** The highest rates of motor vehicle fatality among young, single males in the military mirror the experience of the general population. Further research is necessary to determine modifiable risk factors that can be targeted for specific interventions and whether the elevated late night alcohol-related crash rate among GWV is an effect of deployment or an inherent population bias among those selected for operational deployments.

7. [Am J Epidemiol.](#) 2006 Jan 1;163(1):66-75. Epub 2005 Nov 17.

Chronic multisymptom illness complex in Gulf War I veterans 10 years later.

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Prior research has demonstrated that shortly after the 1991 Gulf War (Gulf War I), chronic multisymptom illness (CMI) was more common among deployed veterans than among nondeployed veterans. The aims of the current study were to determine the prevalence of CMI

among deployed and nondeployed veterans 10 years after Gulf War I, compare the distribution of comorbid conditions, and identify prewar factors associated with CMI. Cross-sectional data collected from 1,061 deployed veterans and 1,128 nondeployed veterans examined between 1999 and 2001 were analyzed. CMI prevalence was 28.9% among deployed veterans and 15.8% among nondeployed veterans (odds ratio = 2.16, 95% confidence interval: 1.61, 2.90). Deployed and nondeployed veterans with CMI had similarly poorer quality-of-life measures and higher prevalences of symptom-based medical conditions, metabolic syndrome, and psychiatric disorders. Diagnoses of prewar anxiety disorders (not related to post-traumatic stress disorder) and depression were associated with CMI among both deployed and nondeployed veterans. Nicotine dependence and veteran-reported physician-diagnosed infectious mononucleosis were associated with CMI among deployed veterans, and migraine headaches and gastritis were associated with CMI among nondeployed veterans. CMI continues to be substantially more prevalent among deployed veterans than among nondeployed veterans 10 years after Gulf War I, but it manifests similarly in both groups. It is likely to be a common, persistent problem among veterans returning from the current Gulf War.

8. [Mil Med.](#) 2006 May;171(5):370-5.

Patterns of health care seeking of Gulf War registry members prior to deployment.

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Following the Gulf War (GW), large numbers of individuals reported illness that they attributed to exposures encountered during the GW deployment. In response, the Department of Veterans Affairs and the Department of Defense established programs and registries for the evaluation and documentation of GW-related illness. We obtained registrants' medical records, which contained information on outpatient encounters during the 1-year period before their GW deployment, to determine whether registrants with multisymptom illness (cases) have patterns of predeployment health care seeking that are different from those of well registrants (controls). We found that subjects had significantly more predeployment outpatient visits than controls, but this varied by type of visit. Although the number of certain types of predeployment outpatient visits is significantly associated with subsequent multisymptom illness, these associations will have limited predictive value. These findings increase our understanding of multisymptom illness, especially its chronic nature, and justify doing additional studies.

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Mortality in US Army Gulf War Veterans Exposed to 1991 Khamisiyah Chemical Munitions Destruction

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Objectives. We investigated whether US Army Gulf War veterans who were potentially exposed to nerve agents during the March 1991 weapons demolitions at Khamisiyah, Iraq, are at increased risk of cause-specific mortality.

Methods. The cause-specific mortality of 100487 exposed US Army Gulf War veterans was compared with that of 224980 unexposed US Army Gulf War veterans. Exposure was determined with the Department of Defense 2000 plume model. Relative risk estimates were derived from Cox proportional hazards models.

Results. The risks of most disease-related mortality were similar for exposed and unexposed veterans. However, exposed veterans had an increased risk of brain cancer deaths (relative risk [RR]=1.94; 95% confidence interval [CI]=1.12, 3.34). The risk of brain cancer death was larger among those exposed 2 or more days than those exposed 1 day when both were compared separately to all unexposed veterans (RR=3.26; 95% CI=1.33, 7.96; RR=1.72; 95% CI=0.95,3.10, respectively).

Conclusions. Exposure to chemical munitions at Khamisiyah may be associated with an increased risk of brain cancer death. Additional research is required to confirm this finding.

10. [Ann Intern Med.](#) 2005 Jun 7;142(11):881-90.

Gulf War veterans' health: medical evaluation of a U.S. cohort.

[Eisen SA](#), [Kang HK](#), [Murphy FM](#), [Blanchard MS](#), [Reda DJ](#), [Henderson WG](#), [Toomey R](#), [Jackson LW](#), [Alpern R](#), [Parks BJ](#), [Klimas N](#), [Hall C](#), [Pak HS](#), [Hunter J](#), [Karlinsky J](#), [Battistone MJ](#), [Lyons MJ](#); [Gulf War Study Participating Investigators](#).

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BACKGROUND: United States military personnel reported various symptoms after deployment to the Persian Gulf during the 1991 Gulf War. However, the symptoms' long-term prevalence and association with deployment remain controversial. **OBJECTIVE:** To assess and compare the prevalence of selected medical conditions in a national cohort of deployed and nondeployed Gulf War veterans who were evaluated by direct medical and teledermatologic examinations. **DESIGN:** A cross-sectional prevalence study performed 10 years after the 1991 Gulf War. **SETTING:** Veterans were examined at 1 of 16 Veterans Affairs medical centers. **PARTICIPANTS:** Deployed (n = 1061) and nondeployed (n = 1128) veterans of the 1991 Gulf War. **MEASUREMENTS:** Primary outcome measures included fibromyalgia, the chronic fatigue syndrome, dermatologic conditions, dyspepsia, physical health-related quality of life (Short Form-36 [SF-36]), hypertension, obstructive lung disease, arthralgias, and peripheral neuropathy. **RESULTS:** Of 12 conditions, only 4 conditions were more prevalent among deployed than nondeployed veterans: fibromyalgia (deployed, 2.0%; nondeployed, 1.2%; odds ratio, 2.32 [95% CI, 1.02 to 5.27]); the chronic fatigue syndrome (deployed, 1.6%; nondeployed 0.1%; odds ratio, 40.6 [CI, 10.2 to 161]); dermatologic conditions (deployed, 34.6%; nondeployed, 26.8%; odds ratio, 1.38 [CI, 1.06 to 1.80]), and dyspepsia (deployed, 9.1%; nondeployed, 6.0%; odds ratio, 1.87 [CI, 1.16 to 2.99]). The mean physical component summary score of the SF-36 for deployed and nondeployed veterans was 49.3 and 50.8, respectively. **LIMITATIONS:** Relatively low participation rates introduce potential participation bias, and deployment-related illnesses that resolved before the research examination could not, by design, be detected. **CONCLUSIONS:** Ten years after the Gulf War, the physical health of deployed and nondeployed veterans is similar. However, Gulf War deployment is associated with an increased risk for fibromyalgia, the chronic fatigue syndrome, skin conditions, dyspepsia, and a clinically insignificant decrease in the SF-36 physical component score.

11. [Am J Ind Med.](#) 2005 Aug;48(2):118-27.

Leveraging existing databases to study vehicle crashes in a combat occupational cohort: epidemiologic methods.

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BACKGROUND: The US military is a large, well-defined occupational cohort offering tremendous opportunities to study risk factors for important health outcomes. This article describes our nested case-control methods to evaluate risk factors for fatal motor vehicle crashes (MVC) within all Service branches in a 1991 Gulf War era cohort. **METHODS:** We identified 1,343 cases of fatal MVC between 1991 and 1995 that were also included in the Department of Transportation's Fatality Analysis Reporting System database and, using risk set sampling, selected 13,430 controls. Our final analytic dataset consisted of 980 male driver cases and 12,807 controls linked to multiple databases. **RESULTS:** Cases were disproportionately younger, less educated, not married, enlisted, and deployed to the Gulf War, compared to controls. **CONCLUSIONS:** The ability to leverage multiple databases to study risk factors for fatal MVC is clearly advantageous and could eventually lead to the reduction of fatalities in similar occupational cohorts.

12. [Ann Epidemiol.](#) 2005 Mar;15(3):191-5.

The role of sexual assault on the risk of PTSD among Gulf War veterans.

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PURPOSE: The 1991 Gulf War was the first major military deployment where female troops were integrated into almost every military unit, except for combat ground units. We evaluated the impact of reported sexual trauma during this deployment on the risk of post-traumatic stress disorder (PTSD) after the war. **METHODS:** A nested case-control analysis was conducted using the data collected in a population-based health survey of 30,000 Gulf War era veterans. A total of 1381 Gulf War veterans with current PTSD were compared with 10,060 Gulf veteran controls without PTSD for self-reported in-theater experiences of sexual harassment/assault and combat exposure. **RESULTS:** The adjusted odds ratio (aOR) for PTSD associated with a report of sexual assault was 5.41 (95% confidence interval [CI], 3.19-9.17) in female veterans and 6.21 (95% CI, 2.26-17.04) in male veterans. The aOR for PTSD associated with "high" combat exposure was also statistically significant (aOR, 4.03 [95% CI, 1.97-8.23] for females; aOR, 4.45 [95% CI, 3.54-5.60] for males). **CONCLUSION:** Notwithstanding a possibility of recall bias of combat and sexual trauma, for both men and women, sexual trauma as well as combat exposure appear to be strong risk factors for PTSD.

13. [Mil Med.](#) 2005 Feb;170(2):149-53.

Is testicular cancer related to Gulf War deployment? Evidence from a pilot population-based study of Gulf War era veterans and cancer registries.

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The possible relationship between military deployment and the subsequent increase in cancer rates has been prominent since the Vietnam War. The objective of this study was to investigate whether any form of cancer was increased among veterans deployed to the Persian Gulf in the 1991 conflict. This study matched data from central cancer registries in the District of Columbia and New Jersey with the records for 1.4 million Gulf War era veterans, i.e., 621,902 veterans who arrived in the Persian Gulf before March 1, 1991, and 746,248 non-Gulf veterans. Using a proportional incidence ratio, testicular cancer was found to be the only significantly increased malignancy among deployed Persian Gulf War veterans. The increase became apparent 2 to 3 years after the Persian Gulf War and peaked 4 to 5 years afterward. Our data and those of investigators studying Vietnam veterans suggest that testicular cancer may be related to military deployment.

14. [Military Medicine.](#) 170(11):935-44, 2005 Nov.

Health effects in Army Gulf War veterans possibly exposed to chemical munitions destruction at Khamisiyah, Iraq: Part I. Morbidity associated with potential exposure.

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In March 1991, U.S. troops detonated the Khamisiyah, Iraq, ammunition depot, possibly releasing two chemical warfare agents, sarin and cyclosarin. The long-term health effects associated with possible exposure to these chemical warfare agents are unknown. This study was undertaken to investigate whether possible exposure was associated with morbidity among Army Gulf War veterans using morbidity data for 5,555 Army veterans who were deployed to the Gulf region. Responses to 86 self-assessed health measures, as reported in the 1995 Department of Veterans Affairs National Health Survey of Gulf War Era Veterans, were evaluated. We found little association between potential exposure and health, after adjustment for demographic variables, and conclude that potential exposure to sarin or cyclosarin at Khamisiyah does not seem to have adversely affected self-perceived health status, as evidenced by a wide range of health measures.

15. Mil Med 2005;170:945-951.

Page WF, Mahan CM, Kang HK, Bullman TA.

Health effects in Army Gulf War veterans possibly exposed to chemical munitions destruction at Khamisiyah, Iraq. II. Morbidity associated with notification of potential exposure.

The purpose of this study was to examine the association of notification of potential exposure to chemical warfare agents in the 1991 Gulf War with subsequent self-reported morbidity. The study sample included 1,056 deployed Army Gulf War veterans who responded to the 1995 National Health Survey of Gulf War Era Veterans and who were resurveyed in 2000. One-half of the subjects had been notified of potential exposure to chemical warfare agents and one-half had not. Comparing notified and non-notified subjects, there were no statistically significant differences with respect to bed days, activity limitations, clinic visits, or hospital visits. Among 71 self-reported medical conditions and symptoms, there were 5 statistically significant differences, 4 of which were for lower rates of illness among notified subjects. Our findings contradict the prevailing notion that perceived exposure to chemical warfare agents should be considered an important cause of morbidity among Gulf War veterans.

16. [Neurology](#). 2004 Sep 28;63(6):1070-7.

Clinical and laboratory assessment of distal peripheral nerves in Gulf War veterans and spouses.

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BACKGROUND: The prevalence of symptoms suggesting distal symmetric polyneuropathy (DSP) was reported to be higher among deployed veterans (DV) to the Persian Gulf in 1990-1991 than to control non-deployed veterans (NDV). The authors therefore compared the prevalence of DSP by direct examination of DV and their spouses to control NDV and spouses. **METHODS:** The authors performed standardized neurologic examinations on 1,061 DV and 1,128 NDV selected from a cohort of veterans who previously participated in a national mail and telephone survey. Presence of DSP was evaluated by history, physical examination, and standardized electrophysiologic assessment of motor and sensory nerves. Similar examinations were performed without electrophysiologic tests in 484 DV spouses and 533 NDV spouses. Statistical analyses were performed with appropriate adjustments for the stratified sampling scheme.

RESULTS: No differences between adjusted population prevalence of DSP in DV and NDV were found by electrophysiology (3.7% vs 6.3%, $p = 0.07$), by neurologic examination (3.1% vs 2.6%, $p = 0.60$), or by the methods combined (6.3% vs 7.3%, $p = 0.47$). Excluding veterans with non-military service related diseases that may cause DSP did not alter outcomes. DV potentially exposed to neurotoxins from the Khamisiyah ammunition depot explosion did not significantly differ in DSP prevalence compared to non-exposed DV. The prevalence of DSP in DV spouses did not differ from NDV spouses (2.7% vs 3.2%, $p = 0.64$). CONCLUSIONS: Neither veterans deployed during the Gulf War era nor their spouses had a higher prevalence of DSP compared to NDV and spouses.

17. [Am J Prev Med](#). 2004 Jun;26(5):443-52.

After more than 10 years of Gulf War veteran medical evaluations, what have we learned?

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Since the 1991 Gulf War, more than 10 years and 1 billion dollars of health evaluations and research have been invested in understanding illnesses among Gulf War veterans. We examined the extensive published healthcare utilization data in an effort to summarize what has been learned. Using multiple search techniques, data as of June 2003 from four different national Gulf War health registries and numerous hospitalization and ambulatory care reports were reviewed. Thus far, published reports have not revealed a unique Gulf War syndrome nor identified specific exposures that might explain postwar morbidity. Instead, they have demonstrated that Gulf War veterans have had an increase in multi-symptom condition, injury, and mental health diagnoses. While these diagnoses are similar to those experienced by other comparable military populations, their explanation is not fully understood. New strategies to identify risk factors for, and to reduce, such postdeployment conditions are summarized.

18. [Arch Intern Med](#). 2004 Dec 13-27;164(22):2488-91.

Late prevalence of respiratory symptoms and pulmonary function abnormalities in Gulf War I Veterans.

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BACKGROUND: Published reports have documented an increased prevalence of self-reported respiratory symptoms among servicemen deployed during the 1990-1991 Gulf War. We evaluated whether this deployment resulted in long-term adverse respiratory effects. **METHODS:** A comprehensive medical history was taken and physical and laboratory evaluations, including pulmonary function tests, were performed in 1036 deployed and 1103 nondeployed veterans of the Gulf War. Participants were classified into 5 groups on the basis of their pulmonary function tests findings: normal pulmonary function; nonreversible airway obstruction; reversible airway obstruction; restrictive lung physiology; and small airway obstruction. **RESULTS:** Deployed veterans were younger, more commonly white, less educated, single, of lower mean family incomes, and more likely to have enlisted than nondeployed veterans. Deployed veterans were also statistically more likely to self-report a history of smoking and wheezing than nondeployed veterans, but comparisons of reported physician visits for pulmonary complaints, pulmonary hospitalizations, numbers of documented episodes of asthma, bronchitis, or emphysema, and pulmonary medications prescribed in the year prior to evaluation did not reveal any differences between deployed and nondeployed veterans. The distribution of pulmonary function test results was identical among deployed and nondeployed veterans. Among both deployed and nondeployed veterans, about 64% had normal pulmonary function, 16% to 18% had nonreversible airway obstruction, 10% to 12.2% had restrictive lung physiology, 6% to 6.7% had small airway obstruction, and the remaining 0.9% to 1.3% had reversible airway obstruction. **CONCLUSION:** Our findings did not confirm the hypothesis that deployment to the Gulf War in 1990-1991 resulted in an increased prevalence of clinically significant pulmonary abnormalities 10 years later.

19. [Ann Epidemiol](#). 2004 Feb;14(2):81-8.

Anthrax vaccination and self-reported symptoms, functional status, and medical conditions in the National Health Survey of Gulf War Era Veterans and Their Families.

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PURPOSE: To evaluate the health status of Gulf War veterans who reported receipt of anthrax vaccination and a small group of Gulf War veterans for whom documentation of anthrax vaccination exists. **METHODS:** Among the 11,441 Gulf War veterans who completed a health survey, 4601 reported receiving the anthrax vaccine during the war; 2979 veterans reported not receiving it; 3861 were uncertain. Also, 352 of these respondents were documented by the Department of Defense as having received anthrax vaccination. We compared the medical history of these groups of veterans using multivariate analyses. Finally, we analyzed perception of exposure and its relation to reporting bias. **RESULTS:** There were statistically significant differences in prevalence for almost all outcomes studied between those who reported having received anthrax vaccination and those who did not so report. However, when we compared the veterans for whom vaccination records exist to the group who self-reported that they had not received the vaccine, the significant differences in prevalence for almost all of the outcomes disappeared. **CONCLUSIONS:** The extent of a reporting bias should be carefully considered when one evaluates the health consequences of anthrax vaccination based on self-reported data.

20. [J Occup Environ Med.](#) 2004 Apr;46(4):386-97.

The postwar hospitalization experience of Gulf War veterans participating in U.S. health registries.

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In response to concerns that Gulf War veterans were experiencing increased morbidity resulting from wartime exposures in the Gulf War, the Department of Veterans Affairs and the Department of Defense (DoD) initiated clinical registries to provide systematic health evaluations for self-referred Gulf War veterans. The authors used Cox's proportional hazard modeling with data from all DoD hospitals to estimate the probability of hospitalization resulting from any cause, resulting from diagnosis in a major diagnostic category, and resulting from a specific diagnosis of interest. After adjusting for other risk factors, registry participants were 1.43 times more likely to have a postwar hospitalization than registry nonparticipants (95% confidence interval, 1.40-1.46). These findings support the hypothesis that registry participants were more likely to experience postwar morbidity than veterans who chose not to enroll in the health registries.

21. [Am J Public Health.](#) 2003 Apr;93(4):624-30.

Symptom patterns among Gulf War registry veterans.

[Hallman WK](#), [Kipen HM](#), [Diefenbach M](#), [Boyd K](#), [Kang H](#), [Leventhal H](#), [Wartenberg D](#).

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OBJECTIVES: We identify symptom patterns among veterans who believe they suffer from Gulf War-related illnesses and characterize groups of individuals with similar patterns. **METHODS:** A mail survey was completed by 1161 veterans drawn from the Gulf War Health Registry. **RESULTS:** An exploratory factor analysis revealed 4 symptom factors. A K-means cluster analysis revealed 2 groups: (1) veterans reporting good health and few moderate/severe symptoms, and (2) veterans reporting fair/poor health and endorsing an average of 37 symptoms, 75% as moderate/severe. Those in Cluster 2 were more likely to report having 1 or more of 24 medical conditions. **CONCLUSIONS:** These findings are consistent with previous investigations of symptom patterns in Gulf War veterans. This multisymptom illness may be more fully characterized by the extent, breadth, and severity of symptoms reported.

22. [Am J Epidemiol.](#) 2003 Jan 15;157(2):141-8.

Post-traumatic stress disorder and chronic fatigue syndrome-like illness among Gulf War veterans: a population-based survey of 30,000 veterans.

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The authors estimated the prevalence of post-traumatic stress disorder (PTSD) and illness resembling chronic fatigue syndrome (CFS) in the entire population of Gulf War and non-Gulf-War veterans. They also evaluated the relation between the extent of deployment-related stress and the risk of either PTSD or CFS. In 1995-1997, the authors conducted a health survey in which these two symptom-based medical diagnoses in a population-based sample of 15,000 Gulf

War veterans representing four military branches and three unit components (active, reserve, and National Guard) were compared with those of 15,000 non-Gulf veteran controls. Gulf War veterans, compared with non-Gulf veteran controls, reported significantly higher rates of PTSD (adjusted odds ratio = 3.1, 95% confidence interval: 2.7, 3.4) and CFS (adjusted odds ratio = 4.8, 95% confidence interval: 3.9, 5.9). The prevalence of PTSD increased monotonically across six levels of deployment-related stress intensity (test for trend: $p < 0.01$), while the prevalence of CFS rose only at the low end of the stress spectrum. While deployment-related stress could account for the higher risks of both PTSD and CFS, additional factor(s) unique to the Gulf environment may have contributed to the risk of CFS among Gulf War veterans.

23. [J Occup Environ Med.](#) 2003 Dec;45(12):1268-73.

Factor analysis of fatiguing syndrome in Gulf War era veterans: implications for etiology and pathogenesis.

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This study used factor analysis to identify possible subgroups of symptoms of fatiguing syndrome (FS). Subjects were classified with FS according to the 1994 modified Centers for Disease Control and Prevention criteria with the exception that the chronicity of excessive fatigue could not be documented. The cases consisted of 640 Gulf War veterans who met the criteria, whereas the control groups were composed of 5417 Gulf War and 6493 non-Gulf War veterans who did not meet the criteria and had none of the medical conditions that were exclusionary in the FS group. Factor analyses were performed separately in each group. Factor analysis revealed 6 subgroups: fatigue, pain, infectious, gastrointestinal, respiratory, and neurologic/mood/fatigue. Although the factors were similar for both groups, they were more differentiated in the FS group than in the control group as evidenced by interfactor correlations.

24. DeBakey S, Paxton M, Weaver R, Lange J, Cowan D, Kang H, et al. Risk of motor vehicle fatality associated with prior morbidity among Gulf War era veterans. *Ann Epidemiol* 2002;12: 509.

Abstract

PURPOSE: Motor vehicle fatalities (MVF) are the leading cause of mortality among military personnel. Previous studies of our population of all U.S. Gulf War veterans (GWVs) and a comparable number of contemporaneous non-deployed veterans (NDVs) found that the GWVs had a nearly 50% higher rate of MVFs. We sought to identify the role of prior morbidity as an indicator of underlying physical and mental health, lifestyle, or behavioral characteristics contributing to MVFs among GW-era veterans.

METHODS: Our 980 cases were the male drivers from a population of 1,441,807 GW-era personnel who were MVFs between 1991 and 1995 having a record in NHTSA's Fatality Analysis Reporting System. For each case, 10 controls alive at the end of the match year in which the case died were randomly selected from the same population. We analyzed all admissions to Department of Defense (DoD) or Veterans Affairs (VA) hospitals and outpatient visits to VA facilities in the interval following the GW and before the end of the match year as risk factors for MVF.

RESULTS: After adjustment for demographic factors (age, marital status, education, race) and military characteristics (rank, occupation, branch, duty component), we found that use of these medical resources for any cause was associated with subsequent MVFs. Prior treatment for mental health problems, especially the subset related to drug or alcohol abuse, was strongly related to subsequent MVFs, particularly for the NDVs. Admissions for injuries due to a prior motor vehicle crash (available only for DoD hospitalizations) were also associated with the occurrence of a subsequent MVF, particularly among GWVs.

CONCLUSIONS: Men with prior military hospitalizations or VA clinic visits were at higher risk for MVFs than those without such morbidity. This relationship held for the entire military population, but health care for substance abuse was more predictive of MVFs for NDVs, while prior motor vehicle injuries were for GWVs. Patients treated for certain diagnoses may be a population to target for interventions to reduce MVFs.

25. Gackstetter GD, DeBakey S, Cowan D, et al. Fatal motor vehicle crashes among veterans of the Gulf War era: A nested case-control study. *Ann Epidemiol* 2002;12:509–510.

Abstract

PURPOSE: Motor vehicle crashes (MVC) are the leading cause of death among military personnel, and deployment has been associated with an increased risk of fatal MVC within military populations. Gulf War (GW) deployment has also been associated with an increased risk of fatal MVC. We evaluated selected variables as predictors of fatal MVC among GW era veterans using existing Department of Defense, Department of Veterans Affairs, and Department of Transportation (DoT) databases.

METHODS: This is a nested case-control study of a cohort comprised of 696,516 Gulf War veterans and 746,291 non-deployed veterans. 1,343 cases of fatal MVC occurring between 1991 and 1995 were identified from the cohort by linking to the DoT Fatality Analysis Reporting System (FARS). Ten controls were selected per case, matched by gender and year of case ascertainment. We examined data on demographic and military characteristics; hospitalizations and outpatient visits; self-reported behaviors, lifestyle, and psychosocial factors; and possible GW exposures as potential risk factors for fatal MVC.

RESULTS: Fatal MVC on US public roads that caused the death of the driver were not randomly distributed across our study population. Fatalities involving female drivers were few (n = 28). Male fatalities were more likely to be younger, less educated, and never married compared to controls. Cases were also more likely to be enlisted, deployed to the GW, have combat occupations, be in the Guard or Reserve, and be other than Air Force. Inpatient and outpatient data and socio-behavioral data, as well as information from FARS will be reported separately.

CONCLUSION: Our findings are consistent with previous studies that have reported military deployment as a risk factor for fatal MVC. We also identified several other factors that increase this risk. Additional studies to investigate potential risk factors for all MVC, not just fatalities, are warranted so that appropriate interventions can be designed and evaluated.

26. [Occup Environ Med.](#) 2002 Dec;59(12):794-9.

Mortality among US and UK veterans of the Persian Gulf War: a review.

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Mortality data on Gulf War veterans was reviewed as a means of evaluating the long term consequences of the war. Studies were located from searches of Medline, Proceedings of the Conference on Federally Sponsored Gulf War Veterans' Illnesses Research, Proceedings of the American Public Health Association Annual Meetings, Annual Reports to Congress, and personal contacts with knowledgeable investigators. Data on study design, methods, and results were obtained from published studies of both US and UK veterans who served in the Persian Gulf. The methodology and results of studies are summarised and evaluated. Additional research recommendations based on reviewed studies are presented. It is concluded that in both US and UK studies, mortality from external causes was higher, while mortality from all illnesses was lower among Gulf War veterans in comparison to those of non-Gulf War veterans. Increased mortality from external causes is consistent with patterns of postwar mortality observed in veterans of previous wars. Further follow up of Gulf War veterans and their controls is warranted for evaluating the mortality risk from diseases with longer latency periods.

27. [Arch Environ Health](#). 2002 Jan-Feb;57(1):61-8.

Evidence for a deployment-related Gulf War syndrome by factor analysis.

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To identify a syndrome unique to Gulf War veterans, the authors applied an exploratory factor analysis to the 47-symptom correlation matrix of 10,423 Gulf War and 8,960 non-Gulf War veteran respondents. A separate factor analysis was performed for Gulf War and non-Gulf War veterans, and the resulting 6 factors were compared between the 2 groups. Five of the factors were very similar in the 2 groups; however, 1 of the factors in the Gulf War group, but not the non-Gulf War group, contained a cluster of symptoms consistent with neurological impairment. Symptoms specific to this factor were blurred vision, loss of balance/dizziness, tremors/shaking, and speech difficulty. The Gulf War veterans who had all of the aforementioned symptoms (n = 277) also reported exposures to several putative risk factors at a rate 3 or more times higher than other Gulf War veterans. This finding suggests a possible syndrome related to Gulf War deployment, which requires objective supporting clinical evidence.

28. [Am J Epidemiol](#). 2001 Sep 1;154(5):399-405.

Mortality among US veterans of the Persian Gulf War: 7-year follow-up.

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To assess the long-term health consequences of the 1991 Persian Gulf War, the authors compared cause-specific mortality rates of 621,902 Gulf War veterans with those of 746,248 non-Gulf veterans, by gender, with adjustment for age, race, marital status, branch of service, and type of unit. Vital status follow-up began with the date of exit from the Persian Gulf theater (Gulf veterans) or May 1, 1991 (control veterans). Follow-up for both groups ended on the date of death or December 31, 1997, whichever came first. Cox proportional hazards models were used for the multivariate analysis. For Gulf veterans, mortality risk was also assessed relative to the likelihood of exposure to nerve gas at Khamisiyah, Iraq. Among Gulf veterans, the significant excess of deaths due to motor vehicle accidents that was observed during the earlier postwar years had decreased steadily to levels found in non-Gulf veterans. The risk of death from natural

causes remained lower among Gulf veterans compared with non-Gulf veterans. This was mainly accounted for by the relatively higher number of deaths related to human immunodeficiency virus infection among non-Gulf veterans. There was no statistically significant difference in cause-specific mortality among Gulf veterans relative to potential nerve gas exposure. The risk of death for both Gulf veterans and non-Gulf veterans stayed less than half of that expected in their civilian counterparts. The authors conclude that the excess risk of mortality from motor vehicle accidents that was associated with Gulf War service has dissipated after 7 years of follow-up.

29. [Ann Epidemiol.](#) 2001 Oct;11(7):504-11.

Pregnancy outcomes among U.S. Gulf War veterans: a population-based survey of 30,000 veterans.

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PURPOSE: We evaluated an association between veterans' Gulf War service and reported adverse pregnancy outcomes. **METHODS:** We conducted a health survey in which selected reproductive outcomes of a population-based sample of 15,000 Gulf War veterans representing four military branches and three unit components (active, reserve, and National Guard) were compared to those of 15,000 non-Gulf veteran controls. **RESULTS:** Male Gulf veterans, compared with their non-Gulf veteran controls, reported a significantly higher rate of miscarriage (odds ratio [OR] = 1.62; 95% confidence interval [CI] = 1.32-1.99). Female Gulf veterans also reported more miscarriages than their respective controls, although their excess was not statistically significant (OR= 1.35; CI = 0.97-1.89). Both men and women deployed to the Gulf theater reported significant excesses of birth defects among their liveborn infants. These excess rates also extended to the subset of "moderate to severe" birth defects [males: OR= 1.78 (CI = 1.19-2.66); females: OR = 2.80 (CI = 1.26-6.25)]. No statistically significant differences by deployment status were found among men or women for stillbirths, pre-term deliveries or infant mortality. **CONCLUSION:** The risk of veterans reporting birth defects among their children was significantly associated with veteran's military service in the Gulf War. This observation needs to be confirmed by a review of medical records to rule out possible reporting bias.

30. [J Occup Environ Med.](#) 2000 May;42(5):491-501.

Illnesses among United States veterans of the Gulf War: a population-based survey of 30,000 veterans.

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Despite numerous studies on veterans of the 1990 to 1991 Gulf War, the fundamental questions of how healthy they are and how their health compares with that of their military peers who were not deployed to the Gulf have not been fully answered. We conducted a health survey in which the health outcomes of a population-based sample of 15,000 Gulf veterans representing various military branches and unit components (regular, reserve, National Guard) were compared with those of 15,000 non-Gulf veterans who were randomly sampled to mirror the number in the same military strata in the Gulf veteran group. In comparison with their peers, Gulf veterans had a higher prevalence of functional impairment, health care utilization, symptoms, and medical

conditions and a higher rate of low general health perceptions. A longitudinal follow-up of the health of these veterans will be needed to detect changes in health status and to detect diseases with a long latency period.

Am J Epidemiol 1999;148:343–349.

31. Gray GC, Hawksworth AW, Smith TC, Kang HK, Knoke JD, Gackstetter, GD. Gulf War Veterans' Health Registries. Who is most likely to seek evaluation?

Since the Persian Gulf War ended in 1991, many veterans have sought medical evaluation in the Department of Veterans Affairs Persian Gulf Veterans' Health Registry (VA registry) or the Department of Defense's Comprehensive Clinical Evaluation Program (DoD registry). Using combined data collected from 1993 to 1997 from the VA and DoD registries, the authors compared the characteristics of registry participants (n=74,653) with those of all Gulf War veterans (n=696,531) to determine the personnel most likely to seek medical evaluation. Using multiple logistic regression, the authors found that service branch and type were strongly associated with registry participation, with Army (adjusted odds ratio (OR)=4.7, 95% confidence interval (CI) 4.6-4.9) and National Guard (OR=2.6, 95% CI 2.5-2.6) personnel at highest odds compared with reference category personnel. Registry participants also were more likely to have been stationed in the Gulf War theater during the fighting (OR=2.2), to be older (>31 years/<22 years OR=2.1), to have been an enlisted person (OR=2.0), to have been construction workers (OR=1.3), to be female (OR=1.3), and to have been hospitalized during the 12-month period before the war (OR=1.2). These findings are useful in generating hypotheses regarding postwar morbidity. They also suggest that subpopulations of Gulf War veterans have a higher prevalence of symptoms and merit further study.

32. Arch Environ Health 1999;54:313–318.

Kipen HM, Hallman W, Kang HK, Fiedler N, Natelson BH. Prevalence of chronic fatigue and chemical sensitivities in Gulf registry veterans.

More than 68000 of the 700000 veterans of the Gulf War have become members of the Veteran Affairs' Gulf War Registry. In 1995, we undertook a questionnaire study of the symptoms and medical histories reported by a randomly selected subsample of 1935 of these veterans to characterize their complaints. All results reported were based on questionnaire responses without face-to-face evaluation or physical examinations. Inasmuch as initial registry symptoms overlapped those of Chronic Fatigue Syndrome and Multiple Chemical Sensitivities, we also included standard questions for these syndromes in the questionnaire. A total of 1161 (60%) individuals responded, and there were no major demographic biases; therefore, 15.7% of registry veterans qualified for Chronic Fatigue Syndrome in accordance with the 1994 Centers for Disease Control definition. In addition, 13.1% qualified for multiple chemical sensitivities in accordance with a widely used definition, and 3.3% of the respondents had both conditions. There were no effects of gender, race, branch, duty status (active or reserve), or rank, although Multiple Chemical Sensitivities was somewhat more prevalent in women and African Americans. The data gleaned in this study suggested that the unexplained symptom syndromes of Chronic Fatigue and Multiple Chemical Sensitivities may characterize an appreciable portion of the complaints of those who volunteered for the Veteran Affairs' Gulf War Registry, and further investigation is warranted.

33. Mil Med 1999;164:327–331

Murphy FM, Kang HK, Dalager NA, Lee KY, Allen RE, Mathers SH, et al. The health status of Gulf War veterans: Lessons learned from the Department of Veterans Affairs Health Registry..

OBJECTIVE: To describe the demographic characteristics and postwar health status of U.S. Gulf War veterans who participated in the Department of Veterans Affairs health examination registry program. **DESIGN:** Case records of 52,835 veterans who participated in a standardized health examination program were reviewed. **SETTING:** Participants volunteered for physical examinations at a Department of Veterans Affairs medical treatment facility from August 1992 to September 1996. **SUBJECTS:** U.S. Gulf War veterans deployed to southwest Asia between August 1990 and 1996. **MAIN OUTCOME MEASURE:** Demographic, military, symptom, and International Classification of Diseases, Ninth Revision, Clinical Modification, diagnostic categories. **RESULTS:** A wide variety of symptoms and diagnoses were reported without apparent internal variation by military characteristics (branch and service component). The frequency of symptoms (fatigue, skin rash, headache, muscle and joint pain, and memory loss) reported increased over time, whereas the proportion of individuals with physician-diagnosed illnesses remained fairly constant. No single category of disease increased or decreased substantially over time. **CONCLUSIONS:** Veterans have experienced a wide variety of health problems since their Gulf War service. These problems, in aggregate, are different from what has been seen in other armed conflicts. The Department of Veterans Affairs registry is a very large case series and has failed to identify a single, unique syndrome or new illness after Gulf War service. An epidemiologic study would better define the prevalence of specific symptoms and medical conditions among Gulf War veterans and to what extent any of the conditions identified are associated with Gulf War military service. The knowledge provided by such studies would be important to development of preventive measures and future deployment medical surveillance planning.

34. N Engl J Med 1996;335:1505–1513.

Gray GC, Coate BD, Anderson CM, Kang HK, et al. The postwar hospitalization experience of U.S. veterans of the Persian Gulf War.

BACKGROUND: Since the Persian Gulf War ended in 1991, many veterans of that conflict have reported diverse, unexplained symptoms. To evaluate the health of Gulf War veterans, we studied their postwar hospitalization experience and compared it with that of other military personnel serving at the same time who did not go to the Persian Gulf. **METHODS:** Using a retrospective cohort approach and data from Department of Defense hospitals, we studied hospitalizations of 547,076 veterans of the Gulf War who were serving in the Army, Navy, Marine Corps, and Air Force and 618,335 other veterans from the same era who did not serve in the Persian Gulf. Using multivariate logistic-regression models, we analyzed risk factors for hospitalization both overall and in 14 broad diagnostic categories during three periods from August 1991 through September 1993 (a total of 45 specific comparisons). **RESULTS:** After the war, the overall odds ratio for hospitalization of the Gulf War veterans was not higher than that of the other veterans, even after adjustment for selection effects related to deployment. In 16 of the 42 comparisons involving specific diagnoses, the risk of hospitalization among Gulf War veterans differed significantly from that among other veterans. Among these 16 comparisons, Gulf War veterans were at higher risk in 5: neoplasms (largely benign) during 1991, diseases of the genitourinary system during 1991, diseases of the blood and blood-forming organs (mostly forms of anemia) during 1992, and mental disorders during both 1992 and 1993. The differences were not consistent over time and could be accounted for by deferred care, postwar pregnancies, and postwar stress. **CONCLUSIONS:** During the two years after the Persian Gulf War, there was no excess of unexplained hospitalization among Americans who remained on active duty after serving in that conflict.

35. N Engl J Med 1996;335:1498–1504.

Kang HK, Bullman TA. Mortality among U.S. veterans of the Persian Gulf War.

BACKGROUND: Since the 1990-1991 Persian Gulf War, there has been persistent concern that U.S. war veterans may have had adverse health consequences, including higher-than-normal mortality. **METHODS:** We conducted a retrospective cohort study of postwar mortality according to cause among 695,516 Gulf War veterans and 746,291 other veterans. The follow-up continued through September 1993. A stratified, multivariate analysis (with Cox proportional-hazards models) controlled for branch of service, type of unit, age, sex, and race in comparing the two groups. We used standardized mortality ratios to compare the groups of veterans with the general population of the United States. **RESULTS:** Among the Gulf War veterans, there was a small but significant excess of deaths as compared with the veterans who did not serve in the Persian Gulf (adjusted rate ratio, 1.09; 95 percent confidence interval, 1.01 to 1.16). The excess deaths were mainly caused by accidents (1.25; 1.13 to 1.39) rather than disease (0.88; 0.77 to 1.02). The corresponding rate ratios among 49,919 female veterans of the Gulf War were 1.32 (0.95 to 1.83) for death from all causes, 1.83 (1.02 to 3.28) for accidental death, and 0.89 (0.45 to 1.78) for death from disease. In both groups of veterans the mortality rates were significantly lower overall than those in the general population. The adjusted standardized mortality ratios were 0.44 (95 percent confidence interval, 0.42 to 0.47) for Gulf War veterans and 0.38 (0.36 to 0.40) for other veterans. **CONCLUSIONS:** Among veterans of the Persian Gulf War, there was a significantly higher mortality rate than among veterans deployed elsewhere, but most of the increase was due to accidents rather than disease, a finding consistent with patterns of postwar mortality among veterans of previous wars.

36. Arch Intern Med 1995;155:262–268.

Blanck RR, Hiatt J, Hyams KC, Kang HK, et al. Unexplained illnesses among Desert Storm veterans: A search for causes, treatment, and cooperation.

Between August 1990 and March 1991, the United States deployed 697,000 troops to the Persian Gulf to liberate Kuwait from Iraqi occupation. Since the Gulf War, most veterans seeking medical care at Departments of Veterans Affairs and Defense medical facilities have had diagnosable conditions, but the symptoms of several thousand veterans have not been readily explained. The most commonly reported, unexplained complaints have been chronic fatigue, rash, headache, arthralgias/myalgias, difficulty concentrating, forgetfulness, and irritability. These symptoms have not been localized to any one organ system, and there has been no consistent physical sign or laboratory abnormality that indicates a single specific disease. Because of the unexplained illnesses being experienced by some Gulf War troops, a comprehensive clinical and research effort has been organized by the Departments of Veterans Affairs, Defense, and Health and Human Services to provide care for veterans and to evaluate their medical problems. To determine the causes and most effective treatments of illnesses among Gulf War veterans, a thorough understanding of all potential health risks associated with service in the Persian Gulf is necessary. These risks are reviewed in this article and include possible reactions to prophylactic drugs and vaccines, infectious diseases, and exposures to chemicals, radiation, and smoke from oil fires.