

NAVAL HEALTH RESEARCH CENTER

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Summary

Assessing the Potential Health Impact of the 1991 Gulf War on Saudi Arabian National Guard Soldiers

Background

There has been considerable publicity that the 1991 Gulf War may have caused a wide array of health problems in military personnel. Although postwar health outcomes have been studied in US, British, Canadian, and other deployed troops, this issue has not been previously evaluated in coalition forces native to the Gulf region.

Methods

A collaborative team of US and Saudi health researchers was assembled, data sources evaluated, and hospitalizations among Saudi Arabian National Guard (SANG) soldiers between 1991 and 1999 analyzed. Multivariate modeling was used to evaluate differences between 8342 soldiers exposed to combat at Al Khafji and a comparison group of 7270 soldiers in the Riyadh area.

Results

Among 15 612 SANG soldiers we identified 148 with at least one hospitalization over the 9 years following the war. The adjusted rate of hospitalization was higher in the combat-exposed group (risk ratio = 1.80, 95% confidence interval, 1.25-2.59). No unusual patterns of diagnoses were found and, because the overall number of hospitalizations was low, the absolute difference in risk was found to be very small.

Conclusions

This is the first reported epidemiological investigation of postwar hospitalization among coalition forces native to the Gulf region that participated in the 1991 Gulf War. A very small increase in hospitalizations was identified in SANG soldiers exposed to combat at Al Khafji. However, because of data limitations, the clinical relevance of this finding should be interpreted with caution. Future collaborative studies to better understand the health effects of deployment should be encouraged.

Keywords: Saudi Arabia, Persian Gulf syndrome, Gulf War syndrome, morbidity, hospitalization, military personnel, military medicine, military deployment, veterans, health, occupational exposure, environmental exposure

Background

In response to the Iraqi invasion of Kuwait, the United Nations coalition forces began a military buildup in the Gulf region in August 1990 and on January 16, 1991, launched air strikes against Iraqi targets. With air supremacy established, ground operations commenced on February 24, 1991, and continued for just 100 hours.¹ A substantial draw-down was initiated once combat operations ceased, and by the end of June 1991, the vast majority of coalition troops had returned to their homes. This is the context in which concern for a wide variety of post-deployment health issues emerged.

Shortly after the 1991 Gulf War ended, some US veterans began reporting symptoms and illnesses that they attributed to war-related experiences.^{2,3} Coalition partners from the United Kingdom, Canada, and Australia also reported multi-symptom conditions that veterans attributed to their participation in this conflict.⁴⁻⁹ Prompted by veteran and general public concern, multiple studies were conducted by the US Department of Defense to investigate the potential health impact of the Gulf War. What has emerged after more than a decade of research is that certain symptoms, primarily fatigue, cognition problems, and musculoskeletal complaints, are reported more frequently among Gulf War veterans than non-deployed veterans of the same era.¹⁰⁻¹⁴ However, these symptoms or symptom-based conditions are also common in the general population and have been previously noted among veterans of other military deployments.^{13, 15-17} A number of etiologic possibilities have been examined including environmental exposures,¹⁸⁻²¹ infectious agents,²² immunizations,²³ and psychological stressors.²⁴ Despite exhaustive epidemiological study, specific Gulf War exposures have not been individually associated with

self-reported illnesses or conditions, and the etiology of these subjective health outcomes remains unclear.^{3, 25, 26}

To our knowledge, a systematic evaluation of military personnel native to the Gulf region has not previously been conducted. Through discussions between US and Saudi Arabian officials, the opportunity to assess the potential health impact of the 1991 Gulf War on Saudi Arabian National Guard (SANG) soldiers was identified. SANG soldiers played a major role in a battle at Al Khafji, a town located along the border between the Kingdom of Saudi Arabia and Kuwait. The soldiers who fought in the Battle of Al Khafji represent a unique study group within SANG because their war-related experiences may have been similar to those of other coalition forces. If war exposures result in postwar morbidity, then SANG soldiers who served at Al Khafji during January 1991 might be expected to have different health outcomes compared with SANG soldiers who served at sites distant from the front lines of combat in Saudi Arabia. A 10-member collaborative team of Saudi and US investigators was established in order to conduct a health study of SANG members to better understand the complex health issues surrounding the 1991 Gulf War. In this article, we report the epidemiological findings from our investigation. A description of our approach to international collaborative epidemiological research in this unique setting is reported separately in a companion article entitled “Saudi-US Collaboration In Health Research: An Approach For Success.”

Preliminary Studies

We assessed the type and nature of existing data within the SANG health care system to determine the feasibility of conducting a systematic assessment of Gulf War health outcomes among SANG soldiers. We sought to first fully characterize the various existing health data sources and their suitability for inclusion in an analyzable data set. Second, we planned to

identify at least two appropriate comparison groups of SANG soldiers with different war-related exposure(s). Our 10-member team of Saudi Arabian and US investigators included scientists from the King Abdul Aziz Medical City (KAMC), formerly known as King Fahad National Guard Hospital, Riyadh, Kingdom of Saudi Arabia; the Uniformed Services University of the Health Sciences (USUHS), Bethesda, Maryland, USA; Centers for Disease Control and Prevention (CDC), Atlanta, Georgia, USA; and the Department of Defense Center for Deployment Health Research at the Naval Health Research Center (NHRC), San Diego, California, USA. We met in Saudi Arabia in late 1999 to assess the availability of data on hospitalizations, ambulatory care, prescription medications, cancer, and mortality at KAMC. KAMC is a large, 560-bed, tertiary care medical center in Riyadh, established in 1981 to provide both primary care and advanced diagnostic, therapeutic, and other referral services for SANG soldiers and their family members. After evaluating each of the available data sources, we found automated hospitalization records maintained at KAMC to be the most promising for our evaluation of postwar health outcomes.

Methods

Study Population and Data Sources

We identified 15 612 SANG soldiers who were on active duty during the 1991 Gulf War, 8342 located at Al Khafji and 7270 located in the Riyadh area during the period January 1 through February 1, 1991. Demographic and deployment data for SANG personnel were provided by the Office of Personnel at SANG Headquarters. These data included a standardized linking variable, date of birth, rank (enlisted or officer), military status (active, resigned/discharged, held/transferred), first date of active service, and date of separation from

military service. Automated health records maintained at KAMC were linked to deployment and demographic data for the period January 1, 1989, through December 31, 1999, to create an analytic data set. Health information for each SANG member included medical record number, unique identifiers, demographic information (sex, estimated age, minimum age, and eligibility code), and medical information (up to eight hospitalization discharge diagnoses, dates of care, up to five procedure codes, and up to two special care unit codes per hospitalization).

Statistical Analyses

We examined hospitalizations resulting from all causes, as well as diagnoses in 14 major categories of the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)²⁷ from January 1, 1991, through December 31, 1999. The decimal components or subcategories of ICD-9-CM diagnoses were grouped under each of the 14 diagnostic categories.

To compare the hospitalization experience of the two groups of SANG soldiers—while accounting for attrition, including resignation or discharge from military service, over the 9-year follow-up period—we used Cox proportional hazard regression analysis. Study subjects were classified as having an event if they were hospitalized. Only the first hospitalization for each of the targeted outcomes was included for each SANG soldier in our study population, as in the method used by Gray et al.¹⁸ Follow-up time was calculated from January 1, 1991, until hospitalization, separation from SANG service, or December 31, 1999, whichever occurred first. Using SAS[®] version 9.0 (SAS Institute, Cary, North Carolina, USA),²⁸ we calculated crude and adjusted risk ratios (RR) and 95% confidence intervals (CI) by location (Al Khafji vs. Riyadh) and other demographic and military service variables for the 15 612 SANG soldiers. Finally, we

compared the probability of all-cause hospitalization between the Al Khafji and Riyadh soldiers as a function of time.

Preliminary analyses using Cox regression included estimates of crude risk ratios for location during the Gulf War (Al Khafji vs. Riyadh), age (quartiles), length of service (quartiles), military rank (officer vs. enlisted), and active-duty status (active, resigned/discharged, held/transferred), and at least one hospitalization for any cause. Regression diagnostics revealed the absence of collinearity, but the likely presence of significant interaction between age and length of service. We estimated the adjusted risk ratio for location, adjusted for age and length of service as continuous variables. A manual, backward stepwise regression technique was used to construct the final model. Rank was not included in our final model because not all rank data could be linked to individual records. Active-duty status did not contribute significantly to the model as a predictor or confounding variable. The final multivariate model included age and length of service as continuous variables, an age by length of service interaction term, and location.

Human Subjects Protection

Institutional assurances and approvals for our collaborative study were obtained from the USUHS, CDC, NHRC, and KAMC institutional review boards. Unique identifiers were used for linking purposes only and were deleted from the analytic data sets by data managers at KAMC prior to distribution to US co-investigators, thus ensuring that individual study participants could not be identified or contacted.

Results

Demographic and military service data were available for 8342 SANG soldiers stationed at Al Khafji and 7270 SANG soldiers stationed at Riyadh (Table 1). The age distribution in the two groups was comparable (mean age was 32.6 years for the Al Khafji group and 32.5 years for the Riyadh group). Similarly, there was very little difference noted in length of service between the two groups (mean length of service was 5.9 years for Al Khafji and 5.7 years for Riyadh). Although the Al Khafji group had a greater proportion of officers, the distribution across all rank categories was roughly comparable in the two groups (Figure 1). Finally, the vast majority of SANG soldiers remained on active duty (91%) during our study period, even though a relatively greater proportion resigned or were discharged from service in the Riyadh group (13.4%) compared to the Al Khafji group (1.9%).

Table 2 displays crude risk ratios and the adjusted risk ratio for all-cause postwar hospitalizations among SANG soldiers at KAMC from January 1, 1991, through December 31, 1999. A total of 148 SANG soldiers were hospitalized one or more times over the 9-year study period (108 among Al Khafji soldiers vs. 40 among Riyadh soldiers). Those soldiers serving in the Al Khafji area were more likely to be hospitalized compared to those soldiers stationed in the Riyadh area (RR = 2.16, 95% CI, 1.50-3.10). Older age was a predictor for hospitalization (36-52 years, RR = 1.31, 95% CI, 0.89-1.92) as was length of service equal to 9 or more years (RR = 11.28, 95% CI, 6.33-20.09). Military rank could not be evaluated as a risk factor because of the large proportion of missing values. The adjusted relative risk for all-cause hospitalizations was 1.80 (95% CI, 1.25-2.59).

Table 3 lists the adjusted risk ratios for postwar hospitalizations in the two study groups from January 1, 1991, through December 31, 1999, within 14 major ICD-9-CM diagnostic

categories. A total of 285 diagnoses in the 14 categories were identified among the 148 individuals who were hospitalized. Although no single category was statistically significant, the relative risk of postwar hospitalization was increased in the Al Khafji group compared with the Riyadh group across all 14 major categories.

Figure 2 shows the frequency of hospitalizations by calendar year for each of the study groups between 1989 and 1999. The frequency of postwar hospitalizations among the soldiers stationed at Al Khafji is parallel but consistently higher than hospitalizations among those stationed at Riyadh.

Figures 3A and 3B illustrate the cumulative probability of all-cause postwar hospitalization at KAMC over the 9-year period of observation since January 1, 1991, comparing SANG soldiers stationed at Al Khafji and those at Riyadh. Although the probability of hospitalization gradually increases over time for both groups, the lines diverge, with the Al Khafji group having a small, but statistically significant, higher probability of hospitalization compared to the Riyadh group. The difference in cumulative probability of hospitalization is 0.004415 at the end of 1999. Note that the inset, Figure 2B, changes the scale on the y-axis, thus magnifying the difference. The mean follow-up time for Al Khafji soldiers was 8.90 years and for Riyadh soldiers 8.21 years.

Discussion

To our knowledge, this is the first study to examine the postwar hospitalization experience among coalition forces native to the Gulf region. While a number of large epidemiologic studies involving Gulf War veterans from outside the Gulf region have demonstrated an increase in self-reported illnesses, similar findings among Saudi veterans have not been reported in the scientific literature, and we were not aware of any concerns voiced by

SANG veterans or by health care providers during the conduct of our collaborative study. Because we were able to identify two separate groups of SANG soldiers, one stationed in a combat zone and another stationed some distance from the fighting, we were able to design a study to compare possible postwar health outcomes in these two groups of soldiers using existing automated health data. After an initial inventory of possible data sources, we limited our study to hospitalization discharge diagnoses at KAMC.

Overall, it is remarkable that so few hospitalizations, 148 total, were identified during the 9-year study period. In fact, there were only 108 soldiers hospitalized at KAMC among the 8 342 soldiers stationed at Al Khafji, and 40 soldiers hospitalized among the 7 270 soldiers stationed near Riyadh. To the extent that we were able to ascertain hospitalizations at KAMC during the 9-year period of observation, we noted a consistent excess in the number of hospitalizations among the Al Khafji soldiers for all causes as well as for each of the 14 major ICD-9-CM categories examined. When we compared the cumulative probability of all-cause hospitalization between the two study groups over time, we found a small, but statistically significant, difference at the end of our study period. However, the magnitude of the risk difference was very small, 0.004415 (cumulative probability of hospitalization for Al Khafji was 0.006955 and for Riyadh 0.002540), suggesting that if 1000 soldiers in each group were observed for nine years, approximately four or five additional hospitalizations would occur in the Al Khafji group.

Because the actual numbers of hospitalizations were so small, we recognize that point estimates are unstable, making it difficult to draw meaningful conclusions. We offer the following as possible explanations for our findings, perhaps the most salient being incomplete capture of hospitalization data. Data capture was dependent upon existing administrative

databases, both from paper as well as electronic records. These records required translation from Arabic to English, as well as the establishment of new procedures for data entry and coding, data linkages, and data quality control and validation.

Several other factors may have also affected the number of hospitalizations at KAMC identified among our study population. Just prior to the Gulf War, a substantial proportion of the local population left the Riyadh area and did not return until after the cessation of hostilities, thus reducing the demand for inpatient care at KAMC. Additionally, during the 1991 Gulf War, KAMC was designated as a war-related trauma center for all coalition forces. As a result, all elective hospital admissions and health care for family members were directed elsewhere. The actual number of war-related hospitalizations was reported to be very low (only 22 patients with ICD-9-CM codes relating specifically to war trauma, E990-E999). Hospital admissions gradually returned to prewar levels by 1993. However, alterations in the health care delivery system or variations in patterns of utilization may have lingered during the transition period following the war. Finally, the battle of Al Khafji took place just after a new contingent of SANG officers (about 300) completed their training and were immediately assigned to the Al Khafji region. A greater than expected rate of resignation from this new group of officers may have contributed to fewer overall hospitalizations since automated health data are not available for those who resign or are discharged from SANG service.

It is interesting to note that soldiers from Al Khafji were consistently hospitalized in greater numbers from 1991 through 1999 across all major ICD-9-CM categories and all diagnoses, even though none of the adjusted relative risks for these categories achieved statistical significance. In comparing the demographic and military service characteristics of SANG soldiers located at Al Khafji and Riyadh, age and length of service were similarly distributed in

the two groups. SANG soldiers typically serve their entire career in the Saudi National Guard, and this is consistent with the high proportion observed to remain on active duty following the Gulf War. As expected, older soldiers were more likely to be hospitalized, as well as those serving 9 or more years in the military. Our findings did not support an association between adverse health outcomes and environmental or war-related exposures in our study groups.

Since no tertiary care facility existed near Al Khafji during our study period, all SANG soldiers with health conditions requiring hospital admission were referred to KAMC in Riyadh. On the other hand, alternate health care services were available to SANG soldiers in the Riyadh area, a more urban and populous region. This may explain, in part, the consistently larger number of hospitalizations across all major diagnostic categories in the Al Khafji group. Another possible explanation may relate to the larger proportion of soldiers stationed at Riyadh who resigned or were discharged from SANG, making them ineligible for care at KAMC.

Finally, our finding of a difference in the hospitalization experience of the Al Khafji and Riyadh soldiers leads us to speculate that the two groups may, in fact, represent two distinct subpopulations within the SANG and that the groups may have had divergent geopolitical, economic, and/or sociobehavioral characteristics that may have affected post-war utilization of health care services at KAMC.

Study Limitations

Outpatient data, pharmacy data, cancer registry data, mortality data, and self-reported symptoms data were either not in an automated format or not available for our study period. As a result, we could not examine a more complete spectrum of possible postwar health effects within our study groups. However, considerable useful information was available within the SANG

health system that allowed us to conduct this initial epidemiologic study. Although the use of hospitalization data has inherent limitations, it is an objective measure that implies morbidity severe enough for individuals to be admitted for inpatient care. We did not have the means to validate the completeness of data or to fully account for missing data, and automated hospitalization data were not available for SANG family members or for soldiers who were discharged or resigned from SANG service.

We recognize that there may be an array of factors that make understanding and interpreting any observed association between Gulf War service and health outcomes among SANG soldiers challenging. Included among these factors are characteristics unique to the SANG health care delivery system, including health services utilization patterns, information technology and health information management systems, sociocultural norms, possible secular trends including disruption in access to care after the war, and availability of alternate health care services. Certainly we acknowledge that our study findings may not be generalizable to the population of SANG soldiers as a whole, nor to Saudi Arabian military forces other than SANG.

Study Strengths

Despite a number of challenges, this was the first systematic epidemiologic investigation of the postwar hospitalization experience of a coalition partner from the Gulf region. We were able to characterize various existing health data sources and evaluate their suitability for monitoring the health status of the SANG population. Additionally, professional collaborative relationships were established among Saudi investigators in Riyadh and US investigators representing the Department of Defense and the Department of Health and Human Services,

which, we are convinced, will ultimately add to our understanding of the possible health effects of deployment.

Summary and Conclusions

We studied postwar health outcomes of Saudi Arabian National Guard soldiers who served in two separate locations within the Kingdom of Saudi Arabia during the 1991 Gulf War, one a combat region and the other some distance from the front lines of battle. Although there was a statistically significant difference in the cumulative probability of hospitalization between Al Khafji and Riyadh soldiers over the 9-year study period, it is important to note that the absolute difference was extremely small. Also, among 15 612 SANG soldiers, a total of only 148 were hospitalized one or more times. Examination of 14 major ICD-9-CM diagnostic categories did not reveal any difference in the adjusted relative risk of hospitalization between the two study groups.

Perhaps the value of this study lies in the recognition of the need for a population-based health surveillance system to monitor postwar health outcomes among military service personnel native to this region. We recommend that future research efforts focus on the development of mechanisms to support more comprehensive epidemiologic studies, both descriptive and analytic, to more completely assess the health status of SANG and other coalition soldiers.

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Table 1. Demographic and military service characteristics of Saudi Arabian National Guard soldiers stationed at Riyadh and Al Khafji between January 1 and February 1, 1991

Variable	Population N = 15 612 Number (%)	Riyadh N = 7270 Number (%)	Al Khafji N = 8342 Number (%)
Age, years*			
18-29	3,599 (23.1)	1,910 (22.9)	1,689 (23.2)
30-32	4,044 (25.9)	2,161 (25.9)	1,883 (25.9)
33-35	4,265 (27.3)	2,285 (27.4)	1,980 (27.3)
36-52	3,704 (23.7)	1,986 (23.8)	1,718 (23.6)
Length of service, years*			
0-3	4,433 (28.4)	2,318 (27.8)	2,115 (29.1)
4-5	3,710 (23.8)	1,998 (23.9)	1,712 (23.6)
6-8	4,364 (27.9)	2,290 (27.5)	2,074 (28.5)
≥9	3,105 (19.9)	1,736 (20.8)	1,369 (18.8)
Military rank†			
Officer	1,971 (12.6)	502 (6.9)	1,469 (17.6)
Enlisted	13,641 (87.4)	6,768 (93.1)	6,873 (82.4)
Active-duty status†			
Active	14,250 (91.3)	6,171 (84.9)	8,079 (96.8)
Resigned/Discharged	1,134 (7.2)	976 (13.4)	158 (1.9)
Held/Transferred	228 (1.5)	123 (1.7)	105 (1.3)

*Age and length of service were computed as of August 1, 1991.

†Military rank and active-duty status were ascertained as of 1991.

Table 2. Crude Risk Ratios for All-Cause Postwar Hospitalization Among Saudi Arabian National Guard Soldiers at King Abdul Aziz Medical City, January 1, 1991, to December 31, 1999

Variable	Number	Number (% Hospitalized)	Crude RR	95% CI	Adjusted RR	95% CI
Exposed to fighting						
Riyadh*	7,270	40 (0.55)	--	--		
Al Khafji	8,342	108 (1.29)	2.16	1.50—3.10	1.80	1.25—2.59
Total	15,612	148 (0.95)				
Age, years						
18-29*	3,599	45 (1.25)	--	--		
30-32	4,044	24 (0.59)	0.48	0.29—0.78		
33-35	4,265	19 (0.45)	0.36	0.21—0.61		
36-52	3,704	60 (1.62)	1.31	0.89—1.92		
Length of service, years						
0-3*	4,433	13 (0.29)	--	--		
4-5	3,710	14(0.38)	1.28	0.60—2.73		
6-8	4,364	20 (0.46)	1.56	0.78—3.14		
≥9	3,105	101 (3.25)	11.28	6.33—20.09		
Military rank						
Officer*	1,628	67 (4.12)	--	--		
Enlisted	8,811	81 (0.92)	4.41	3.19—6.09		
Missing	5,173	0 (0.0)				
Active-duty status						
Active*	14,250	137 (0.96)	--	--		
Resigned/Discharged	1,134	9 (0.79)	2.16	1.09—4.27		
Held/Transferred	228	2 (0.88)	0.95	0.24—3.85		

*Reference category.

RR = risk ratio; CI = confidence interval.

Table 3. Adjusted Risk Ratios for the Major Diagnostic Categories of Postwar Hospitalization at King Abdul Aziz Medical City, January 1, 1991, to December 31, 1999

ICD-9-CM Codes	Major Diagnostic Categories	Al Khafji	Riyadh	RR	95% CI
		(n = 8342)	(n = 7270)		
		Number (% hospitalized with diagnosis)			
001-139	Infection and parasitic diseases	12 (0.14)	2 (0.03)	3.83	0.84–17.38
140-239	Neoplasms	8 (0.10)	1 (0.01)	5.22	0.65–42.09
240-279	Endocrine, nutritional, and metabolic diseases	16 (0.19)	6 (0.08)	1.50	0.58–3.90
280-289	Blood diseases	9 (0.11)	0 (0.00)	--	--
290-319	Mental disorders	4 (0.05)	0 (0.00)	--	--
320-389	Nervous system diseases	13 (0.16)	4 (0.06)	2.24	0.72–6.89
390-459	Circulatory system diseases	25 (0.30)	9 (0.12)	1.76	0.82–3.81
460-519	Respiratory system diseases	25 (0.30)	13 (0.18)	1.30	0.66–2.56
520-579	Digestive system diseases	37 (0.44)	17 (0.23)	1.36	0.76–2.43
580-629	Genitourinary system diseases	12 (0.14)	4 (0.06)	2.37	0.76–7.35
680-709	Skin diseases	10 (0.12)	3 (0.04)	2.21	0.60–8.15
710-739	Musculoskeletal system diseases	17 (0.20)	5 (0.07)	2.37	0.87–6.47
780-799	Symptoms, signs, ill-defined conditions	9 (0.11)	2 (0.03)	2.78	0.60–12.94
800-999	Injury and poisoning	18 (0.22)	4 (0.06)	2.84	0.95–8.50
Total number of diagnoses		215 (2.58)	70 (0.96)		

ICD-9-CM = *International Classification of Diseases, 9th Revision, Clinical Modification*; RR = adjusted risk ratio; CI = confidence interval.

Figure 1. Rank distribution of soldiers stationed at Al Khafji and Riyadh.

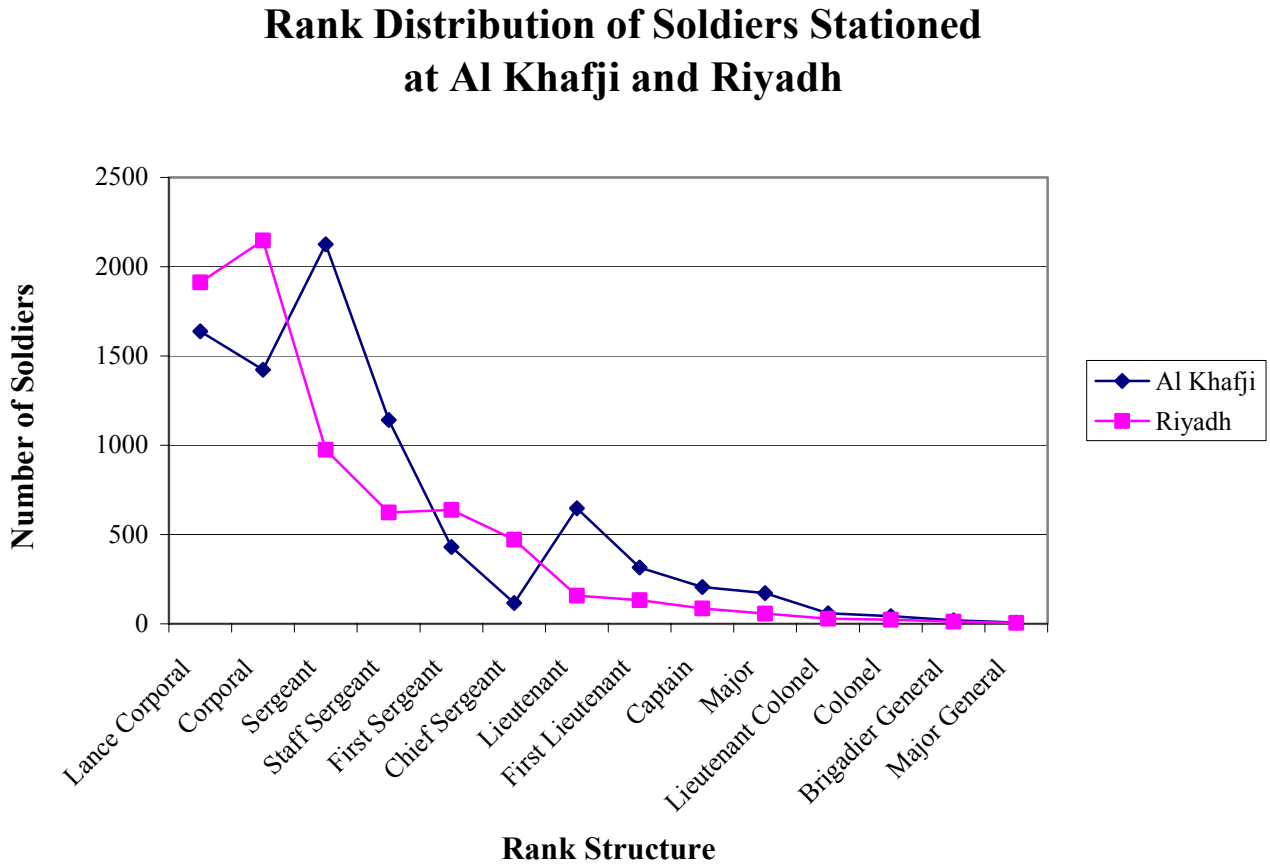


Figure 2. Frequency of postwar hospitalizations at King Abdul Aziz Medical City among SANG soldiers stationed at Riyadh and at Al Khafji, 1989 through 1999.

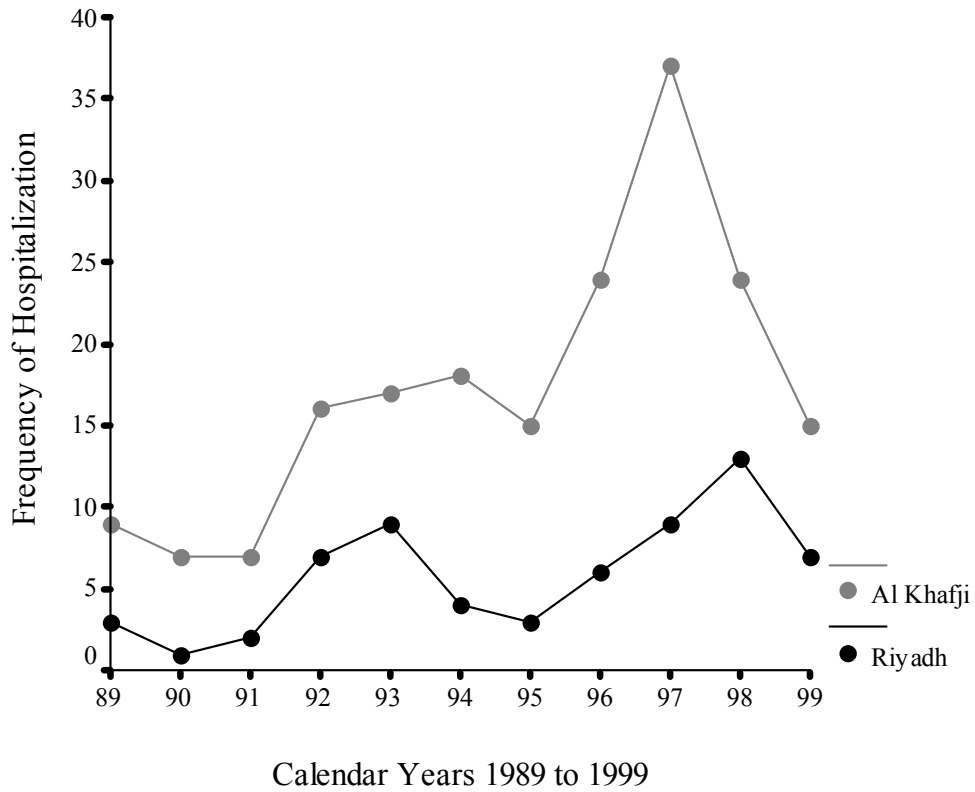
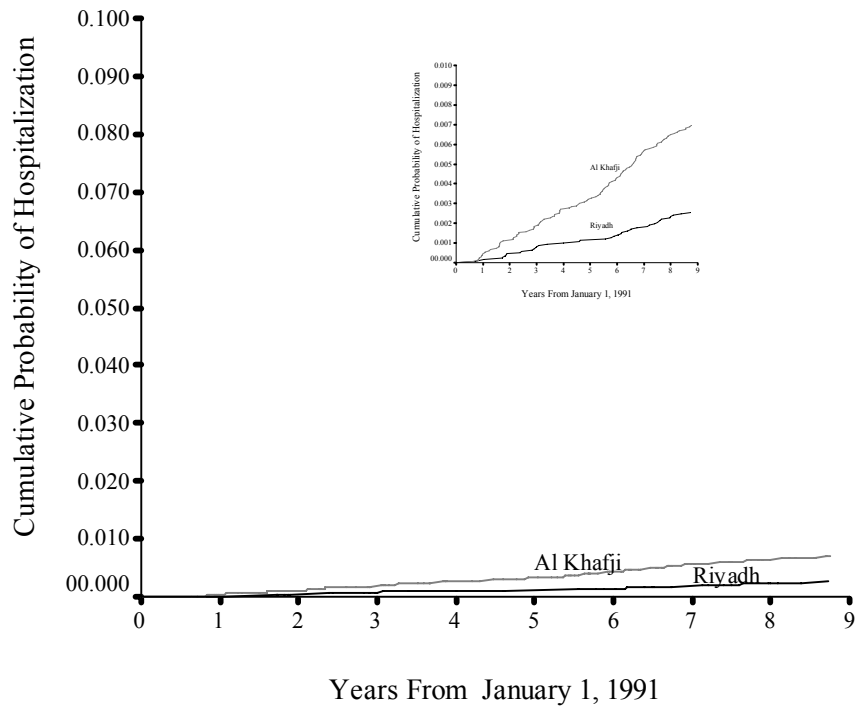


Figure 3A and 3B. The adjusted cumulative probability of postwar hospitalization at King Abdul Aziz Medical City among SANG soldiers stationed at Riyadh and at Al Khafji, January 1, 1991, through December 31, 1999.



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14. ABSTRACT (maximum 200 words)

Background

There has been considerable publicity that the 1991 Gulf War may have caused a wide array of health problems in military personnel. Although postwar health outcomes have been studied in US, British, Canadian, and other deployed troops, this issue has not been previously evaluated in coalition forces native to the Gulf region.

Methods

A collaborative team of US and Saudi health researchers was assembled, data sources evaluated, and hospitalizations among Saudi Arabian National Guard (SANG) soldiers between 1991 and 1999 analyzed. Multivariate modeling was used to evaluate differences between 8342 soldiers exposed to combat at Al Khafji and a comparison group of 7270 soldiers in the Riyadh area.

Results

Among 15 612 SANG soldiers we identified 148 with at least one hospitalization over the 9 years following the war. The adjusted rate of hospitalization was higher in the combat-exposed group (risk ratio = 1.80, 95% confidence interval, 1.25-2.59). No unusual patterns of diagnoses were found and, because the overall number of hospitalizations was low, the absolute difference in risk was found to be very small.

Conclusions

This is the first reported epidemiological investigation of postwar hospitalization among coalition forces native to the Gulf region that participated in the 1991 Gulf War. A very small increase in hospitalizations was identified in SANG soldiers exposed to combat at Al Khafji. However, because of data limitations, the clinical relevance of this finding should be interpreted with caution. Future collaborative studies to better understand the health effects of deployment should be encouraged.

15. SUBJECT TERMS

Saudi Arabia, Persian Gulf syndrome, Gulf War syndrome, morbidity, hospitalization, military personnel, military medicine, military deployment, veterans, health, occupational exposure, environmental exposure

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