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Health Effects Associated With Geographical Area of Residence During the 1991 Gulf War: A Comparative Health Study of Iraqi Soldiers and Civilians

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Abstract

Context—Although Iraqis sustained the gravest exposure conditions during the 1991 Gulf War (GW), little is known about the possible relationship between environmental exposures during the GW and long-term health in Iraqis.

Objective—To study the relationship between distance from Kuwait during the GW and somatic health among Iraqi Soldiers vs civilians.

Methods—A survey questionnaire was distributed to a sample of 742 GW veterans and 413 civilians in Iraq. The odds ratios were calculated for somatic disorders as a function of distance from Kuwait during the GW, as well as a self-reported environmental exposure index.

Results—Soldiers reported a significantly higher prevalence of somatic disorders as compared to civilians. Soldiers closest to Kuwait reported significantly more somatic disorders as compared to Soldiers deployed further away from Kuwait.

Conclusion—Iraqi GW veterans are at an increased risk of numerous somatic disorders. Soldiers are at an increased risk compared to civilians, suggesting that war-associated exposures are of etiologic relevance.

Introduction

The 1991 Gulf War (GW), also known as Operation Desert Shield/Desert Storm, occurred between August 1, 1990 and June 1, 1991. The war involved Iraqi Soldiers and Allied forces from nearly 50 countries. When the Allied Soldiers returned to their home countries, large numbers of them reported a series of somatic and mental health disorders. The most common complaints were headaches, respiratory symptoms, skin disorders, fatigue,

depression, symptoms of posttraumatic stress disorder (PTSD), forgetfulness, etc.[1–17] There have been a series of studies concerning health-related disorders associated with the Gulf War. However, the rates of these disorders vary markedly between studies, with a low of less than 2% to a high of 20%. The Gulf War syndrome has been used as a collective term for these symptoms, although it is not known whether such a specific constellation of symptoms actually exists or if they are part of a more general group of environmental illnesses.[14–18] Similar symptoms have been reported by Soldiers deployed to other recent conflicts, including the 2003 invasion of Iraq, albeit more limited in the numbers affected.[19–24] Epidemiological studies provide evidence for an increased prevalence of nonspecific medical symptoms, and common mental disorders among GW veterans as compared to nondeployed Soldiers, or Soldiers deployed to other conflicts.[6,11,25,26] Somatic disorders, on the other hand, do not seem to be overrepresented in GW veterans versus comparison populations.[27]

A number of factors have been evaluated as to their potential etiologic role in precipitating the GW syndrome, including sand flies, molds, infectious agents, vaccines, medical prophylaxis (for example, pyridostigmine bromide), pesticides, depleted uranium, oil-fire smoke, biological and chemical warfare agents (including sarin and cyclosarin), and psychological stress.[6,28–30] However, no generally accepted theory has been developed to explain these symptoms.

An important limitation in prior epidemiological studies is the risk for nondifferential and differential misclassifications of exposure, as well as lack of sufficient and reliable data to allow a complete assessment of exposures of interest. Without the ability to properly monitor potential exposures from, for example, plumes from destruction of stockpiles of chemical munitions, health risk assessments become difficult. Another important limitation of studies to date is that they most typically concern veterans from non-Gulf countries, including the United States, United Kingdom, Denmark, Australia, France, and Canada. When Allied Soldiers are compared with nondepioyed Soldiers, there is a range of factors that differ between the groups, apart from the Gulf War experience and environmental exposures per se. For example, most Allied forces were not accustomed to the Gulf War region's geographic, ethnic, and cultural characteristics, nor to the desert climate. Comparing Allied Soldiers new to the Iraq/Kuwait environment to controls or nondepioyed Soldiers makes it difficult to evaluate other exposures of etiologic interest. Furthermore, GW veterans are more commonly single, less educated, and/or with a lower socioeconomic status and exhibit a higher participation rate in surveys as compared to nondepioyed comparison groups.[31,32] A major limitation is the fact that most previous studies have been conducted on Soldiers who have left the Gulf War Region and have been in their native country for some time.

Studies comparing Iraqi Soldiers (both deployed and not deployed to Kuwait) during the GW with Iraqi civilians would attenuate differences between the groups' prior experiences (for example, they are used to the desert environment and local culture), and enhance the ability to identify possible GW-related exposures of relevance. By including civilians who were living in the same geographical areas to which Soldiers were deployed, apart from Kuwait per se, we were able to substantially reduce the number of potential Soldier-specific exposures of interest, assuming Soldiers were more exposed than civilians to such agents. Iraqi Soldiers were also the group most at risk for exposure to war-related factors due to limited protective equipment and intensive assault from the Allied forces. To the best of our knowledge, Iraqi Soldiers did not receive the wide array of preventive biological and pharmacological treatments provided to the Allied forces.

There have been prior studies of the mental and somatic well-being of Iraqi Gulf War veteran refugees living in the United States.[33–35] In general, these studies report poor mental health and high prevalence of PTSD, depression, and anxiety among them.

The aims of this study, conducted 10 years after the GW, are to determine if self-reported medical conditions varied by distance from Kuwait, and if self-reported medical conditions varied between Iraqi Soldiers deployed during the Gulf War and civilians after controlling for age, years of military service, and education. The 2 main hypotheses tested were:

- Soldiers report more symptoms than civilians, controlling for distance from the Kuwait war zone.
- Soldiers deployed further away from the Kuwait war front suffered less from physical symptoms as compared to Soldiers deployed in Kuwait.

Participants and Setting

The study sample selected consisted of a convenience sample of men who were Soldiers, or civilians, between the ages of 18–45 years and resided in the Iraq provinces of Basrah or Messanat the time of the 1991 Gulf War. They had to live within 300 km of the Kuwait border to be eligible for the study. Participants were enrolled during 2002. Three surgical residents from Basrah University were trained by one of the coauthors to administer a questionnaire to participants and their acquaintances (Soldiers and civilians) found in waiting rooms at 3 local medical clinics and government outpatient clinics. Individuals who accompanied patients attending the 3 outpatient clinics in the Basrah and Messan Provinces in Iraq were eligible to participate in the study. Thus, in order to minimize selection bias, we only interviewed persons accompanying patients to the health clinics. The 3 clinics were run by the Iraq Ministry of Health and were available to all Iraqis, further limiting the possibility to differential recruitment biases. Potential participants were approached by the medical residents and asked about their interest in participating in a study evaluating long-term health effects from the Gulf War. Participation was voluntary and respondents were able to withdraw from the study at any time. Once verbal consent was obtained, the medical residents proceeded to ask each question and read their respective response choices in Arabic and recorded the participants' responses.

A structured interviewer-administered questionnaire was based on the survey developed and used in several studies of large numbers of US Gulf War Veterans.[36,37] This questionnaire was initially designed and validated at the University of Iowa, the Iowa Department of Health, and the Centers for Disease Control and Prevention, and was used with permission. The original questionnaire was translated into Arabic and back-translated into English to ensure the validity of the phrasing of the questions. In this study, we excluded a total of 24 questions from the original English version since 12 questions were not applicable, and an additional 12 questions were deemed culturally too sensitive.

Briefly, the questionnaire contained questions concerning socioeconomics, smoking history, age, height, and weight. Body mass index (kg/m^2) was calculated arid participants were classified into 3 categories: underweight, <18.5; normal weight, ≥18.5 to <25; overweight to obese, ≥25. Obese participants were included in the overweight category because there were very few obese participants. The participants' residential or deployed distance from Kuwait was queried. Distance from Kuwait was classified into 3 zones: $zone_1$ consisted of Soldiers in Kuwait, 1 to 100 km; $zone_2$, participants (Soldiers and civilians) 101 to 200 km from Kuwait; and $zone_3$, participants (Soldiers and participants) between 201 to 300 km from Kuwait. Out of a total of 1200 respondents, 45 respondents were removed from the analysis because they had resided between 300 km to 860 km from Kuwait. We collected self-

reported years of military experience, military status (deployed/nondeployed, Soldier/civilian) and primary job at time of the survey in 2002 and prior to 1990. Fifteen primary employment classifications were available. They were collapsed into the following categories: students, unskilled workers, Soldiers, skilled workers (farmers, self-claimed skilled workers, and clerks), and professional workers (teachers, doctors, self-claimed professionals, and those in the health profession).

The survey also included detailed questions regarding possible exposures to a range of environmental contaminants in water, food, ground, and the air, including burning oil wells. The participants were asked to respond to whether they had had any of a number of specific medical conditions during the last year. If they responded affirmatively to any of the medical conditions, they were asked whether the conditions had debuted before, during or after the Gulf War. Respondents were asked about symptoms experienced in the month before the interview. They were asked to rate to what degree they were affected by specific symptoms. Scores ranged from 1 (symptom not experienced) to 5 (extremely affected). Participants were asked if, during the last year, they had had any of 35 physical health symptoms, including fatigue, fever, inflammation, neurological symptoms, seizures and convulsion, headaches, cardiovascular symptoms, gastrointestinal symptoms, dermatological signs and symptoms, and musculoskeletal symptoms.

With regard to medical diseases/disorders, participants were presented a list of 57 specified conditions and asked if they had one or more during the last year. If so, follow-up questions related to whether the disorders had debuted before, during, or after the GW. All but 6 specific medical conditions were collapsed into broader medical history categories by body system (Table 1). These categories included hypertension, cardiovascular disease (coronary heart disease and tachycardia), headaches (recurrent headaches and migraines), respiratory disease (bronchitis, pneumonia, tuberculosis, and other lung condition), asthma, ear/nose/throat diseases (chronic sinusitis and ear infection), ulcer disease, gastrointestinal disease (gastritis, enteritis, colitis, hepatitis, cirrhosis, frequent diarrhea), diabetes, genitourinary disease (recurrent bladder infections, renal disease, and any disease of the genital organs), hematology disease (aplastic anemia, leukemia, lymphoma, and any other cancer), rheumatologic disease (arthritis, rheumatism, fibromyalgia, or fibrositis), musculoskeletal disease (lumbago and any disease of the muscles or tendons), chronic fatigue syndrome, allergy (rhinitis and any allergy), skin disorders (skin cancer, tumors, cysts, eczema, psoriasis, dermatitis, and any disease of the hair or scalp including hair loss). A category referred to as “other medical conditions” was created for medical conditions with very low reported prevalence. Other medical conditions included neurological diseases (repeated seizures, convulsions or blackouts, neuralgia or neuritis), endocrine diseases (thyroid and other endocrine disorders), infectious diseases (malaria, leishmaniasis, chronic mononucleosis, and hepatitis), chronic candidiasis, amnesia, and sleep apnea.

All aspects of this study were approved by the Human Investigative Committees at Basrah University and Wayne State University as a collaborative research investigation. Arnetz et al[38] provide further details of study design.

Statistical Analyses

The proportions of Soldiers and civilians (no civilians in $zone_1$, the epicenter of the war) in each zone were calculated. Means and standard deviations for continuous variables are reported. Chi-square (χ^2) tests were used to determine differences between groups for categorical variables, and *P* values are reported. Yates’s correction for χ^2 tests was used as indicated by the data. We calculated unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) to determine the univariate associations between military status and self-

reported medical conditions. We then reported the adjusted ORs for these associations controlling for age, smoking status, and years of education based on unconditional logistic regression modeling. Age and years of education were included as continuous variables. We also examined associations between distance from Kuwait and self-reported medical conditions. Specifically, we compared $zone_1$ to $zone_3$ and $zone_2$ to $zone_3$ where $zone_3$ served as the reference group. All reported *P* values are 2-tailed, and *P* values ≤.05 were considered statistically significant. All analyses were performed using SAS version 9.1.2 (SAS Institute, Cary, NC).

Results

Of 1200 participants asked to participate in the survey, 1155 accepted for an overall response rate of 96.3%. Sixty-four percent (n=742) of the participants had been deployed as Soldiers during the 1990–1991 GW. Among the Soldiers, 168 (22.6%) had been deployed to $zone_1$, the Kuwait war zone; 253 (34.1%) to $zone_2$; and 321 (43.4%) to $zone_3$, the reference zone. Among the 413 civilians, 147 (35.6% of all civilians) had resided in $zone_2$ and 266 (64.4%) in $zone_3$ during the war.

Table 2 depicts demographics by military status. Soldiers were significantly older, and had fewer years of formal schooling as compared to civilians. They also reported higher income, less underweight but worse self-rated health. It was more typical that civilians had been students prior to the 1990 GW. There were no significant differences in smoking history between Soldiers and civilians.

Table 1 depicts unadjusted and adjusted (age, smoking status, and years of education) odds ratios for 17 defined somatic disorders. Based on unadjusted odds ratios, the 2 study groups (Soldiers vs non-Soldiers) differed significantly on 9 of the somatic disorders, including a higher risk of hypertension, cardiac disease, headaches, respiratory disease, gastrointestinal, genitourinary, musculoskeletal, chronic fatigue, and skin disorders among Soldiers as compared to civilians. However, after adjusting for age, smoking status, and years of education, the odds ratios remained statistically elevated for 8 out of the original 9, including hypertension, cardiac disease, headaches, respiratory disease, gastrointestinal disorders, diabetes, chronic fatigue, allergy, and skin disorders. Following the adjustment, Soldiers also exhibited a significantly higher risk of suffering from allergies as compared to civilians. In the second phase of the analysis, we were interested in studying whether there was a dose-response relationship between zones (distance from the Kuwait war zone) and the specific somatic disorders studied, regardless of military status. Table 3 shows that the odds ratios were significantly elevated for 9 of the 17 somatic disorders in $zone_1$ as compared to $zone_3$, the reference zone. With regard to $zone_2$ vs $zone_3$, 10 somatic disorders exhibited significantly elevated odds ratios. The odds ratios for respiratory disease, rheumatologic disease, chronic fatigue syndrome, allergies, and skin disorders were elevated both in $zone_1$ and $zone_2$ as compared to the reference zone. Using $zone_3$ as the reference category, we looked at the possible increased risks of suffering from somatic disorders among Soldiers only exposed to the most intense war zone, ie, $zone_1$. The risks were increased for 9 of the 10 somatic disorders studied (Table 4).

Discussion

During the last 16 years, there have been a large number of studies of medical symptoms and diseases among veterans of the 1991 Gulf War.[1–13] More recently, studies conducted among GW veterans 10 years after the completion of the active first Gulf War are starting to appear.[27] Compared to other recent conflicts (for example, the 2003 wars in Iraq and

Afghanistan), the GW appears to have resulted in a higher prevalence of medical symptoms with longer durations.[19]

Studies to date have mostly dealt with members of the Allied forces. Epidemiological studies typically compare Soldiers that have been deployed to the Gulf in 1991 to nondepioyed Soldiers, or Soldiers deployed elsewhere. However, these studies are characterized by a number of important limitations. Typically, Soldiers deployed are younger, less educated, of lower socioeconomic status and military rank, and more often single.[18,31] Medical charts, including total dosage of vaccines and medical prophylaxis received, are not always known. Details about exposure during the war are commonly inferred from the location of the Soldier's battalion rather than based on person-specific data. Modeling of exposure to oil-well smoke, for example, is also complex. Exposure assessments based on self-reported data and modeled exposure do not necessarily coincide.[31] More seriously, however, Allied Soldiers deployed to Iraq experienced a number of potentially stressful exposures, apart from GW-specific factors, including being away from familiar territory, the desert climate, sand flies, and an environment with different microbial composition from their natural habitat, A major limitation is also the fact that most studies of Allied forces occurred some time after the Soldiers have returned to their native countries. We are thus unable to pinpoint more specifically at what process purported war-related symptoms debut. There is also no compensation schemes available to Iraqi Soldiers as compared to WS and UK Soldiers. AH of these factors might be of importance in identifying reason for the increased rates of medical symptoms in GW veterans, and these exposures differ systematically and nonrandomly between GW veterans and nondeployed referents. In terms of exposure, Iraqi Soldiers and civilians, by most accounts, were exposed to higher dose of war-related environmental factors, and for a considerably longer period of time. Thus, there are numerous reasons why there is a need for long-term follow up health studies of Iraqis, regardless of whether they were deployed during the Gulf War or not.

To the best of our knowledge, this is the first epidemiological study of the health of Iraqi Soldiers being part of the GW operations in 1991, Moreover, we have assessed Iraqi civilians using well-validated measures. We applied a theoretical dose-response exposure-effect model, based on the distance from Kuwait. The theoretical dose-response model is based on the a priori assumption that:

- Soldiers, as compared to civilians, controlling for distance from Kuwait, were exposed to higher doses and a more varied assortment of environmental factors, including biological and chemical warfare agents, oil fire smoke, and mental stressors.
- Soldiers closer to Kuwait should exhibit a higher cumulative harmful exposure dose as compared to Soldiers further away from Kuwait.

As reported in many studies of Allied forces, Soldiers included in our convenient sample, were less educated and had lower income.[18,24] However, in contrast to many studies of Allied forces, Soldiers in our sample were older,[18,31] There were no differences in smoking habits between deployed Soldiers and civilian controls. Prior to the 1991 GW, military service was obligatory for all Iraqi men. This fact is supported by the fact that Soldiers in this study had a mean military service period of 14.1 years as compared to 10.7 for civilians. Many of the Soldiers as well as the non-Soldiers had most likely been part of prior wars, predominantly the war between Iran and Iraq. Overall, we believe our convenient sample is representative for Iraqi Soldiers and civilians in the areas studied.

The odds ratios for a number of somatic disorders were elevated for Soldiers as compared to civilians, including cardiac disease, headaches, respiratory disease, chronic fatigue syndrome, allergies, and skin disorders. This held true even after adjusting for possible

confounders such as age, smoking status, and years of education. A number of studies of Allied forces also report an increase in mental disorders, including depression and anxiety, and chronic fatigue syndrome.[6,11,19,23] Studies of Allied forces have also reported an increased prevalence of skin disorders[31] and respiratory symptoms, including bronchitis and asthma.[29] The increased risk for respiratory disease in this study of 1.94 (95% CI, 1.22–3.09) is similar to that reported by Iowa Persian Gulf Study Group.[36] Our study confirms prior findings of GW veterans that psychosomatic disorders, including headaches and fatigue, appear to be the most systematically increased somatic and psychosomatic disorders.[6,8,18,21,31]

With regard to our á priori hypothesis of a dose-response relationship between an increased odds ratios for somatic disorders and closeness to Kuwait, we confirmed the hypothesis for a total of 15 out of 16 conditions studied. Even after controlling for a person's distance from Kuwait during the GW, we confirmed an increased risk for over half of the somatic disorders studied. However, counter to our á priori hypothesis, the odds ratios were not uniformly increased for persons closest to Kuwait. Rather, both $zone_1$ and $zone_2$ appeared to be at increased risk for symptoms. Interestingly, however, headaches, chronic fatigue, allergies, and skin disorders were all more common in the 2 first zones as compared to $zone_3$. In the most refined analysis, we studied only Soldiers and medical conditions and symptoms as a function of distance from Kuwait. Restricting the analysis to Soldiers only, we still found a dose-response relationship for 14 of the 17 somatic disorders studied. Once again, the increased risks for specific somatic disorders seemed to be related to both $zone_1$ and $zone_2$.

In reality, most of the fighting occurred in the first 2 zones, that is, within 200 km of Kuwait. Environmental and war-specific exposures, including oil well smoke and aerial bombings, were also most frequent in this area.

In conclusion, this study of Iraqi GW veterans and civilians confirms many of the prior findings from Allied GW veterans. Moreover, Iraqi Soldiers exhibited significantly more somatic disorders than did civilians. Closeness to Kuwait was an independent risk factor for most somatic disorders. Since our sample population is used to the climate, culture, and microbial characteristics of Iraq, many of the confounders from prior epidemiological studies of Allied GW veterans can be eliminated as possible precipitators of GW-related symptoms and syndromes. Iraqi Soldiers were not administered any of the biological and pharmacological treatments, including anthrax vaccine, that most Allied Soldiers received. Nevertheless, they exhibited a higher rate of a range of somatic disorders, as compared to Iraqi civilians. This suggests there were other risk factors for these disorders than the medical countermeasures. We have reported a dose-response relationship between distance from Kuwait during the 1991 GW and a range of somatic disorders studied. This suggests that one or more war-associated factor or factors contributed to the findings. We are now in the process of planning further studies of the Iraqi cohort in order to better define prior environmental exposures and current somatic and mental well-being.

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Table 1

Reported medical history by military status: unadjusted and adjusted associations between somatic disorders and military status.

Somatic Disorders	Soldiers n_1=742	Civilians n_2=413		Unadjusted	Adjusted†
	CD: Count by Disorder			Odds Ratio (95% CI)	
	CD (%n_1)	CD (%n_2)	p*		
Hypertension	77 (11.3)	28(6.9)	.018	1.72 (1.09–2.70)[a]	1.22 (0.74–2.02)[b]
Cardiac disorder	90 (13.1)	32 (7.8)	.007	1.78 (1.17–2.72)[c]	1.73 (1.08–2.77)[a]
Headaches	215 (30.0)	83 (20.2)	.003	1.70(1.27–2.26)[d]	1.43 (1.04–2.00)[a]
Respiratory disorder	106 (15.1)	39 (9.6)	.008	1.68 (1.14–2.48)[c]	1.94 (1.22–3.09)[c]
Asthma	31(4.6)	21 (5.2)	.666	0.88 (0.50–1.56)[b]	0.77 (0.42–1.42)[b]
Ear/nose/throat disorder	91(13.3)	44(10.8)	.223	1.27 (0.87–1.86)[b]	1.22 (0.80–1.86)[b]
Ulcer	42 (6.2)	17 (4.2)	.156	1.52 (0.85–2.70)[b]	1.42 (0.75–2.66)[b]
Gastrointestinal disorder	253 (36.0)	113 (27.8)	.005	1.46 (1.12–1.91)[d]	1.60(1.17–2.18)[c]
Diabetes	24(3.6)	11 (2.8)	.443	1.33 (0.64–2.74)[b]	1.26 (0.55–2.86)[b]
Genitourinary disorder	131(18.5)	40(9.8)	<.001	2.09 (1.44–3.05)[e]	1.82 (1.18–2.80)[c]
Hematology disorder	09 (1.3)	11 (2.7)	.105	0.49 (0.20–1.18)[b]	0.68 (0.23–2.01)[b]
Rheumatology disorder	87 (12.8)	37 (9.1)	.063	1.47 (0.98–2.20)[b]	1.06 (0.68–1.64)[b]
Musculoskeletal disorder	195 (27.3)	86 (21.0)	.019	1.41 (1.06–1.89)[a]	1.28 (0.92–1.78)[b]
Chronic fatigue	56(8.1)	11 (2.7)	.001	3.19 (1.65–6.17)[d]	6.99 (2.49–19.66)[d]
Allergies	253(36.6)	131 (32.0)	.117	1.23 (0.95–1.59)0	1.42(1.06–1.91)[a]
Skin disorders	181 (26.6)	72 (17.7)	.001	1.69 (1.24–2.29)[d]	1.66 (1.16–2.36)[c]
Miscellaneous disorders	46 (6.5)	20(4.9)	.267	1.36 (0.79–2.33)[b]	1.15 (0.63–2.09)[b]

Percentages are based on non-missing data.

Odds ratio represents the magnitude of association between medical condition and military status with civilians.

*Represents the p-value for χ^2 tests for each medical condition by military status.

†Adjusted for age, smoking status, and years of education.

[a]P<. 05

[b]No significant difference

[c]P<.01

[d]P<.001

[e]P<.0001

Table 2

Demographic data by military status.

	Civilians n_1=413	Soldiers n_2=742	All Participants N=1155
		Mean (SD)	
Age, years*	28.7 (5.6)	32.1 (8.0)	31.0 (7.5)
Military service, years*	10.7 (5.6)	14.1 (8.0)	13.0 (7.5)
Body mass index	20.7 (2.4)	20.9 (2.7)	20.8 (2.6)
		CC: Count by Category	
	CC (%n_1)	CC (%n_2)	CC (%N)
Education status*			
8th grade or less	73 (18.3)	212 (28.6)	285 (25.3)
8th grade or more, no high school	150 (37.5)	218 (30.1)	368 (32.7)
Completed high school	91 (22.8)	161 (22.2)	252 (22.4)
Some college (Incomplete)	20 (5.0)	28 (3.9)	48 (4.3)
Bachelors degree/higher	66 (16.5)	106 (14.6)	172 (15.3)
Smoking Status			
Never smoked	205 (50.1)	344 (47.3)	549 (48.3)
Former smoker	62 (15.2)	115 (15.8)	177 (15.6)
Current smoker	142 (34.7)	268 (36.9)	410 (36.1)
Income*			
Less than $20,000	373 (94.7)	606 (84.3)	979 (88.0)
$20,000 to <$50,000	6 (1.5)	66 (9.2)	72 (6.5)
$50,000 or more	15 (3.8)	47 (6.5)	62(5.6)
Primary job prior to 1990*			
Student	195 (49.7)	239 (34.8)	434 (40.2)
Unskilled worker	21 (5.4)	63 (9.2)	84 (7.8)
Skilled worker	34 (8.7)	112 (16.3)	146 (13.5)
Soldier	66 (16.8)	112 (16.3)	178 (16.5)
Professional	38 (9.7)	57 (8.3)	95(8.8)
Other	38 (9.7)	104 (15.1)	142 (13.2)
Primary Job at time of survey*			
Student	25 (7.7)	23 (4.7)	48 (5.9)
Unskilled worker	25 (7.7)	75 (15.4)	100 (12.3)
Skilled worker	74 (22.8)	206 (42.3)	280 (34.5)
Soldier	8(2.5)	32 (6.6)	40 (4.9)
Professional	192 (59.3)	151 (31.0)	343 (42.3)
Body mass index classification*			
<18.5: underweight	101 (24.5)	145 (19.5)	246 (21.3)
≥ 18.5 to < 25: normal	301 (72.9)	586 (79.0)	887 (76.8)
≥25: overweight to obese	11 (2.7)	11 (1.5)	22 (1.9)

	Civilians n_1=413	Soldiers n_2=742	All Participants N=1155
		Mean (SD)	
Self-rated health status at time of survey*			
Excellent	16(3.9)	32 (4.3)	48 (4.2)
Very good	100 (24.5)	131 (17.7)	231 (20.1)
Good	258 (63.2)	465 (62.8)	723 (63.0)
Fair	27 (6.6)	98 (13.2)	125 (10.9)
Poor	7 (1.7)	14 (1.9)	21 (1.8)

Percentages are based on non-missing data.

*P (range between < .05 and < .001) represents the P value for overall χ^2 tests.

Table 3

Reported medical history by zone and odds ratios (95% CI) for zones 1 vs 3 and zones 2 vs 3.

Somatic Disorders	All Zones N=1155	Zone 1 n_1=168	Zone 2 n_2=400	Zone 3 n_2=587	P^*	$p^{Trend\dagger}$	Zones 1 vs 3‡	Zones 2 vs 3§
	CD: Count by Disorder						Odds Ratio (95% CI)	
	CD (%N)	CD (%n_1)	CD (%n_2)	CD (%n_3)				
Hypertension	105(9.7)	18 (14.9)	25 (6.7)	62 (10.6)	.017	.871	1.48 (0.84–2.60)[a]	1.66 (1.02–2.69)[b]
Cardiac disorder	122 (11.2)	20(16.5)	22 (5.7)	80(13.6)	<.001	.258	1.26 (0.74–2.14)[a]	2.61(1.60–4.26)[c]
Headaches	296 (26.4)	1 (54.7)	71(18.1)	146 (24.9)	<.001	<.001	3.65 (2.51–5.31)[c]	1.50(1.09–2.06)[b]
Respiratory disorder	145 (13.1)	42 (31.3)	44(11.3)	59(10.1)	<.001	<.001	4.09 (2.60–6.43)[c]	0.88 (0.60–1.32)[a]
Asthma	52(4.8)	11(9.8)	7(1.8)	34(5.8)	<.001	.975	1.77 (0.87–3.61)[a]	3.29 (1.44–7.51)[d]
Ear/nose/throat disorder	135 (12.4)	130 (95.6)	27 (7.0)	85 (14.9)	<.001	.597	1.43 (0.86–2.38)[a]	2.25(1.43–3.53)[e]
Ulcer	59 (5.4)	13 (11.4)	17 (4.4)	29 (4.9)	.012	.054	2.48 (1.25–4.93)[e]	1.12 (0.61–2.07)[a]
Gastrointestinal disorder	366 (32.9)	58 (42.9)	103 (26.6)	205(34.9)	.008	.852	1.40(0.96–20.05)[a]	1.48 (1.12–1.97)[d]
Diabetes	35(3.3)	7 (6.3)	6(1.7)	22(3.8)	.038	865	1.71 (0.71–4.11)[a]	2.31(0.93–5.76)[a]
Genitourinary disorder	171(15.3)	50 (35.5)	51(13.0)	70(11.9)	<.001	<.001	4.06 (2.65–6.21)[c]	0.91(0.62–1.33)[a]
Hematology disorder	20(1.9)	4(3.6)	44 (37.6)	9(1.5)	.402	.203	2.40 (0.73–7.94)[a]	0.84 (0.31–2.28)[a]
Rheumatology disorder	124(11.4)	27 (23.7)	14(3.7)	83(14.1)	<.001	.789	1.88(1.15–3.08)[b]	4.34 (2.43–7.77)[c]
Musculoskeletal disorder	281 (25.0)	78 (53.4)	80 (20.4)	123 (21.0)	<.001	<.001	4.33 (2.96–6.33)[a]	1.03 (0.75–1.42)[a]
Chronic fatigue	67 (6.1)	38 (30.2)	27(7.0)	2 (0.3)	<.001	<.001	126.3(29.9–532.8)[c]	0.05 (0.01–0.19)[c]
Allergies	384(34.9)	61 (47.3)	107 (27.8)	216(36.8)	<.001	.665	1.54 (1.05–2.26)[b]	1.51(1.14–2.00)[d]
Skin disorders	253 (23.3)	44 (37.6)	67 (17.5)	142 (24.2)	<.001	.2285	1.89(1.24–2.87)[d]	1.51(1.09–2.08)[b]
Miscellaneous disorders	66(5.9)	23 (17.0)	17(4.4)	26(4.4)	<.001	<.001	4.43 (2.44–8.05)[c]	1.02(0.54–1.90)[a]

Percentages are based on non-missing data.

*Represents the *P* value for overall χ^2 test.

†pTrend represents the *P* value for trend test.

‡OR represents the magnitude of association between medical condition and zone 1 where zone 3 Is the reference zone.

§OR represents the magnitude of association between medical condition and zone 2 where zone 3 Is the reference zone.

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Note: Zone 1 = In Kuwait; Zone 2 =>100–190 km from Kuwait; Zone 3 = 360 km from Kuwait

[a] No significant difference

[b] $P<.05$

[c] Pc.0001

[d] $P<.01$

[e] $P<.001$

Table 4

Reported medical history among study group and odds ratios (95% CI) for zones 1 vs 3 and zones 2 vs 3.

Somatic Disorders	All Zones N=742	Zone 1 n_1=168	Zone 2 n_2=253	Zone 3 n_3=321	P^*	Zones 1 vs 3†	Zones 2 vs 3‡
	CD: Count by Disorder					Odds Ratio (95 % CI)	
	CD (%N)	CD (%n_1)	CD (%n_2)	CD (%n_3)			
Hypertension	77 (11.3)	18 (14.9)	19(8.0)	40 (12.5)	.102	1.22 (0.67–2.23)[a]	1.65 (0.93–2.92)[a]
Cardiac disorder	90(13.1)	20 (16.5)	16(6.6)	54 (16.8)	.001	0.98 (0.56–1.72)[a]	2.87 (1.60–5.15)[b]
Headaches	215 (30.0)	81 (54.7)	46 (18.6)	88 (27.4)	.001	3.2 (2.13–4.80)[c]	1.65 (1.10–2.47)[d]
Respiratory disorder	106 (15.1)	42 (31.3)	25 (10.1)	39 (12.2)	.001	3.30 (2.02–5.42)[c]	1.23 (0.72–2.09)[a]
Asthma	31 (4.6)	11 (9.8)	4(1.7)	16 (5.0)	.003	2.08 (0.93–4.62)[a]	3.12 (1.03–9.46)[d]
Ear/nose/throat disorder	91 (13.3)	23 (19.5)	19 (7.8)	49 (15.3)	.003	1.34 (0.78–2.32)[a]	2.13 (1.22–3.73)[e]
Ulcer	42 (6.2)	13 (11.4)	11 (4.5)	18 (5.6)	.036	2.17 (1.03–4.58)[d]	1.26 (0.58–2.70)[a]
Gastrointestinal disorder	253 (36.0)	58 (43.0)	70 (28.3)	125 (38.9)	.006	1.18 (0.79–1.78)[a]	1.61 (1.13–2.30)[e]
Diabetes	24 (3.6)	7 (6.3)	5 (2.2)	12 (3.7)	.167	1.72 (0.66–4.47)[e]	1.74 (0.60–5.01)[a]
Genitourinary disorder	131 (18.5)	50(35.5)	35(14.1)	46(14.3)	.001	3.28 (2.06–5.23)[c]	1.02 (0.63–1.64)[a]
Hematology disorder	9 (1.3)	4 (3.6)	1(0.4)	4 (1.3)	.051	2.96 (0.73–12.05)[a]	3.07(0.34–27.61)[a]
Rheumatology disorder	87 (12.8)	27 (23.7)	12(4.9)	48 (15.0)	.001	1.77 (1.04–3.00)[d]	3.38 (1.76–6.53)[b]
Musculoskeletal disorder	195 (27.3)	78 (53.4)	55 (22.2)	62 (19.3)	.001	4.79 (3.13–7.35)[c]	0.84 (0.56–1.26)[a]
Chronic fatigue	56(8.1)	38 (30.2)	18 (7.4)	0 (0.0)	.001	277 (16.6–4558.60)[c]	0.02 (0.001–0.32)[c]
Allergies	253 (36.6)	61 (47.3)	68 (28.2)	124 (38.6)	.001	1.42 (0.94–2.15)[e]	1.60 (1.12–2.29)[e]
Skin disorders v	181 (26.6)	44 (37.6)	40 (16.5)	97 (30.2)	.001	1.39 (0.89–2.17)[a]	2.19 (1.45–3.31)[b]
Miscellaneous disorders	66 (5.9)	23 (17.0)	17 (4.4)	26 (4.4)	.001	5.29 (2.55–10.98)[c]	0.84 (0.36–1.93)[a]

Percentages are based on non-missing data.

*Represents the *P* value for overall χ^2 test.

†OR represents the magnitude of association between medical condition and zone 1 where zone 3 Is the reference zone.

‡OR represents the magnitude of association between medical condition and zone 2 where zone 3 Is the reference zone.

Note: Zone 1 = In Kuwait; Zone2=100–190 km from Kuwait; Zone 3=360 km from Kuwait.

[a] No significant difference

[b] $P<.001$

[c] $P<0001$

[d] $P<.05$

[e] $P<.01$