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The Long Term Impact between Chemical and Non-Chemical Stressors and Musculoskeletal Disorders on Iraqi Residents during the Gulf War

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Abstract

Background: Gulf War (GW) yielded high rates of diseases and disorders to all who participated and those near these active warzones. Certain stressors play a direct role in the prevalence of musculoskeletal disorders.

Objective: To determine the effects chemical (Ch) and non-chemical (NCh) stressors have on musculoskeletal disorders of those in and near active warzones and to inform primary care physicians about these adverse effects.

Methods: A volunteer, validated, self-reporting survey was given to those who accompanied patients of clinics available to all in the Basrah and Messan provinces of Iraq. In order to examine the severity Ch and NCh stressors have on musculoskeletal disorders three zones were partitioned according to their distance from war zone. Also participants answered questions related to environmental exposure and self-rated health assessment.

Results: We found a significant (P<0.001) difference between Ch and NCh exposure across the three zones. Specifically, 49% of those in zone 1 displayed one or more musculoskeletal disorders and those in zone 1 also self-reported having the highest prevalence of fair to poor health. There were also significant predictors to three Ch and two NCh exposures on musculoskeletal disorders. In addition, the likelihood the participants will have one or more musculoskeletal disorder doubles with each exposure which expands the description of.

Conclusion: The study showed that the Ch and NCh stressors has a significantly impact on the prevalence of musculoskeletal disorder. In addition, this study found significant, previously unreported links between some of these Ch and NCh exposures and musculoskeletal disorders. This study reports the impact of Ch and NCh exposure on musculoskeletal disorders among non-military persons in active warzones.

Keywords: Chemical; Non-Chemical stressors; Arthritis; Lumbago; Muscle/Tendon disorders; Gulf war 1991; Iraq

Introduction

In general, literature is lacking in regards to the health repercussions and risk factors in people who are in active engagement in the war or near war zones. In this study we will compare adverse health effects of Iraqi people who were engaged in the Gulf war 1991 (GW) zones, with the focus of identifying environmental chemical (Ch) and non-chemical (NCh) exposure risk factors in relation to musculoskeletal disorders (MSD). Although 26 years have passed since the GW, the study is relevant due to the lacking literature from community-based research on the impact Ch and NCh have on musculoskeletal disorders. Additionally, studies on MSD of those in the Gulf War are continuing to be published, with some citing no changes in symptoms 10 years or more after the initial study [1-3]. We will compare data from three different GW zone areas: directly in the war zone (zone 1); within 101-200 km of war zone (zone 2); and greater than 201-300 km of war zones (zone 3) where combat and conflict occurred.

In contrast to literature on non-military civilians in war zones, there is ample data published about the health consequences war has on those in direct engagement [4-16]. Large numbers of veterans returning from combat have reported or been diagnosed with MSD such as arthritis [4-12,14-16]; lumbago [4,6,9,12,14,16] and other MSD [4-6,9-16]. Veterans have reported all of the above conditions in higher percentages than the general population [17-19]. Studies suggest that these MSD among veterans are caused by various Ch and NCh exposures [4-16]. The prevalence of arthritis, for example, has increased due to the chemical environmental exposures veterans were subject to [15]. Ch exposures can include several items including inhalation of smoke from oil well fires, exposure to depleted uranium shells, as well as chemical and biological attacks [15].

The impact and association between exposure and MSD of non-combatant civilians within war zones is also critical when identifying the etiology between the two, and in distinguishing them as Ch or

NCh, the latter of which may lead to a range of psychosocial illnesses [20]. This study hypothesizes that participants who were closer to the war zone will have: (1) high level of war Ch and NCh environmental exposure items, (2) high prevalence rate of MSD as combined or not, (3) strong associate with an increased risk of MSD. As such, this study aims (a) To increase awareness of primary health care physicians about treatment of these disorders taking into consideration the possible war risk factors on MSD in relation to patient location during war, and (b) To offer policy makers insight as to the importance of educating all the communities on the impact of Ch and NCh exposure to their health and what precautions should be taken in the event of exposure.

Methodology

This paper is an addition to the sequence of papers whose main purpose is to ascertain the impact of GW Ch and NCh environmental exposure and its risk factors on MSD (arthritis, lumbago and muscle/tendons disorders) among Iraqis living in the North of Iraq, 10 years after their exposure to the Gulf war 1991 [21-22].

Data collection

Data were collected via a survey, and in order to be eligible, the participants in the survey were required to be male, aged 18-45, reside in the provinces of Basrah or Messan during the GW, and to have lived within 300 km of the Kuwait (War Zone=Zone 1) Iraq border which was determined based on the participant's area of residence during the GW. Three postgraduate physician residents of Basrah University were instructed by one of the co-authors to administer this questionnaire to those found in the waiting rooms of three local government outpatient clinics that were accompanying patients. Differential recruitment bias was offset by choosing clinics that were available to all Iraqi's and run by the Iraqi Ministry of Health. Furthermore, the patients of the clinic were not given a survey; only those accompanying the patients were given the choice to participate in the survey with an option to withdraw.

Questionnaires

Validated self-reporting surveys are the most simple and least costly method of acquiring data. In addition, surveys are quick to administer and are shown to obtain situational factors [23]. The survey was produced and corroborated at the University of Iowa, The Iowa Department of Health, and the Center for Disease Control [22] with their permission. For the perseverance of legitimacy the survey questionnaire was translated into Arabic and then retranslated into English.

This survey was used in other collaborator papers on U.S. Gulf war veterans; for further details refer to Arnetz et al [21].

Participants

Participants were asked a multitude of questions including those about their health and geographical location. Based on where they lived during the GW (August 1990 to June 1991), they were separated by their geographical responses into the three groups for comparison. Of the 1200 participants, 45 were removed for residing outside the zones of interest (301 km to 860 km) (n=1155). The three zones were classified as follows: Zone 1 included those within 1 km to 100 km of Kuwait (War zone); Zone 2 included those 101 km to 200 km from Kuwait; and Zone 3 included those 201 km to 300 km from War zone. The survey asked participants to report having any of the following: arthritis, lumbago, and muscle/tendons disorders, and it included follow up questions on whether treatment for such disorders was ever given. The survey asked whether conditions identified by participants occurred before, during, or after the GW and if the participants received treatment for that disorder. Afterwards, the three disorders were combined to establish a new variable where either the participants have one or more of these disorders, or none. The survey also included questions about demographics and socioeconomic status. Additional information regarding the methods of data acquisition and depth and breadth of the survey can be found in previous studies [22].

Selected instruments

Self-rated health: Self-rated health (SRH) was evaluated with a five point scale that spanned from "1" being excellent health to "5" signifying poor health. This SRH scale represents a well-defined proxy for prospective health status, specifically including minority populaces [24,25]. In addition to being well corroborated, it is shown to forecast future health and mortality in presently health persons. The scale was bifurcated into good health (excellent, very good, and good) versus poor health (fair and poor). This categorization was suitable in order to treat our analysis as continuous given that an item measured on a Likert scale signifies ordinal level data [26-28].

Environmental exposure assessment: In order to understand causation and correlation, the participants were asked to indicate any type of Ch and NCh exposures, and indicate whether exposure was due to direct contact with, or being indirectly exposed to stressors during the Gulf War. There is a set of questions in the questionnaire that addresses Ch and NCh environmental exposure [29,30]. The validated exposure indices include: 1) Aggregate Ch Environmental Exposure dose, and 2) Aggregate NCh Exposure dose. The Ch environmental exposure scale consists originally of 15 questions, but participants do not respond to 6 questions for unknown reasons, yielding 9 questions: smoke from oil burning fires; exhaust from heaters or generators; diesel fumes or other petrochemical fumes; burning trash or burning feces; diesel or other petrochemical fuel on their skin; depleted uranium; pesticides on clothing or bedding; bathing or drinking water contaminated with smoke oil or other chemical; and bathing or swimming in local ponds, rivers, or in the Arab Gulf. The duration for each class of Ch exposure was categorized into three duration groups where "1" meant an exposure of less than 5 days, "2" as exposure between 6 to 30 days and "3" as exposure for more than 30 days. This Ch exposure duration was multiplied by the exposure status variable to obtain the cumulative exposure dose. The level of exposure was attained by combining the responses from the Ch exposure questions [23]. The range of the scale for Ch environmental exposure was between 0 and 27 points.

Eight different NCh exposure questions were asked of participants including hearing chemical alarms, scud missiles exploding in the air or on the ground within one mile, artillery, rockets or mortars (anything other than scud missiles) explosions within one mile, being subjected to small arm fire, seeing dead bodies, exposure to dead animals, witnessing a person dying, or any other war related exposure which the participant considered harmful or extremely stressful. The Diagnostic and Statistical Manual for Mental Health Disorders considers these NCh exposures sufficient in severity to be classified as exposure criteria A for post-traumatic stress syndrome. These NCh exposures were similarly classified into the following groups: "1"

meaning an exposure of less than 5 days; "2" as exposure between 6 to 30 days; "3" as exposure for more than 30 days [19-20]. The range of NCh scale was between 0 and 24. The Ch and NCh scales exhibited excellent psychometric properties with a Cronbach's α of >0.85.

Statistical analysis

Chi square test was used to calculate the proportion of the categorical variables while the T-test was used for continuous variables and both were used to test for similarities and differences for selected variables between groups. The reported P values are 2-tailed with $P \leq 0.05$ was considered statistically significant. To predict the risk factors for each of the musculoskeletal disorders and the combined disorders we used binary logistic regression analysis which also shows the strength of association between any of the musculoskeletal disorders or the combined disorders and the distance from war zone (within the three zones). Also the study was interested to see if any of the 9 Ch and 8 NCh exposures would be a risk factor to these participants who had one or more of the musculoskeletal disorders versus those without illnesses, by using binomial logistic regression analysis, including the calculation of point estimates within 95% confidence intervals. SPSS 21.0 for Windows was the program used in the data analysis.

Results

The results of the study (Table 1) show a significant differences (P<0.001) between the three zones when examining the participants by age, number of years in the military services, Ch, and NCh exposures, smoking status and BMI, but not with education. Worth noting is that Ch exposure was highest in zone 1 (Mean 2.5 ± 3.00) in comparison to zone 2 (Mean 1.0 ± 2.07) and zone 3 (Mean 0.0 ± 0.24), respectfully. Similar trends were found for NCh exposures.

Variable	Zone 1 [n=168]	Zone 2 [n=400]	Zone 3 [n=587]	Total [n=1155]
ANOVAs Test Mean (SD)				
Age in year***	34.3 (5.86)	32.4 (10.31)	29.4 (5.18)	31.1 (7.48)
Year in Military Service***	16.5 (5.64)	14.3 (9.45)	11.4 (5.4)	13.1 (7.19)
Chemical Exposure***	2.5 (3)	1 (2.07)	0 (0.24)	0.7 (1.89)
Non-Chemical Exposure***	3.7 (4.1)	2.9 (5.49)	0 (0.68)	1.6 (3.95)
Chi-square test	No. (%)	No. (%)	No. (%)	No. (%)
Education				
High School or less	125 (75.3)	311 (82.5)	469 (80.6)	905 (80.4)
More than High School	41 (24.7)	66 (17.5)	113 (19.4)	220 (19.6)
Smoking status*				
Smokers	96 (57.1)	214 (53.5)	277 (47.2)	587 (50.8)
Never smoke	72 (42.9)	186 (46.5)	310 (52.8)	568 (49.2)
BMI***				
Less 18.5 Underweight	33 (19.6)	107 (26.8)	106 (18.1)	246 (21.3)
18.6-24.9 (Normal	128 (76.2)	288 (72)	471 (80.2)	887 (76.8)
25 & more (Overweight)	7 (4.2)	5 (1.3)	10 (1.7)	22 (1.9)
*P < 0.05, **P < 0.01, ***P < 0.001.				

Table 1: Characteristics Variables of the Study Population by Area of Residents during Gulf War 1991.

Table 2a indicates differences in the prevalence of the MSD (Arthritis, Lumbago and Muscle/tendon disorders) between the participants according to their zonation during GW 1991. These differences were significant in lumbago and Muscle/tendon disorders (P <0.001) but not in arthritis. In general the number of participants who have one or more of these MSD were significantly higher among those who were located in zone 1 compare to other zones, e.g., 49% of participants in zone 1 have one or more of the MSD followed by 20.4% of those in zone 3. Table 2a also shows differences in self-rated health (SRH) of the participants and their zone location. In addition, participants who are located further away from the zone 1 reported higher percentage of excellent to good health compared to participants in other locations. Table 2b shows the binomial logistic regression analysis that was used to predict risk factors for excellent to good health after adjusting to all variables shown in Table 1. The likelihood of having reported excellent to good health exhibited significant factors such as those participants who were in zone 3 compared to those in zone 1 (P<0.004, OR=2.35), those who never smoked (P<0.039, OR=1.53), and those having no MSD (P<0.008, OR=1.75). This was compared to those participants that were present in zone 1, are smokers, or have one or more disorders (Table 2b).

Variable	Zone 1 [n=168]	Zone 2 [n=400]	Zone 3 [n=587]	Total [n=1155]
	No. (%)	No. (%)	No. (%)	No. (%)
Prevalence of Musculoskeletal Disorders				
Arthritis	7 (7.1)	10 (2.6)	30 (5.2)	47 (4.4)
Lumbago***	64 (47.8)	69 (18.0)	96 (17.0)	229 (21.1)
Muscle/Tendon***	6 (6.1)	4 (1.0)	10 (2.0)	20 (1.9)
Frequency				
0 (No disease)	72 (51.1)	311 (79.9)	467 (79.6)	850 (76.1)
1	62 (44.0)	73 (18.8)	106 (18.1)	241 (21.6)
2	6 (4.3)	5 (1.3)	12 (2.0)	23 (2.1)
3	1 (0.7)		2 (0.3)	3 (0.3)
Have disease	48.9	20.1	20.4	23.9
Self-Rated Health at Survey time* **				
Excellent	18 (10.7)	12 (3)	18 (3.1)	48 (4.2)
Very good	35 (20.8)	93 (23.4)	103 (17.7)	231 (20.1)
Good	78 (46.4)	233 (58.7)	412 (70.7)	723 (63)
Fair	31 (18.5)	52 (13.1)	42 (7.2)	125 (10.9)
Poor	6 (3.6)	7 (1.8)	8 (1.4)	21 (1.8)

Table 2a: The Prevalence of Musculoskeletal Disorder among Study Population by area of Residence during the Gulf War.

Likelihood of have excellent to good health	B	Sig.	Odd Ratio	95% C.I. Lower (Upper)
Participants location		0.011		
Participants in zone 2	0.358	0.213	1.43	0.815 (2.512)
Participants in zone 3	0.854	0.004	2.349	1.315 (4.198)
Never Smoke	0.427	0.039	1.532	1.023 (2.295)
Having one or more Musculoskeletal Disorders	-0.557	0.008	0.573	0.38 (0.864)
Ref. : Participants present in zone 1 Smokers, No medical condition				
Adjusted for: age, education, BMI, chemical exposures, non-chemical exposure, years in the military service, *P < 0.05, **P < 0.01, ***P < 0.001				

Table 2b: Binomial logistic regression analysis to predict risk factors for excellent to good health.

Table 3 shows the binary logistic regression analysis that was used to predict risk factors for each of the three MSD studied. Both age (OR=1.060) and Ch exposures (OR=1.282) are shown to be significant risk factors in the likelihood of having arthritis. Furthermore those participants in zone 3 in relation to zone 1 showed significant decrease in the likelihood of arthritis (P<0.029, OR=0.353). Factors that significantly impacted the likelihood of lumbago were those in zone 1 in relation to zone 2 with an OR=2.683, and Ch exposures (OR=1.225). Education and smoking status showed to be significant factors in decreasing the likelihood of lumbago. The likelihood to have muscle/tendon disorders was decreased by distance from the battle zone, specifically those within zone 2 from zone 1 (OR=3.604). The likelihood of having one or more MSD decreased when the participants were in zone 2 as opposed to zone 1. Combined MSD also decreased if participants never smoked, however, multiple disorders' likelihood increased when considering their Ch exposure (OR=1.240). In order to predict which Ch or NCh exposures were risk factors to having one or more of the MSD, we repeated the binary logistic analysis 17 times (9 Ch and 8 NCh), so in each test we examined one of these Ch or NCh variable.

Likelihood one of the medical condition	B	Sig.	Odd Ratio	95% CI	
				Lower	Upper
Likelihood to have arthritis					
Participants location during Gulf war		0.091			
Participants in zone 2 (Ref. zone 1)	-0.582	0.309	0.559	0.182	1.714
Participants in zone 3 (Ref. zone 1)	-1.042	0.029	0.353	0.138	0.9
Age in year	0.058	0.005	1.06	1.017	1.104
Chemical Exposures Score	0.248	0.017	1.282	1.046	1.571
Likelihood to have Lumbago					
Participants location during Gulf war		0.001			
Participants in zone 2 (Ref. zone 1)	0.987	0.001	2.683	1.636	4.402
Participants in zone 3 (Ref. zone 1)	-0.059	0.777	0.943	0.625	1.421
H. S. or less vs. More than H.S. [Ref.]	-0.467	0.019	0.627	0.425	0.926
Never smoke vs. Smokers [Ref.]	-0.65	0.001	0.522	0.372	0.731
Chemical Exposures Score	0.203	0.001	1.225	1.087	1.38
Likelihood to have Muscle/Tendon Disorders					
Participants location during Gulf war		0.042			
Participants in zone 2 (Ref. zone 1)	1.282	0.052	3.604	0.989	13.134
Participants in zone 3 (Ref. zone 1)	-0.559	0.417	0.572	0.148	2.207
Likelihood to have One or more Musculoskeletal Disorders					
Participants location during Gulf war		0.001			
Participants in zone 2 (Ref. zone 1)	-0.967	0.001	0.38	0.238	0.609
Participants in zone 3 (Ref. zone 1)	-0.435	0.065	0.647	0.408	1.027
Never Smoke	-0.512	0.001	0.599	0.446	0.806
Chemical Exposures Score	0.212	0.001	1.237	1.1	1.39
Ref. : Participants present in Kuwait, Smokers.					

Table 3: Binary logistic regression analysis testing each time one of the Musculoskeletal Disorders studied to predict risk factors.

Table 4 shows only the significant predictors to 9 Ch and 8 NCh types of exposures tested. The Ch exposures of smoke from oil well fires (P<0.000, OR=2.31), burning trash/feces (P<0.048, OR=2.07), and diesel or other petrochemical fuel on skin (P<0.008, OR=2.37) all were statistically significant in predicting one or more MSD.

The NCh exposures of hearing scud missile explosions (P<0.041, OR=1.25) and exposure to artillery, rockets, mortars or anything else (P<0.000, OR=4.18) significantly increased the likelihood of one or more MSD while hearing chemical alarm sounds (P<0.016, OR=0.28) increased the likelihood of one or more MSD compared to those hearing alarms farther away from the battle zone.

Furthermore, those who never smoked showed an increased risk in the likelihood of exposure to all Ch and NCH exposures tested (P ≤ 0.001 for all 6 exposures) (Table 4). Lastly, participants in zone 1 were at higher risk for Ch and NCh exposure compares to zone 2 or zone 3, and the difference was significant.

Therefore, there is a decreased likelihood of having one or more M in zone 2 as compared to zone 1. As expected, similar trends were seen for participants in zone 3 compare to zone 1. This is correct for 4 of the 6 exposures (Ch and NCh), with the two exceptions being exposure to smoke from oil well fires and hearing artillery, rockets, mortars or any other explosion (Table 4).

Likelihood of have one or more Musculoskeletal Disorders	B	Sig.	Odd Ratio	95% CI	
				Lower	Upper
Testing Chemical Exposure to Smoke from oil well fires					
Participants location		0.001			
Participants in zone 2	-0.67	0.009	0.51	0.31	0.84
Participants in zone 3	0.00	0.985	1.00	0.60T	1.65
Never smoke	0.45	0.003	1.57	1.16	2.13
Exposure to smoke from oil well fires	0.84	0.001	2.31	1.76	3.03
Testing Chemical Exposure to Burning trash or bumming feces					
Participants location		0.001			
Participants in zone 2	-1.19	0.001	0.3	0.19	0.47
Participants in zone 3	-0.79	0.001	0.45	0.30	0.68
Never smoke	0.57	0.001	1.76	1.32	2.37
Exposure to burning trash or burning feces	0.73	0.048	2.07	1.01	4.24
Testing Chemical Exposure to Diesel or other petrochemical fuel on your skin					
Participants location		0.001			
Participants in zone 2	-1.07	0.001	0.34	0.22	0.54
Participants in zone 3	-0.66	0.003	0.52	0.34	0.79
Never smoke	0.56	0.003	1.75	1.31	2.35
Exposure to diesel or other petrochemical fuel on your skin	0.86	0.008	2.37	1.25	4.48
Testing Non-Chemical Exposure to Hear chemical alarms sounding					
Participants location		0.001			
Participants in zone 2	-1.38	0.001	0.25	0.16	0.39
Participants in zone 3	-1.00	0.001	0.37	0.24	0.55
Never smoke	0.58	0.001	1.78	1.33	2.38
Exposure to hearing chemical alarms sounding	-1.27	0.016	0.28	0.1	0.79
Testing Non-Chemical Exposure to Have a scud missile explode in the air					
Participants location		0.001			
Participants in zone 2	-1.19	0.001	0.31	0.2	0.48
Participants in zone 3	-0.69	0.002	0.5	0.32	0.77
Never smoke	0.57	0.001	1.77	1.32	2.37
Exposure to hearing a scud missile explode in the air	0.23	0.041	1.25	1.01	1.56
Testing Non-Chemical Exposure to Have artillery, rockets, mortars, or anything else					
Participants location		0.001			
Participants in zone 2	-0.82	0.001	0.44	0.27	0.71
Participants in zone 3	-0.29	0.226	0.75	0.47	1.2

Never smoke	0.52	0.001	1.69	1.25	2.27
Exposure to hearing artillery, rockets, mortars, or anything else	1.43	0.001	4.18	2.43	7.19
Ref.: Participants present in war zone (zone 1 Smokers; Adjusted for: age, education, BMI, years in the military service.					

Table 4: Applying binary logistic regression analysis for each of the Ch or NCh variables to predict risk factors for having one or more musculoskeletal disorders. Only those who showed significant predictor were present in the table.

Discussion

The results of the study accept its hypothesis as there were high level of Ch environmental exposure in Zone 1 compared to other zones. The impact of both Ch and NCh environmental exposure on all types of MSD were clear through higher level of their prevalence rates in zone 1 compared to other zones. In addition, the study results indicate that participants were healthier in zone 3 compared to other zones, in particular zone 1. Results of logistic regression analysis showed clearly that the location of participants during the GW environmental exposure was risk factors in each type of MSD. It is of interest to predict 3 war Ch environmental risk factors out of 9 analysis, these risk factors are: Smoke from oil well fires; Burning trash or burning feces, and diesel or other petrochemical fuel on the skin. We found 3 war NCh environmental risk factors out of 8 analysis to be previously unreported as significant risk factors. These risk factors are: Hearing chemical alarms sounding; having a scud missile explode in the air; and Having artillery/rockets/mortars/anything else. One article showed the adverse effects of smoke from oil well fires on musculoskeletal disorders [31], while many other studies did not list musculoskeletal as being adversely effected by similar Ch and NCh exposures [32-35].

The literature on veterans, specifically the occurrences of similar MSD, is supported by our finding for both Ch and NCh exposure [4-16,35]. The results of our study showed that the prevalence of arthritis in zone 1 is higher than that in veterans of other studies [5,9-12,20] except one [13]. On the other hand, the prevalence of joint pain among veterans was higher than muscle/tendon disorders [5-6,8-12,36-38] of those in zone 1, while the prevalence of Lumbago in our study was higher than veterans in some studies [9,12] and lower in other studies [7,20,38-39]. Our study showed that the participants in zone 1 reported Lumbago at a rate of 47.8%, which is much higher than among the general population (22.2%) [40]. Our participants in zones 1, 2, and 3 all reported lower rates muscle/tendon disorders than that of the general population [41].

One article suggests that only the Ch exposure of smoke from oil well fires has been linked to MSD [31]. Our study demonstrated that two other Ch exposures (burning trash/feces and exposure to diesel/petrochemicals on the skin) and three of the NCh exposures which we tested (hearing chemical alarms, scud missile explosion or any other type of missile explosion) showed significant risk factors to having one or more MSD. In addition, this study found a relationship between being in zone 1 and MSD. Specifically, those nearest to Zone 1 displayed higher prevalence's of arthritis, lumbago and muscle/tendon disorders. Also, participants reported a high percentage of fair to poor health compared to those further away (zones 2 and 3). Almost half of those in the zone 1 showed one or more MSD that decreased in zones 2 and 3, respectfully. The total percentage of MSD was 24.5%. Furthermore, both Ch and NCh exposures were greatest in zone 1 in addition to reports of no MSD being lowest in zone 1 (Table 2). The different Ch exposures across the zones was dramatic, with zone 1 having the highest, followed by zone 2 and, on average, no Ch exposure for those in zone 3. The smoking status of the participants across the zones showed no specific trend, similarly to BMI, though there was a slightly higher prevalence of overweight participants in zone 1, than 2 and 3, respectfully (Table 3).

The NCh exposure, such as hearing scud missiles explode in the air, slightly increased the likelihood of one or more MSD while hearing artillery, rockets, mortars, or any other explosion more than quadrupled this likelihood. Also, the NCh exposure of hearing chemical alarms sounding decreased the probability of one or more MSD exhibited. Lastly, the NCh exposure of psychological stress showed us a similar trend of being highest in zone 1 and tapering in zone 2 followed by again, an average, of no exposure for zone 3 (Table 4).

The findings are the first to demonstrate that the likelihood that the participants will have one or more MSD more than doubles with each chemical exposure. This research extends the previous studies by reporting on non-military persons in an active war zone. This research also expands the description of these MSD to include disorders based on multiple risk-factors, and furthermore evaluates association with Ch and NCh exposures. Our findings list significant risk factors to the disorders we examined and shows that the closer to the war zone the participants were, the more likely they were to have higher Ch and NCh exposure, which are significant risk factors to the MSD.

The limitations to our study include firstly that the MSD were self-reported by the participants and are subject to misclassification. The survey included many diseases and disorders to increase the sensitivity of the measure and could result in an overestimation of actual MSD and perhaps could explain the stronger association with two or more MSD. In addition, the survey was given several years after the Gulf War ended and could result in recall bias. Furthermore the participants exposures with undetectable agents (e.g., depleted uranium) [24]. However, due to the adequate sample size, we were able to examine 17 individual Ch and NCh exposures and found six of these to be significant risk factors.

Conclusion

The major outcomes of this study reveal the impact of war Ch and NCh environmental exposure on the prevalence rate of different types of MSD and the strength of the impact was associated with location of the participants from the war zone. Also the study identified some Ch and NCh risk factors to MSD. Also, participants reported poor health when their location was closer to war zone, as well as more MSD.

The study recommends primary health care physicians consider the effect these exposures have in their plan of care. We also recommend policy makers establish an education program for the general population to increase awareness that these Ch and NCh exposure

have on MSD and to take strict precaution against such exposures. Further research should specifically focus on these types of disorders via an impartial means, such as medical examinations, in order to explain links between war exposures and these types of MSD. If these findings are further confirmed, then practice can be implemented to limit exposures and reduce prevalence's of MSD.

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