Belief in Exposure to Chemical and Biological Agents in Persian Gulf War Soldiers

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Abstract: This is the first longitudinal cohort study of Persian Gulf War US soldiers to examine belief in exposure to chemical and biological weapons before and shortly after combat. A longitudinal sample of $n = 1250$ male Persian Gulf War US Army soldiers were surveyed 3 to 4 months before and 6 to 10 months after the 1991 War. Six to 10 months after combat, 4.6% of the cohort believed they had been exposed to chemical and biological weapons. Adjusting for demographics only, those who reported a greater number of combat exposures (odds ratio, OR: 18.8), or higher combat stress (OR: 12.27) were more likely to believe they were exposed. Adjusting for all variables soldiers who reported higher combat stress continued to be most likely (OR: 6.58) to believe they had been exposed to chemical and biological weapons. Individuals reporting higher combat stress are at substantially greater risk of reporting they have been exposed to chemical or biological weapons.

Key Words: Chemical biological exposure, chemical biological stress, trauma exposure.

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The London bombings in July of 2005, the 2004 Madrid bombings, the World Trade Center and Pentagon terrorist attacks on September 11, 2001, and the 2001 anthrax attacks are reminders that nations remain vigilant to terrorism and the potential for chemical and biological attacks—both real and perceived. Belief in exposure to toxic agents, including chemical and biological agents even when none are documented, is not uncommon and necessitates health care evaluation and services (North et al., 2005; Rubin et al., 2005; Ursano, 2002; Ursano et al., 2002; Valverde, 2005).

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Studies have shown a strong relationship between physical and psychological symptoms and belief in exposure after military and civilian trauma. Concern about sarin gas attacks in Israel and Japan, radiological contamination in Brazil, the effects of the Chernobyl nuclear accident in Norway, and the anthrax attacks on the US capital are well documented examples of increased healthcare utilization related to belief in exposure to toxic agents (Bleich et al., 1992; Ohbu et al., 1997; Weisaeth, 1994). Women and those who were older experienced more threat and reported greater negative emotional reactions after the Chernobyl accident (Havenaar et al., 1997). In a study of terrorist threat perceptions, British researchers demonstrated factors such as age, gender, and proximity to threat were predictors of perceived threat, avoidance, and adaptive behaviors (Goodwin et al., 2005).

We have previously reported on soldiers of the Persian Gulf War (in 1991) who were registered in the Department of Defense's Comprehensive Clinical Evaluation Program ($n = 44{,}168$) for post-Persian Gulf War health services. At 4 to 5 years after conflict, women, those who were older, nonwhite, reported poorer health, and had greater war-related exposures were more likely to believe they had been exposed to a chemical agent (e.g., nerve/mustard gas) (Stuart et al., 2002, 2003). Approximately 6.3% of women and 4.9% of men believed they had been exposed to a chemical agent. In a UK Persian Gulf War cohort, examined 6 years after the 1990–1991 War and again in 2002, 9.5% reported in 1997 that they believed they had been exposed to a chemical or nerve gas attack during the Persian Gulf War. In 2002, 13.8% of the same cohort believed they had been exposed (Unwin et al., 1999). Other studies of US troops many years after the war, using different methodologies and samples, have reported as high as 63.4% of combat troops and 53% of Persian Gulf War veterans believing they were exposed to chemical and biological warfare (Brewer et al., 2006; McCauley et al., 1999). There is no convincing evidence of any deliberate exposure of US troops to chemical weapons, nor of any accidental exposure to any significant levels of chemical agents. Nevertheless, many soldiers now have come to believe that they were exposed to chemical or biological weapons (Riddle et al., 2003; US General Accounting Office, 2001; US Government Printing Office, 1996; The National Academies Institute of Medicine, 2006).

To better understand belief in exposure to chemical and biological agents, we examined a cohort of Persian Gulf War soldiers before and 6 to 9 months after combat. This is the

first longitudinal study of US soldiers to examine belief in exposure shortly after combat.

METHODS

Researchers from the Walter Reed Army Institute of Research examined US Army soldiers deployed to the Persian Gulf Region from late Fall of 1990 through early 1991 ($N = 2781$). Postwar assessments were conducted 6 to 9 months later ($N = 6736$; May 1991 through September 1991). Formal research approval was granted by the US Army Research Institute and the Walter Reed Army Institute of Research. All subjects were informed that participation was voluntary and confidential. Approximately 97% agreed to participate. The purpose of this research was to examine psychological and behavioral responses of US Army combat soldiers to deployment, combat, and family stress (Stuart and Halverson, 1997). This research provided a real-time precombat opportunity to study responses immediately before the ground war and the unique opportunity to examine the relationship of precombat stressors and mental health and postcombat beliefs in exposure and mental health. To better understand precombat predictors of postcombat belief in exposure to chemical and biological weapons we identified subjects who completed both pre and post-Persian Gulf War questionnaires to create a matched sample with precombat assessments.

Sample

Precombat questionnaires were administered in Saudi Arabia to soldiers from 17 US Army combat units from November through December 1990. Combat units surveyed ranged in size of 30 to 900 soldiers. To examine the effects of combat, units of soldiers engaged actively in war and which could be identified and resurveyed upon redeployment home. This included 5 Army posts in central, eastern, and southern US states. Of the 2781 male solders surveyed before combat, 1250 remained on active military duty, were available for follow-up, and agreed to participate in the follow-up assessment. The remaining soldiers had transferred to other US locations, or been discharged from the military, and were not available for follow-up. The turnover rate in these units (about 50%) was normal after combat for units at that time. Female soldiers were not authorized in combat units at that time. Average age at the time of the war was 24 years (range, 18–59), 31% ($N = 382$) were married and 64% ($N = 811$) were white. Nearly all were enlisted soldiers (99.2%; $N = 1240$). Comparison of our pre- and postmatched sample with precombat subjects not assessed at the postcombat showed no significant differences in age, marital status, or ethnicity. In addition, our precombat sample and pre- and postmatched combat sample were similar in age, race, and marital status to enlisted combat soldiers deployed in the Persian Gulf War (Joseph, 1997).

Measures

Participants completed 2 questionnaires (November through January 1991—precombat and May through December 1991—postcombat). The questionnaire solicited information on demographics, combat-related anticipated worry or stress, current and previous family-related adjustment, and assessed precombat anxiety, depression, and somatization using 3 subscales of the Brief Symptoms Inventory (Derogatis, 1993). Participants were asked "Were there any problems in your family before you deployed?" and "Are there currently any problems in your family that require you to be home?" Anticipatory combat fear to combat events was measured by a 10-item scale taken from a previously used exposure scale (Kulka and Schlenger, 1986; Stretch and Figley, 1984). Recently this scale has been further validated (Dohrenwend et al., 2006). Soldiers were asked about future combat and exposures "how much worry or stress the following events cause you when thinking about combat" (e.g., attack by enemy tanks, being wounded or killed in action). For each item, anticipatory combat fear was measured on a 5-point Likert-type scale—"None at all" = 1 to "Extreme" = 5 ($N = 1166$, mean = 2.96, $SD = 0.80$) (Stretch and Bliese, 1996).

The second survey administration was accomplished after return home in mid to late 1991. Returned soldiers were asked to indicate rates of combat exposure from a 26-item scale and to what extent each exposure was stressful (Hoge et al., 2004; Stretch and Bliese, 1996). Most soldiers sampled reported one or more combat exposures (e.g., "I was wounded in combat" or "I went on combat patrols"). Combat exposure was measured as a count of the endorsed items. A 5-point Likert-type scale was used to measure combat stress: "None at all" = 0 to "Extreme" = 4 ($N = 1192$, mean = 2.74, $SD = 0.98$). The primary outcome variable in this study is the item "belief in exposure to enemy chemical or biological weapons." This item, a part of the combat exposure scale, was independently analyzed, thus reducing the 26-item scale by 1. This item was measured on the same 5-point Likert scale ($N = 58$, mean = 0.046, $SD = 0.210$). The same 3 Brief Symptoms Inventory subscales—anxiety, depression, and somatization—and the Global Severity Index (GSI), were included to measure postcombat psychological symptoms.

Data Analysis

To identify risk factors for belief in exposure to chemical or biological weapons while in combat, parameter estimates were generated for the demographics (age, marital status, and ethnicity), family problems before and currently while deployed, anticipated combat fear, combat exposure, and combat stress during the war. The outcome variable, belief in exposure to chemical or biological weapons during the war was dichotomized to reference those who reported they believed they had been exposed (4.6% of $N = 1250$) versus those who did not. Odds ratios (ORs) for belief in exposure to chemical or biological weapons according to each risk factor were calculated using logistic regression.

Age was constructed as a binary variable 18 to 23 years versus 24 to 59. Marital status was coded as whether married or not, and ethnicity into white and nonwhite. Individuals were classified into high or low/no exposure groups on measures of anticipatory combat fear. Combat stress was defined as above or below the median. Combat exposure was dichotomized at 5 or more exposures (51%). Similarly the pre- and postmeasures for anxiety, depression, somatization, and the GSI were dichotomized as above and below the median. We know from our earlier work that categorical referent groups offered a useful result for comparing with

previous work and addressing issues of clinical concern and health risks.

Univariate and multivariate statistics and logistic regression models were used given the large number of participants and the binary nature of the variables. We examined whether there was a relationship between belief in exposure to chemical or biological weapons while serving in the Persian Gulf region and the potential pre- and postcombat risk factors. All factors modeled were coded to depict meaningful comparisons and interpretations, decrease case loss, and to maximize cell proportions before analysis (Cohen and Cohen, 1983). All variables were examined against the risk factor using p value of 0.05. Goodness of Fit test (Hosmer-Lemenshow) for differences between observed and model-predicted values for each risk factor or block of risk factors was examined (Hosmer and Lemenshow, 1989). Descriptive, univariate, and multivariate data analyses were performed using SPSS (SPSS, 1999).

RESULTS

Of our study group of 1250 soldiers, 4.6% ($n = 58$) believed they were exposed to a chemical or biological weapon. There was no significant relationship between marital status (married, $N = 16$ vs. not married, $N = 42$, $\chi^2 = 0.253$, $df = 1$, $p = 0.615$) or age (mean age = 24.27, $SD = 4.77$; $t = 1.28$, $df = 1242$, $p = 0.175$) and belief in exposure to chemical or biological weapons. We examined age distribution and noted a bimodal distribution with most 20 to 25 and 30 to 36 in age. Age was not related to belief in exposure. Among ethnic categories, nonwhite, (predominately African American) soldiers more often reported they believed they were exposed to chemical or biological weapons (nonwhite, $N = 37$ vs. white, $N = 21$, $\chi^2 = 21.95$, $df = 1$, $p < 0.001$). Further inspection of the ethnic category found African American [OR: 3.5; 95% confidence interval (CI): 1.91–6.43 $p < 0.0001$], Hispanics (OR: 3.68; 95% CI: 1.64–8.27, $p < 0.0001$), and "all Others" (OR: 2.98; 95% CI: 1.08–8.18, $p < 0.0001$), each more likely to report the belief they were exposed to chemical or biological weapons when compared with white soldiers.

Of all the soldiers only 2.6% ($N = 33$) reported no combat exposures and 59% ($N = 738$) reported 5 or more combat exposures. Before the combat, 89.3% ($N = 1116$) reported "A little bit" to "Extreme" worry or stress about a chemical or biological attack by the enemy during combat. Approximately 30.6% ($N = 382$) reported family problems before deployment, whereas 8.9% ($N = 111$) indicated current problems at home before combat. Before combat, soldiers reported anxiety ($N = 1243$, mean = 0.519, median = 0.333, $SD = 0.67$), depression ($N = 1243$, mean = 0.855, median = 0.600, $SD = 0.87$), and somatization ($N = 1243$, mean = 0.317, median = 0.000, $SD = 0.563$). Postcombat, soldiers reported anxiety ($N = 1244$, mean = 0.382, median = 0.167, $SD = 0.599$), depression ($N = 1243$, mean = 0.528, median = 0.167, $SD = 0.769$), somatization ($N = 1245$, mean = 0.289, median = 0.000, $SD = 0.542$), and the GSI ($N = 1232$, mean = 0.48, median = 0.226, $SD = 0.607$).

Univariate logistic regression indicated that nonwhites were 3.46 times more likely to believe that they were exposed to chemical or biological weapons (95% CI: 2.00–5.99, $p < 0.001$). Persian Gulf War soldiers who reported 5 or more combat exposures were 10 times more likely to believe they were exposed (95% CI: 3.60–27.86, $p < 0.001$). Those who reported higher combat stress were 11.8 times more likely to believe they had been exposed to a chemical or biological weapon (95% CI: 4.68–29.73, $p < 0.001$) (Table 1). Marital status, age, and precombat family problems were not significantly related to belief in exposure. In addition, anticipatory combat fear, pre- and postcombat anxiety, depression, somatization, and postcombat GSI were not significant predictors of belief in exposure.

Using a multivariate logistic model, we examined demographics (age, marital status, and ethnicity) adjusted for each other. Ethnicity remained a significant predictor for belief in exposure to chemical and biological weapons. Nonwhites were 4.08 times more likely to believe they had been exposed (OR: 4.08; 95% CI: 2.28–7.28, $p < 0.0001$). We next examined each predictor variable controlling for demographics. Soldiers who reported higher levels of combat exposure were 18.8 times more likely to believe they had been exposed to a chemical or biological weapon (95% CI: 3.89–30.35, $p < 0.000$). Those who reported greater combat stress were 12.27 times more likely to believe they had been exposed (OR: 12.27; 95% CI: 4.85–31.05, $p < 0.000$).

To further examine the relationship of belief in exposure to precombat family problems, anticipatory combat fear, postcombat exposures, and combat stress, we used in a multivariate logistic model including these variables and the demographics (Table 2). Those soldiers who reported higher levels of combat stress after adjusting for combat exposure and the other variables were more likely to believe they had been exposed to a chemical or biological weapon during deployment, (OR: 6.58; CI: 2.13–20.53, $p < 0.001$).

DISCUSSION

Understanding belief in exposure to toxic agents is important to planning for health care delivery for military and civilian populations. To our knowledge this is the only longitudinal study to examine predictors of belief in exposure to chemical or biological weapons in Persian Gulf War soldiers studied pre- and postcombat.

Combat stress was the major predictor of belief in exposure to chemical and biological weapons. Even after controlling for the number of combat exposures, soldiers with greater combat stress were 6.58 times more likely to believe they had been exposed to chemical and biological weapons. The lack of a significant relationship of belief in exposure to pre- or postcombat anxiety, depression, somatization, or to family problems is striking and unexpected. These findings suggest that combat stress management through training, leadership, and postcombat intervention require study as possible interventions to affect belief in exposure to chemical and biological agents.

Of our sample, 4.6% believed they had been exposed to chemical or biological weapons. Other studies, using various

TABLE 1. Univariate Logistic Regression Predicting Belief in Chemical/Biological Exposure

	Prevalence of Belief in Chemical/Biological Exposure								
	With Risk Factor		Without Risk Factor						
Risk Factor	***N***	**%**	***N***	**%**	***b***	***W***	***p***	**OR**	**CI**
Marital status									
Married	25	4.30	33	4.90	−0.130	0.23	0.633	0.88	0.516–1.49
Ethnicity									
Not white	37	8.40	21	2.60	1.242	19.68	0.000	3.46	2.00–5.99
Age—Gulf War									
18–23	37	5.50	21	3.70	0.418	2.25	0.134	1.52	0.87–2.63
Precombat									
Family problems before deployment									
Yes	21	5.50	37	4.30	0.267	0.909	0.340	1.307	0.754–2.265
Family problems currently while deployed									
Yes	6	5.40	52	4.60	0.178	0.16	0.688	1.20	0.501–2.85
Family problems before or currently									
Yes	22	5.40	36	4.30	0.248	0.81	0.372	1.30	0.743–2.207
Anticipatory combat fear									
High combat fear	26	4.80	32	4.50	0.069	0.07	0.798	1.02	0.631–1.82
Anxiety									
High anxiety	34	5.20	24	4.10	0.248	0.82	0.364	1.21	0.750–2.187
Depression									
High depression	33	4.60	25	4.70	−0.023	0.01	0.932	0.98	0.574–1.664
Somatization									
High somatization	31	5.10	27	4.20	0.199	0.54	0.461	1.22	0.719–2.069
Postcombat									
Combat exposures									
High exposures	54	7.30	4	0.80	2.305	19.54	0.000	10.02	3.60–27.86
Combat stress									
High combat stress	53	8.60	5	0.80	2.460	27.41	0.000	11.80	4.68–29.73
Anxiety									
High anxiety	34	5.20	24	4.10	0.254	0.87	0.351	1.29	0.755–2.20
Depression									
High depression	31	5.00	27	4.30	0.165	0.38	0.540	1.17	0.695–2.000
GSI									
High GSI	19	5.10	39	4.20	0.220	0.58	0.443	1.25	0.710–2.19

Marital status: (1) married, (0) not married; ethnicity: (1) not white, (0) white; age: (1) 18–22-yr-old, (0) 23–59-yr-old. Deployed—family problems before deploy: (1) yes, (0) no; deployed, family problems currently: (1) yes, (0) no. Deployed—family problems before or currently: (1) yes, (0) no; anticipatory combat fear: (1) higher stress levels, (0) lower stress levels; combat exposures: (1) high exposures–5 or greater, (0) low exposures–less than 5. Combat exposure stress: (1) higher than median at 14, (0) lower than median. Anxiety: (1) higher than median, (0) lower than median; depression: (1) higher than median, (0) lower than median. Somatization: (1) higher than median, (0) lower than median; GSI caseness: (1) higher levels of distress ge 0.58, (0) lower distress less than 0.58.

samples and methodologies and which were done years after the war, have found a wide range of rates of belief in exposure to chemical and biological weapons in veterans (Brewer et al., 2006; McCauley et al., 1999; Unwin et al., 1999). In our previous study of a large health care-seeking sample of Persian Gulf War veterans (n = 44,168), about 4.9% reported they believed they had been exposed to chemical weapons. These rates are quite similar, even though the samples and time since the War differ (6–8 months vs. 3–7 years).

Importantly, no pre- or postcombat psychological symptoms were associated with postcombat belief in exposure including pre- and postcombat somatization symptoms. In the earlier study of health care-seeking veterans, women, nonwhites, those who were older, and those with poorer health were more likely to believe they had been exposed to chemical weapons (Stuart et al., 2002, 2003). In addition, those with a primary mental disorder (OR: 1.72), or ill-defined conditions diagnosis (OR: 1.34) at the time of evaluation, were more likely to believe they had been exposed. In the present study, we were unable to assess gender, which included only combat units, and therefore only men were examined. Age and psychological symptoms were not significantly related to belief in exposure. The difference in these 2 studies may be because the present sample is nonhealth care seeking and was assessed much earlier after combat (6–8 months vs. 4–5 years). Similar to our previous study, non-

TABLE 2. Multivariate Logistic Regression Predicting Belief in Chemical/Biological Attack Exposure[a]

	Prevalence of Belief in Chemical/Biological Exposure								
	With Risk Factor		Without Risk Factor						
Risk Factor	*N*	%	*N*	%	*b*	*W*	*p*	OR	CI
Family problems—before deployment or currently while deployed									
Yes	22	5.40	36	4.30	0.246	0.64	0.425	1.28	0.699–2.343
Anticipatory combat fear									
High combat fear	26	4.80	32	4.50	−0.268	0.85	0.358	0.77	0.432–1.354
Combat exposure									
High exposure	54	7.30	4	0.80	1.058	2.74	0.098	2.88	0.822–10.100
Combat exposure stress									
High stress	53	8.60	5	0.80	1.883	10.64	0.001	6.58	2.121–20.385
GSI									
High GSI	19	5.10	39	4.20	−0.046	0.02	0.881	0.96	0.525–1.737

[a]Risk factors adjusted for marital status, age, ethnicity. Deployed, family problems before or currently while deployed: (1) yes, (0) no. Anticipatory combat fear, (1) higher stress levels. (0) lower stress levels. Combat exposures: (1) high exposures 5 or greater, (0) low exposures less than 5. Combat exposure stress, (1) higher than median at 14, (0) lower than median. GSI caseness, (1) significant distress ge 0.58, (0) lower distress less than 0.58

whites (OR: 3.5) were more likely to believe they had been exposed to chemical and biological agents.

Generalization from these results is limited by the nature of the sample, i.e., Persian Gulf War combat soldiers. The samples of soldiers were healthy, employed, trained for chemical and biological attacks, and in a high demand environment when their concerns about exposures developed. These results may be most comparable to other military, police, or emergency responder groups who may face possible exposure to toxic agents and later seek health care. The relatively small rate of belief in exposure (4.4%), may have limited the power of this study to detect some associations. The response rate (45%) is lower than desired. However, this included all available subjects. Individuals who left active military service represent an unmeasured effect on our results. It is not clear in which direction this might affect any outcomes.

Sample selection is also influenced by operational requirements, which affects the recruitment of units before war as well as after. In addition, postwar soldiers are not available because of training, rotation to other units, and because some have left the service. This may introduce unknown bias. However, we can say that the demographics of our study sample were not different from our precombat sample and are also very similar to Persian Gulf War combat soldiers (Joseph, 1997).

The results of this study suggest that studies be done to test whether stress reduction interventions, for both individuals and groups can affect rates of belief in exposure to toxic agents. Further longitudinal studies before and after believed exposures are needed to understand the predictors and trajectory of belief in toxic exposures. Healthcare planning for military populations, terrorist attacks, and the more frequently occurring toxic industrial exposures, must include planning for those who believe they were exposed as well as those who have actually been exposed. Healthcare resources are needed for both populations.

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