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Lifetime Prevalence of Respiratory Diseases and Exposures Among Veterans of Operation Enduring Freedom and Operation Iraqi Freedom Veterans:

Results From the National Health Study for a New Generation of U.S. Veterans

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Abstract

Objective—The objective of this study was to determine the prevalence of respiratory exposures and the association between respiratory exposures and respiratory disease among veterans deployed to Operation Enduring Freedom and Operation Iraqi Freedom (OEF/OIF) compared with nondeployed veterans of this era.

Methods—Data come from a national health survey of 20,563 deployed and nondeployed OEF/OIF era veterans. Prevalence estimates and adjusted odds ratios were calculated. Results were weighted to represent the population.

Results—Prevalence of at least one respiratory exposure was high among both deployed and nondeployed groups (95% and 70%, respectively). In both groups, those with any respiratory exposure were at an increased risk for reporting a respiratory disease.

Conclusion—Respiratory exposures are highly prevalent and are associated with increased odds of respiratory diseases among the OEF/OIF era population.

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Veterans deployed to Afghanistan and Iraq in support of Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) may encounter a number of potentially harmful respiratory exposures during their time in theater. In Southwest Asia, particulate matter levels are higher than in the U.S., and exposure may come from dust due to storms and motor vehicle disturbance, or emissions from local industries or burn pits.¹ Veterans who served in Iraq and Afghanistan have reported concerns about smoke from burning trash and feces and poor air quality during deployment.^{2,3} This study examines the relationship between service in OEF or OIF, environmental exposures that may impact the respiratory system, and respiratory diseases using data from a population-based health survey of recent veterans.

A number of studies have reported new or increased respiratory diseases among OEF/OIF military personnel following deployment. A survey of returning OEF/OIF soldiers and Department of Defense (DoD) contractors found statistically significant increased respiratory symptoms during deployment compared with pre-deployment.⁴ In a health survey of returning OEF/OIF military personnel at the end of their deployment or during a rest and recuperation program, nearly 70% reported respiratory illnesses during their deployment, and 17% experienced symptoms severe enough to require medical care.⁵ A report of surveillance of ambulatory care and hospital visits among deployed OEF/OIF individuals described “excessive” cases of respiratory conditions among both males and females with repeated deployments.⁶ A study of deployment and medical records data of deployed OEF/OIF military personnel found an increased rate of obstructive pulmonary disease, mainly asthma and bronchitis, for those that deployed once, but not for those that deployed multiple times.⁷ The Millennium Cohort Study, in a prospective longitudinal study on the health effects of military service among OEF/OIF deployed and nondeployed military members, found those who were deployed had higher rates of new respiratory symptoms than the nondeployed group and a linear relationship between length of deployment and increased respiratory symptoms among Army respondents.⁸

A review of the literature by Falvo et al⁹ found that respiratory diseases are common among deployed service members.

Concerns of exposure to airborne hazards during deployment to this region are not unique to the OEF/OIF population. Studies have also evaluated the association between service in the 1990 to 1991 Persian Gulf War and respiratory illnesses, including asthma, bronchitis, and sinusitis. A study of Australian Gulf War veterans found that since their service in the Gulf War, veterans of this war had a higher than expected prevalence of respiratory symptoms and conditions, including asthma and bronchitis, but not poorer lung function, than a military comparison group without similar exposure.¹⁰ Another study found a significantly higher prevalence of asthma and bronchitis among deployed Gulf War military personnel than nondeployed military personnel.¹¹ One study using hospitalization data of Gulf War veterans and nondeployed veterans found more hospitalizations for various respiratory diseases, including asthma.¹² However, another study found no statistical difference in the prevalence of pulmonary function abnormalities between deployed Gulf War veterans and nondeployed veterans 10 years after the war.¹³

Several studies have reviewed the relationship between deployment to Southwest Asia, respiratory illnesses, and various environmental exposures. In a case-control study of Gulf War veterans, a significant association was found between asthma and oil well fire smoke exposure.¹⁴ Lange et al¹⁵ found a dose-response association between oil well fire smoke exposure and asthma and bronchitis among Gulf War veterans. A study on the effects of acute exposure to diesel vapors showed that ill Gulf War veterans had reduced end-tidal CO₂; increased systolic blood pressure and respiratory variability; and disorientation, dizziness, and headache, compared with healthy Gulf War veterans.¹⁶ A study of deployed Gulf War veterans exposed to 1991 Kuwait oil well fires compared with unexposed veterans did not find that the exposure led to increased hospitalization after the war.¹⁷ Among Millennium Cohort Study participants who served in the Army or Air Force and were deployed during OEF/OIF, there was not an elevated risk of respiratory illnesses among those exposed within a three or 5 mile radius of open-air burn pits. However, there was a marginally significant increased risk for respiratory symptoms among Air Force personnel located within a 2 mile radius of the burn pit at Joint Base Balad, compared with Air Force personnel who were not located near a burn pit.¹⁸ A study of Army reserve personnel returning from OEF/OIF deployment found that those with more exposures reported greater severity of physical symptoms.¹⁹

This analysis describes the relationship between self-reported respiratory exposures during military service, self-reported doctor-diagnosed respiratory conditions, and OEF/OIF service in a sample of 20,563 veteran respondents to a population-based cohort study. Respiratory conditions in this study population were previously analyzed, and deployed veterans were 29% more likely to be diagnosed with sinusitis during or after the start of OEF and OIF than their nondeployed counterparts, but there was no significant difference in asthma or bronchitis risk between the deployed and nondeployed veterans.²⁰ This paper expands on that knowledge by describing the relationship between respiratory exposures and respiratory diseases. The analysis described below addresses some of the weaknesses in the literature by using a population-based cohort from a national survey, including a comparison group for OEF/OIF deployment status, and controlling for smoking status in the analyses. It also adds to the literature on recent veterans and the possible health consequences of their environmental exposures.

METHODS

Data Collection

Data came from the “National Health Survey for a New Generation of U.S. Veterans” (NewGen), a population-based health survey of 30,000 OEF/OIF veterans and 30,000 nondeployed veterans who served in the military between October 2001 and 2008. This study was reviewed and approved by the Washington, DC, Veterans Affairs (VA) Medical Center Institutional Review Board.

The random sample, selected from the Defense Manpower Data Center at the DoD and VA/DoD Identity Repository database, was stratified by branch of service (Air Force, Army, Navy, Marine Corps), unit component (Active Duty, Reserve, National Guard), and sex. Women were oversampled by 20%. Survey questions covered a considerable range of topics

such as self-reported mental health, health behaviors, health conditions, doctor and hospital visits, reproductive health, environmental exposures, and use of the VA health care system.

Following a modified Dillman method, veterans in the selected cohort were mailed a 16-page questionnaire package with the option to complete the survey on-line.²¹ The package contained a \$10 check as an incentive to complete the survey. Those who did not respond to the mailing were contacted by telephone with the option to complete the survey by phone. Data collection occurred between August 2009 and January 2011 resulting in 20,563 accepted surveys (34% response rate). A detailed description of the survey methods has been published elsewhere.²²

Measures

Asthma, sinusitis, and bronchitis measures were derived from the survey question “Has a doctor ever told you that you have any of the following conditions?” An additional variable for “any respiratory disease” was created to represent any combination of reporting asthma, sinusitis, or bronchitis.

Smoking status was coded as a categorical measure, including current smoker, recent former smoker, former smoker, or never smoked. This variable was developed using the survey question “During the past 12 months have you smoked cigarettes?” and the follow-up questions, “If no, have you ever smoked cigarettes even occasionally?” and “If yes, in what year did you last stop?” Current smokers were defined as those who answered the first question affirmatively; recent former smokers were defined as those who responded negatively to the first question and positively to the second question with year equal to 2001 or later; former smokers were defined as those who responded negatively to the first question and positively to the second question with year equal to 2000 or earlier; never smoked was defined as those who responded negatively to the first and second question.

Respiratory exposures were measured with the following survey questions: “During military service, were you exposed to or did you experience the following?” Response options included dust and sand; burning trash/feces; diesel, kerosene and/or other petrochemical fumes; smoke from oil fires; industrial pollution. Respondents could select “no” or “yes” for each exposure listed. A dichotomous variable was created to indicate an affirmative response to any of the above-listed respiratory exposures. In addition, the five respiratory exposures listed above were summed per individual to create a variable for the number of different exposures (low = one to two different exposures; high = three to five different exposures). Approximately 32% had low exposure count, 55% had high exposure count, and 13% had no exposure.

Self-reported race/ethnicity was coded as Hispanic, non-Hispanic black, non-Hispanic white, non-Hispanic other race, or unknown. Sex was also based on self-reported data. The self-reported education variable was grouped into three levels: high school or less, bachelor’s degree/some college, advanced degree. Respondents were also asked if they had ever used the VA health care system. Respondents reported the number of deployments to OEF and OIF. For these analyses, those who reported at least one deployment but were classified as nondeployed were deleted.

Birth year, unit component, and branch of service were based on administrative data. Birth year was grouped into the following categories: pre-1960, 1960 to 1969, 1970 to 1979, 1980, or later. Unit component was coded as Active Duty, National Reserve, or Guard. Service branch was coded as Army, Air Force, Marine Corps, or Navy.

Statistical Analyses

Weights were created to improve accuracy of the population prevalence estimates by adjusting for the sample design, nonresponse, and misclassification in the sampling frame. Detailed information about the weighting process can be found in a previous publication.²³

Unweighted frequency counts and within-group weighted percentages of birth year, sex, service branch, unit component, race/ethnicity, education, smoking status, number of deployments, deployment status, and VA health care system user status were calculated for asthma, bronchitis, sinusitis, and any respiratory disease. Cross-tabs (unweighted frequencies and weighted percentage) of respiratory exposures reported among those reporting respiratory disease were also calculated.

Logistic regression analyses were used to calculate weighted, adjusted odds of respiratory disease stratified by deployment status (deployed to OEF/OIF vs not deployed) while controlling for sex, birth year, race/ethnicity, education, smoking status, unit component, and service branch, and number of OEF/OIF deployments. Adjusted odds ratios (aORs) with 95% confidence intervals (95% CIs) that did not include 1.00 were considered statistically significant. Statistical analyses were conducted using SAS software version 9.1.3 (SAS Institute Inc., Cary, North Carolina). Z-scores and associated *P* values were calculated to determine significant differences between deployed and nondeployed estimates.

RESULTS

Table 1 presents the unweighted frequencies and weighted percentages of demographic and military characteristics by asthma, bronchitis, sinusitis, and any respiratory disease. Nearly 24% of all respondents reported at least one respiratory disease. The prevalence of having any respiratory disease increased with age, though this pattern was not observed for asthma or bronchitis when examined separately. More women reported respiratory disease diagnoses than men (35% of women reported at least one respiratory disease compared with approximately 22% of men). The Air Force had the highest prevalence of reporting any respiratory disease (26%). Twenty-nine percent of the nondeployed group and nearly 20% of the deployed group reported at least one respiratory disease. The prevalence for any respiratory disease among former smokers was greater than for any other smoking category (approximately 32%). VA health care users had a higher prevalence of reporting any respiratory disease than non-VA users (28% vs 21%, respectively).

Table 2 presents the unweighted frequencies and weighted percentages of asthma, bronchitis, sinusitis, and any respiratory disease by respiratory exposures, stratified by deployment status. This table also includes the total percentages of reported respiratory exposures among deployed and nondeployed veterans. Among deployed veterans, 95% reported at least one respiratory exposure; 92% reported dust and sand exposure; 66%

reported exposure to burning trash/feces; 84% reported diesel, kerosene, and/or other petrochemical fumes; 38% reported smoke from oil fires; and 42% reported industrial pollution. When looking at exposure levels, 70% reported high exposure count and 25% reported low exposure count. Among the nondeployed, the prevalence of any respiratory exposure was 70%; 58% reported dust and sand; 18% reported burning trash/feces; 54% reported diesel, kerosene, and/or other petrochemical fumes; 10% reported smoke from oil fires; and 19% reported industrial pollution. Twenty-four percent of the nondeployed reported high exposure count and 47% reported low exposure count. Twenty-two percent of deployed veterans reported at least one respiratory condition, while the prevalence among nondeployed was slightly greater at nearly 26%. Within the deployed group reporting any respiratory exposure, approximately 23% reported at least one respiratory disease. Among the nondeployed with any respiratory exposure, 28% reported a respiratory disease. Among the deployed group, smoke from oil fires and industrial pollution had the highest prevalence of respiratory diseases. Reports of exposure to smoke from oil fires had the highest prevalence of respiratory conditions among the nondeployed group. For both the deployed and nondeployed veterans, those in the high exposure count group had greater prevalence of all respiratory diseases.

Table 3 presents the aORs and 95% CIs of models calculating odds for self-report of asthma, bronchitis, or sinusitis, stratified by deployment status among those with respiratory exposures compared with those without. For both deployed and nondeployed veterans, those with any respiratory exposure were at an increased risk for reporting at least one respiratory disease (deployed: aOR = 1.80, 95% CI = 1.41 to 2.29; nondeployed: aOR = 1.70, 95% CI = 1.45 to 2.00). This pattern is demonstrated for each of the separate exposures, as well as high and low exposure counts.

Among deployed veterans, those reporting any respiratory exposure were more than two times as likely to report bronchitis (aOR = 2.04, 95% CI = 1.41 to 2.96) and 80% more likely to report sinusitis (aOR = 1.82, 95% CI = 1.37 to 2.41). Among the nondeployed, those with any respiratory exposure were at an increased risk for asthma (aOR = 1.44, 95% CI = 1.12 to 1.86), bronchitis (aOR = 1.76, 95% CI = 1.43 to 2.15), or sinusitis (aOR = 1.68, 95% CI = 1.38 to 2.03). For all veterans, reporting an exposure was associated with an increased risk for bronchitis and sinusitis for each of the separate exposures.

Both low and high exposure counts were associated with bronchitis and sinusitis among deployed and nondeployed veterans. In both groups, only those in the high exposure count group were associated with asthma. When looking at odds ratios resulting from the exposure count models, a dose-response pattern was observed. Z-score tests were calculated to compare differences in point estimates between the deployment groups. Statistically significant differences were found for many comparisons. Notably, among the majority of significant comparisons, the nondeployed veterans had greater odds of respiratory conditions.

DISCUSSION

Findings from this study demonstrate that veterans from the OEF/OIF era have high prevalence levels of respiratory exposures. Ninety-five percent of deployed veterans reported at least one of the five respiratory exposures queried in this study. Dust and sand exposure and diesel, kerosene, and/or other petrochemical fumes were the most frequently reported (92% and 84%, respectively). Our data suggest that respiratory exposures are not only a concern among deployed veterans, but also among nondeployed veterans. Prevalence of exposures was remarkable even among the nondeployed group, with 70% of veterans in the nondeployed group reporting at least one of the five respiratory exposures at some point during their military service. These results indicate that respiratory exposure concerns are a characteristic of all military personnel, not specifically those who deployed to OEF/OIF.

We found an increased risk for respiratory disease among all categories of exposures reported, within both the deployed and nondeployed groups. Consistent with previous reports,¹⁵ we found a dose-response relationship between level of exposure and risk for respiratory disease among both deployed and nondeployed, though our findings must be interpreted with caution. Higher number of summed exposures do not necessarily equal greater exposure, as information on the duration, frequency, and magnitude of each exposure was not collected on the survey. In addition, due to the differing time periods of the disease and exposure questions, we are unable to determine temporal causality.

There are some limitations to this study that should be taken into consideration when interpreting the findings. Recall bias is a potential problem with survey data. We are unsure of the actual dates of OEF/OIF deployment, as the survey asks only for the date of last deployment and number of deployments. In addition, we do not know dates of respondents' entry into the military. Without this information, we were unable to determine if the respiratory condition occurred before or after joining the military or deployment episodes. The survey question regarding respiratory exposures inquires about exposures during military service, not specifically OEF/OIF deployment. Veterans who were not deployed to OEF/OIF but were deployed to other conflicts may have experienced these respiratory exposures. For example, veterans reporting exposure to oil fire smoke may have experienced this during deployment to the 1990 to 1991 Gulf War. In addition, media coverage of respiratory disease among veterans may have influenced reporting in the OEF/OIF deployed group.

There are several notable strengths to this study. Smoking history questions were included on the survey allowing for smoking status to be controlled for in logistic regression models. Although the response rate was 34%, the number of responses was large at 20,563. In addition, the cohort is population-based and survey weights allow for estimates to represent the population. The cohort included both users and nonusers of the VA health care system, as well as deployed and nondeployed veterans.

There has been heightened concern about respiratory diseases and exposures within the DoD and VA since the 1991 Gulf War and VA has taken several steps to address this issue. VA health care facilities employ Environmental Health Coordinators to assist with health

concerns related to exposures during military service. Veterans may file a claim for compensation for health conditions they believe were caused by exposure to burn pits during military service. Mandated by Public Law 112–260, the Airborne Hazards and Open Burn Pit (AH&OBP) Registry was opened to eligible service members and veterans on June 19, 2014, with the purpose of determining and monitoring exposure to airborne hazards.²⁴

Results from this study were comparable to similar studies. The 2011 Institute of Medicine (IOM) study found inadequate or insufficient evidence for respiratory diseases related to burn pit exposures.³ A report on exposures and health conditions using data from the AH&OBP Registry reported that working in burn pits was associated with chronic obstructive pulmonary disease, chronic bronchitis, or emphysema.²⁴ Similar to our findings, Lange et al¹⁵ found an increased risk for asthma and bronchitis among Gulf War veterans self-reporting exposure to oil well fire smoke. Consistent with our findings, an analysis from the Airborne Hazards and Open Burn Pit Registry found that asthma and chronic bronchitis were associated with dust storm exposure, though these data must be interpreted with caution given the potentially biased nature of the voluntary registry.²⁴

To our knowledge, this is the first study to investigate multiple military respiratory exposures and correlations with respiratory diseases among OEF/OIF veterans and nondeployed veterans at a population level. These findings indicate that, in the OEF/OIF era veteran population, respiratory exposures are highly related to respiratory diseases, and that respiratory exposures and diseases are a concern of deployed and nondeployed veterans. Respiratory exposures should be considered a hazard of military service in general, not solely deployment. Future research on this topic is needed to determine if a causal relationship exists between these exposures and diseases, ideally including biological indicators, such as pre-military and pre-deployment lung capacity measurements.

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Self-Reported Prevalence of Respiratory Exposure and Disease (Unweighted *n*, Weighted %) Among OEF/OIF Veteran Population by Demographic and Military Characteristics; National Health Study for a New Generation of U.S. Veterans, 2009–2011

TABLE 1

	Asthma		Bronchitis		Sinusitis		Any Respiratory Disease	
	<i>N</i>	%	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
Total	1,366	6.90	2,588	12.46	3,190	13.79	5,132	23.90
Birth year [*]								
Pre-1960	217	7.39	449	14.45	725	24.67	989	32.96
1960–1969	418	7.84	821	14.92	1,212	21.88	1,704	31.02
1970–1979	386	6.80	734	12.54	832	13.89	1,413	23.81
1980 or later	345	6.37	584	10.68	421	7.11	1,026	18.27
Sex [†]								
Men	937	6.12	1,783	11.27	2,208	12.10	3,615	21.71
Women	429	10.95	805	18.65	982	22.56	1,517	35.27
Service branch [*]								
Army	800	7.41	1,416	12.63	1,655	13.07	2,783	23.82
Air Force	240	6.20	578	13.48	810	17.63	1,147	26.13
Navy	214	6.99	388	12.34	525	15.15	804	24.78
Marine Corps	112	5.83	206	10.39	200	8.85	398	19.55
Unit component [*]								
Active duty	640	8.01	1,046	13.15	1,280	14.17	2,114	25.32
National Guard	294	4.99	684	11.55	815	12.63	1,301	21.47
Reserve	432	6.15	858	11.77	1,095	13.99	1,717	22.93
Race/ethnicity [‡]								
Hispanic	162	7.43	207	9.41	301	11.43	483	20.46
White non-Hispanic	916	6.62	1,957	13.44	2,234	13.73	3,649	24.32
Black non-Hispanic	206	8.48	264	9.37	445	15.61	680	24.44
Non-Hispanic other race	76	6.41	149	12.94	190	15.02	290	23.99
Missing	6	5.07	11	9.60	20	15.23	30	25.07
Education [‡]								

	Asthma		Bronchitis		Sinusitis		Any Respiratory Disease	
	N	%	n	%	n	%	N	%
High school or less	175	5.88	311	10.77	300	8.45	602	19.47
Bachelor's degree/some college	963	6.99	1,889	12.72	2,291	14.08	3,689	24.20
Advanced degree	227	8.24	387	14.06	594	22.02	834	30.46
Missing	1	2.54	1	1.77	5	7.42	7	11.74
Smoking [†]								
Current smoker	351	6.71	846	14.98	786	12.12	1,428	24.64
Recent former smoker	197	6.96	375	11.95	419	12.89	719	22.60
Former smoker	168	9.12	284	14.64	440	21.71	624	31.70
Never smoked	598	6.53	989	10.48	1,402	13.86	2,161	22.39
Missing	52	7.60	94	10.54	143	15.61	200	23.17
Number of OEF/OIF deployments [‡]								
0	456	8.44	810	14.08	965	15.11	1,572	26.48
1	429	5.62	866	11.67	1,015	12.13	1,684	21.71
2	264	6.21	519	11.21	664	13.30	1,053	22.89
3+	89	5.61	206	12.94	273	15.46	413	24.74
Missing	128	7.45	187	10.96	273	13.88	410	22.47
Deployment status [‡]								
Deployed to OEF/OIF	805	5.86	1,617	11.65	1,995	12.96	3,214	22.48
Nondeployed	561	8.24	971	13.51	1,195	14.87	1,918	25.74
VA user status [‡]								
User	632	8.65	1,102	14.58	1,448	17.31	2,239	28.39
Nonuser	734	5.90	1,485	11.26	1,741	11.79	2,892	21.35
Missing	0	6.93	1	6.93	1	6.93	1	6.93

OEF/OIF, Operation Enduring Freedom and Operation Iraqi Freedom.

* From sampling frame variable.

[‡] Self-reported variable.

TABLE 2

Self-Reported Prevalence (Unweighted *n*, Weighted %) of Respiratory Exposure and Disease Among OEF/OIF Veteran Population, National Health Study for a New Generation of U.S. Veterans, 2009–2011

	Total		Asthma		Bronchitis		Sinusitis		Any Respiratory Disease	
	<i>n</i>	%	<i>N</i>	%	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%
Deployed to OEF/OIF										
Total	12,940	100.00	802	5.83	1,615	11.63	1,990	12.92	3,214	22.48
Any respiratory exposure	12,259	95.17	764	5.88	1,568	11.89	1,916	13.09	3,091	22.76
Dust and sand	11,823	91.51	742	5.95	1,517	11.94	1,860	13.25	2,997	22.95
Burning trash/feces	8,242	65.73	551	6.14	1,133	12.49	1,351	13.57	2,190	23.61
Diesel, kerosene, and/or other petrochemical fumes	10,547	83.55	651	5.88	1,401	12.40	1,670	13.35	2,705	23.30
Smoke from oil fires	4,892	38.17	354	6.94	721	14.02	875	15.30	1,388	26.12
Industrial pollution	5,462	42.18	385	6.98	808	13.95	1,009	15.62	1,571	26.46
Exposure count										
Low	3,281	24.82	184	5.18	348	9.68	458	11.04	736	19.60
High	8,978	70.35	580	6.13	1,220	12.67	1,458	13.82	2,355	23.88
Not deployed to OEF/OIF										
Total	7,006	100.00	559	8.20	970	13.46	1,195	14.87	1,918	25.74
Any respiratory exposure	5,013	70.44	440	8.83	759	14.94	946	16.38	1,510	28.15
Dust and sand	4,140	57.78	363	8.76	641	15.30	817	17.19	1,271	28.61
Burning trash/feces	1,421	17.64	158	11.64	251	17.55	336	21.52	499	33.26
Diesel, kerosene and/or other petrochemical fumes	3,960	54.19	351	8.98	613	15.22	783	17.34	1,234	29.18
Smoke from oil fires	878	10.31	87	11.32	157	19.08	221	24.26	321	37.10
Industrial pollution	1,452	19.28	159	10.81	271	18.15	379	23.24	535	34.17
Exposure count										
Low	3,126	46.68	242	7.74	419	13.39	480	13.22	834	25.00
High	1,887	23.76	198	10.96	340	17.97	2,083	22.60	676	34.32

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TABLE 3

Weighted, Adjusted Odds Ratios (aORs), and 95% Confidence Intervals (95% CIs) of Respiratory Diseases Stratified by Deployment Status; National Health Study for a New Generation of U.S. Veterans, 2009–2011

	Asthma	Bronchitis	Sinusitis	Any Respiratory Disease
	aOR (95% CI)*	aOR (95% CI)*	aOR (95% CI)*	aOR (95% CI)*
Deployed to OEF/OIF				
Any respiratory exposure	1.35 (0.93–1.97)	2.04 (1.41–2.96)	1.82 (1.37–2.41)	1.80 (1.41–2.29)
Dust and sand	1.46 (1.06–2.00)	1.57 (1.20–2.05)	1.80 (1.44–2.23)	1.65 (1.37–2.01)
Burning trash/feces	1.24 (1.01–1.53)	1.37 (1.18–1.60)	1.45 (1.27–1.65)	1.37 (1.23–1.54)
Diesel, kerosene, and/or other petrochemical fumes	1.11 (0.89–1.39)	1.79 (1.48–2.16)	1.57 (1.34–1.83)	1.57 (1.37–1.79)
Smoke from oil fires	1.36 (1.14–1.62)	1.50 (1.31–1.70)	1.49 (1.33–1.67)	1.45 (1.31–1.60)
Industrial pollution	1.39 (1.18–1.65)	1.49 (1.31–1.69)	1.51 (1.35–1.69)	1.50 (1.36–1.65)
Exposure count				
Low	1.19 (0.80–1.77)	1.55 (1.05–2.30)	1.56 (1.16–2.10)	1.49 (1.15–1.93)
High	1.49 (1.01–2.20)	2.49 (1.70–3.63)	2.11 (1.58–2.81)	2.10 (1.63–2.70)
Not deployed to OEF/OIF				
Any respiratory exposure	1.44 (1.12–1.86)	1.76 (1.43–2.15)	1.68 (1.39–2.03)	1.70 (1.45–2.00)
Dust and sand	1.23 (0.99–1.53)	1.60 (1.34–1.91)	1.67 (1.41–1.98)	1.51 (1.32–1.73)
Burning trash/feces	1.64 (1.29–2.08)	1.52 (1.25–1.86)	1.46 (1.22–1.75)	1.40 (1.23–1.54)
Diesel, kerosene, and/or other petrochemical fumes	1.38 (1.11–1.71)	1.55 (1.30–1.85)	1.68 (1.42–1.98)	1.62 (1.41–1.87)
Smoke from oil fires	1.53 (1.14–2.04)	1.67 (1.33–2.09)	1.55 (1.26–1.91)	1.61 (1.34–1.93)
Industrial pollution	1.50 (1.19–1.89)	1.67 (1.38–2.03)	1.81 (1.52–2.15)	1.60 (1.37–1.86)
Exposure count				
Low	1.26 (0.96–1.66)	1.55 (1.25–1.93)	1.45 (1.19–1.78)	1.53 (1.30–1.81)
High	1.92 (1.40–2.62)	2.32 (1.79–3.00)	2.54 (2.00–3.21)	2.27 (1.86–2.77)

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* Adjusted models control for number of deployments, sex, age, race/ethnicity, education, smoking, branch of service, unit component.