The Impact of Deployment on COPD in Active Duty Military Personnel

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ABSTRACT Purpose: To identify trends in chronic obstructive pulmonary disease (COPD) diagnoses among active duty U.S. military personnel based on deployment history and whether International Classification of Disease, 9th edition (ICD-9) coding meet criteria for the diagnosis of COPD. Methods: A retrospective chart review using the electronic medical system was conducted for military personnel diagnosed with COPD based on ICD-9 codes for emphysema or chronic obstructive lung disease with at least three qualifying outpatient COPD-coded encounters. Clinical symptoms, smoking history, pulmonary function testing, and radiographs obtained during the diagnostic workup were reviewed. The established diagnosis of COPD was analyzed in relation to deployment. Results: A total of 371 patients were identified during the study period (2005–2009). Of these patients, 194 (52.3%) deployed, whereas 177 (47.7%) did not deploy to Southwest Asia since 2003. Thirty-four percent had no documented smoking history despite the diagnosis of COPD. Airway obstruction was identified by spirometry in only 67% of individuals diagnosed with COPD. No statistically significant differences in pulmonary function testing values were identified between those deployed and nondeployed individuals. Conclusion: Despite evidence of increased respiratory symptoms in deployed military personnel, the impact of deployment on increased diagnosis of COPD or severity of disease appears minimal.

INTRODUCTION

During Operations Desert Shield, Desert Storm, and Operations Iraqi Freedom and Enduring Freedom (OIF/OEF), all conducted in Southwest Asia (SWA), U.S. military personnel have documented exposures to dust storms, oil fires, burn pits, and other hazards, which have the potential to adversely influence respiratory health. However, the impacts of military deployment and associated exposures on chronic respiratory diseases such as asthma and chronic obstructive pulmonary disease (COPD) are unknown. Reported increases in nonspecific respiratory symptoms such as cough and dyspnea based on survey data have been associated with these deployments.[1–4] Among participants in the Millennium Cohort Study, conducted by the Naval Health Research Center, for example, a higher rate of newly reported respiratory symptoms was observed in deployed personnel, relative to never-deployed personnel, but rates of chronic bronchitis/emphysema and asthma were similar between the deployed and nondeployed groups.[3] In a survey of Army personnel deployed to SWA, 5% were found to have a previous diagnosis of asthma, an increase in deployment-related respiratory symptoms was found relative to predeployment symptoms.[5] A recent chart review based solely on diagnostic codes of Veterans' Administration medical records between 2004 and 2007 found higher rates of asthma (6.6% vs. 4.3%) in deployed military personnel compared to their nondeployed counterparts, but lacked information on the presence of predeployment lung disease.[6]

Questions remain as to whether and to what degree deployment associated exposures impact new and established diagnoses of COPD in the military population. We hypothesized that exposure to environmental hazards and increased smoking during deployment may have the potential to increase COPD symptoms and severity. This retrospective study of military electronic medical records was conducted to estimated incident cases of COPD over a 5-year time period and to evaluate whether SWA deployment is associated with increases in the prevalence or severity of COPD in military personnel.

METHODS

This study was conducted as a retrospective review of DoD electronic medical records after obtaining written approval from the local Institutional Review Board. The central database repository for all inpatient and outpatient records was queried to identify active duty military personnel from all branches of service with the ICD-9 code for either "emphysema" (492.8) or "chronic airway obstruction, not elsewhere classified" (496) for 5 consecutive years from 2005 to 2009. The default ICD-9 code is 496 when the term COPD is entered as a diagnosis in the outpatient DoD electronic medical record. This study excluded patients with the diagnosis of asthma (493) or chronic bronchitis (490). Initial review of ICD-9 coding demonstrated a large percentage of single encounters for "chronic bronchitis," which were

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deemed not to represent chronic lung disease. After the initial query was conducted and qualifying subjects were identified, individual electronic medical records meeting the stated criteria were reviewed to obtain the following information: (1) patient demographics; (2) date of diagnosis; (3) deployment history and location; (4) pulmonary function testing (PFT) results to include forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), FEV_1/FVC ratio, post-bronchodilator (BD) FEV_1, total lung capacity (TLC), residual volume (RV), and diffusing capacity for carbon monoxide (DLCO); (5) smoking history; (6) radiographic examinations (both chest radiograph and computed tomography scans; and (7) α-1 antitrypsin levels.

Medical record review was limited to those individuals with a minimum of three outpatient encounters with the listed diagnosis of COPD/emphysema during the study period. Three encounters were chosen to include those patients seen for continuous respiratory symptoms. Patient records that lacked any documented medical encounters or recorded clinical information about the diagnosis of COPD/emphysema were excluded from further analysis. Deployment information for patients with qualifying medical records was obtained from the Armed Forces Health Surveillance Center. Patients were then classified into deployers and nondeployers based on whether or not they had deployed to SWA during the recent conflicts (since 2003). The timing of the pulmonary diagnoses with respect to deployment was noted. We then determined the number of patients who had the following basic evaluation completed: (1) documentation of smoking history, (2) chest imaging, and (3) PFT. A determination was made if these individuals met the primary criteria for the diagnosis of COPD based on (1) clinical respiratory symptoms such as dyspnea, cough, or exercise intolerance; (2) documented smoking history; and (3) evidence of airway obstruction on spirometry (as per the Global Initiative on Obstructive Lung Disease guidelines).[7] Finally, laboratory studies (α-1-antitrypsin) were reviewed to determine if this testing was completed and showed any reduction in values.

Initial comparisons were made between deployed and nondeployed personnel. Statistical analysis was performed using commercially available software (SPSS Version 19.0). Normality was evaluated for the continuously distributed demographic and PFT variables, and a Student's *t*-test or Mann–Whitney U test was used as appropriate between the two groups. Specific comparisons were made for age, FEV_1 (% predicted), FEV_1 post-BD (% predicted) and percent change, FVC (% predicted), FEV_1/FVC, TLC, RV, and DLCO.

We also assessed 5-year trends (2005–2009) in annual rates of emphysema and chronic airway obstruction among active component military personnel. To estimate these rates, we used medical encounter diagnoses code (ICD-9) data from the Defense Medical Surveillance System. This database contains discharge and diagnostic code records corresponding to ambulatory (outpatient) medical encounters for beneficiaries of TRICARE, the health system serving U.S. military personnel. To qualify as an emphysema case, individuals were required to have had a minimum of three outpatient encounters coded with ICD-9 492. The date of the first medical encounter with the corresponding ICD-9 code was defined as the date of incidence for the purpose of person-time calculation. Individuals with an emphysema diagnosis before 2005 were excluded from the analysis; emphysema cases identified in a given year were excluded from the rate calculations for subsequent years. Individuals with chronic airway obstruction were identified using the same methodology as described for emphysema, although using ICD-9 496 as the diagnostic code of interest. Trends are presented for all qualifying personnel, by military branch and by deployment history (ever vs. never deployed in support of OIF/OEF). Statistical differences in rates over time were assessed using χ^2 tests for trends; differences in trends by branch of military service and deployment history were evaluated with *t*-statistics.

RESULTS

There were 533 medical records that met study criteria with an ICD-9 code of 492 or 496 with a minimum of three encounters from the DoD medical record database (from approximately 4,500 individuals). From these, 71 charts were identified as having "pulmonary obstructive disease" listed as a clinical diagnosis and were excluded from further analysis. (It is uncertain if providers felt these patients had COPD or asthma.) An additional 91 charts either had no clinical encounters in the DoD electronic medical record for either COPD or emphysema. A total of 371 records were reviewed in depth for clinical evaluation, chest imaging, laboratory testing, and PFT results. Among these records, 194 (52.3%) individuals had a deployment history, whereas 177 (47.7%) did not deploy to SWA since 2003. Of the 194 deployers, 25 (12.9%) were diagnosed predeployment and the remaining

TABLE I. Demographics of Military Personnel With Diagnosis of COPD/Emphysema Based on Deployment History

	All	Nondeployed	All Deployers	Predeploy Diagnosis	Postdeploy Diagnosis
Male (*n*)	371	177	194	25	169
Male	89%	85%	93%	92%	94%
Mean Age at Diagnosis	40.4 ± 8.2	40.8 ± 8.9	39.9 ± 7.6	37.0 ± 8.4	40.3 ± 7.4
Documented Smoking History	242 (65%)	110 (62%)	132 (68%)	19 (76%)	113 (67%)
Mean Pack-Years (Smokers Only)	18.9 ± 10.3	19.7 ± 10.3	18.3 ± 10.4	20.5 ± 15.4	17.9 ± 9.2
Deployment Length (Days)	N/A	N/A	413 ± 237	338 ± 175	424 ± 243

TABLE II. Clinical Evaluation of Military Personnel for COPD/Emphysema

Diagnostic Evaluation	Overall
Documented Smoking History	242/371 (65.2%)
Documented Spirometry	270/371 (72.8%)
Spirometry With Obstruction (Below 95th Confidence Interval)	164/245 (66.9%)
Chest Radiograph Obtained	238/371 (64.2%)
Chest Radiograph With Hyperinflation	31/238 (13.0%)
Chest Computed Tomography With Hyperinflation	74/256 (28.9%)
α-1-Antitrypsin Level	88/371 (23.7%)
Pulmonary Clinic Evaluation	184/371 (49.6%)

169 (87.1%) were diagnosed postdeployment. Table I shows the demographic characteristics of the overall group with further categorization by deployment history. As expected, there were more males (89%) than females (11%) in the sample. The average age of diagnosis was expectedly young at 40.4 ± 8.2 years based on the sample population. Individuals with a documented smoking history had smoked for an average of 18.9 ± 10.43 pack-years. No statistically significant differences in demographic data were otherwise noted between the deployed and nondeployed groups.

The evaluation and documentation of COPD risk factors (smoking), clinical symptoms, and objective measurement of lung function with spirometry was varied in this patient group. Table II characterizes the diagnostic workup of all personnel in the study. Although all personnel included in the study were listed with a diagnosis of COPD or emphysema, 34% did not have a documented smoking history identified within their clinical encounters for COPD. There was no increased association between smoking and a history of deployment as 132 deployers (68%) were smokers, whereas 110 nondeployers were (62%) smokers. Nearly all (88%) of the population had spirometry conducted, but only 270 studies (73%) were available for review in the electronic medical record (25 studies had only partial results). Airways obstruction (as defined by current American Thoracic Society reference values) was only identified in 164/245 (67%) of the cohort. In those patients with both a documented smoking history and spirometry values, 65% of deployers met established criteria for COPD, whereas only 46% of nondeployers met criteria. On the basis of the GOLD classification (using the pre-BD FEV_1), disease severity was similar for both deployers and nondeployers: 26 (30%) vs. 24 (33%) with mild disease, 50 (57%) vs. 44 (60%) with moderate disease, and 12 (14%) vs. 5 (7%) with severe disease. A chest radiograph was obtained in 64% and 13% had evidence of hyperinflation. Referral for pulmonary subspecialty evaluation (indicated on the basis of age with suspicion of COPD) was only conducted in half of the personnel. Interestingly, 24% of the cohort did have an α-1-antitrypsin level ordered with a mean value of 131.0 ± 32.3 mg/dL and only one individual was identified with an abnormal level.

Statistically significant decrements in PFT values were not identified comparing the deployed to nondeployed patients. As shown in Table III, only 270 (73%) individuals had documented testing with a similar distribution between the deployed ($n = 155$) and nondeployed ($n = 115$) groups. There was an overall reduction in the % predicted FEV_1 (75.5 ± 17.1%) compared to normal reference values and corresponding decrease in the FEV_1/FVC (67.9 ± 10.4) consistent with airway obstruction. The reported value for the % predicted TLC (100.8 ± 15.2%) was normal and the % predicted RV (116.7 ± 43.7%) showed mild hyperinflation, whereas the % predicted DLCO (83.4 ± 21.8) was within normal predicted values. These mean values for lung volumes and diffusing capacity are not suggestive of COPD. There was no statistical difference between the deployed and nondeployed groups for percent predicted values. Comparison of deployers (Table III) with a pre- and postdeployment diagnosis did not show significant differences in PFT values with the exception of % predicted TLC where the postdeployers had a higher value (99.7 ± 14.3% vs. 85.3 ± 10.4%). Further subset analysis of those individuals with both a documented smoking history and PFTs (more likely to have confirmed diagnosis of COPD) also did not demonstrate differences between deployed and nondeployed groups for percent predicted values (Table IV).

Figure 1 presents 5-year trends for emphysema (ICD-9 492) by branch of Service (panel A) and by OIF/OEF deployment history (panel B). Overall, encounter rates for emphysema

TABLE III. PFT Values Based on Deployment History

	Overall ($n = 270$)	Nondeployed ($n = 115$)	Deployed ($n = 155$)	p-Value	Predeploy Diagnosis ($n = 19$)	Postdeploy Diagnosis ($n = 136$)
FVC (L) (% Predicted)	89.2 ± 14.3	90.4 ± 15.2	88.4 ± 13.6	0.26	87.0 ± 11.7	88.6 ± 13.9
FEV_1 (% Predicted)	75.5 ± 17.1	75.7 ± 18.1	75.7 ± 16.4	0.99	75.3 ± 12.4	75.7 ± 16.9
FEV_1 Post-BD (% Predicted)	78.9 ± 15.0	77.5 ± 15.4	79.9 ± 14.7	0.28	83.8 ± 10.2	79.3 ± 15.2
FEV_1 % Change Post-BD	6.9 ± 7.7	6.9 ± 8.8	6.9 ± 6.9	0.99	7.7 ± 6.9	6.8 ± 7.0
FEV_1/FVC (%)	67.9 ± 10.4	66.8 ± 10.4	68.7 ± 10.3	0.95	70.9 ± 7.9	68.4 ± 10.6
TLC (% Predicted)	100.8 ± 15.2	105.3 ± 15.4	98.2 ± 14.6	0.03	85.3 ± 10.4	99.7 ± 14.3
RV (% Predicted)	116.7 ± 43.7	127.6 ± 43.7	110.3 ± 42.8	0.07	104.8 ± 54.8	111.0 ± 41.8
DLCO (% Predicted)	83.4 ± 21.8	79.3 ± 20.2	86.4 ± 22.6	0.12	89.9 ± 45.7	86.2 ± 20.6

Student's t-test compared values between nondeployed (column 3) and deployed (column 4). A p value less than 0.05 is significant.

TABLE IV. PFT of Documented Smokers

	N	Deployed	*N*	Nondeployed	*p*-Value
FVC (L)	100	4.45 ± 0.83	67	4.32 ± 0.98	0.62
FVC (% Predicted)	106	88.6 ± 14.2	69	89.8 ± 14.5	0.59
FEV_1 (L)	102	3.06 ± 0.74	68	2.93 ± 0.81	0.26
FEV_1 (% Predicted)	107	75.5 ± 17.3	70	74.0 ± 18.5	0.58
FEV_1 Post-BD (% Predicted)	76	79.7 ± 15.7	45	75.9 ± 14.2	0.18
FEV_1 % Change Post-BD	77	6.7 ± 6.7	47	7.0 ± 8.9	0.84
FEV_1/FVC	99	68.4 ± 10.8	67	65.8 ± 11.6	0.80
TLC (L)	37	6.73 ± 1.18	19	7.02 ± 1.11	0.37
TLC (% Predicted)	41	98.9 ± 16.9	20	105.2 ± 16.0	0.17
RV (L)	35	2.09 ± 0.76	19	2.53 ± 0.88	0.06
RV (% Predicted)	38	112.0 ± 46.9	20	132.7 ± 53.0	0.13
DLCO (mL/mm Hg/min)	29	26.2 ± 6.6	23	22.3 ± 6.3	0.03
DLCO (% Predicted)	38	86.7 ± 25.2	23	75.2 ± 21.4	0.07

FVC, forced vital capacity; FEV1, forced expiratory volume at one second; BD, bronchodilator; TLC, total lung capacity; RV, residual volume; DLCO, diffusing capacity for carbon monoxide.

increased over this time period ($p = 0.028$), although none of the Service-specific trends were statistically significant ($p > 0.120$). Trends in the rates of emphysema encounters did not vary significantly by branch of Service ($p = 0.577$). The increase in the rate of emphysema encounters among "ever-deployed" personnel was of borderline statistical significance ($p = 0.064$). Figure 2 presents 5-year trends for chronic airway obstruction (ICD-9 496) by branch of Service (panel A) and by OIF/OEF deployment history (panel B). Overall, encounter rates for chronic airway obstruction (panel A) did not change significantly over time ($p = 0.462$). Time trends did not vary significantly by branch of Service ($p = 0.491$),

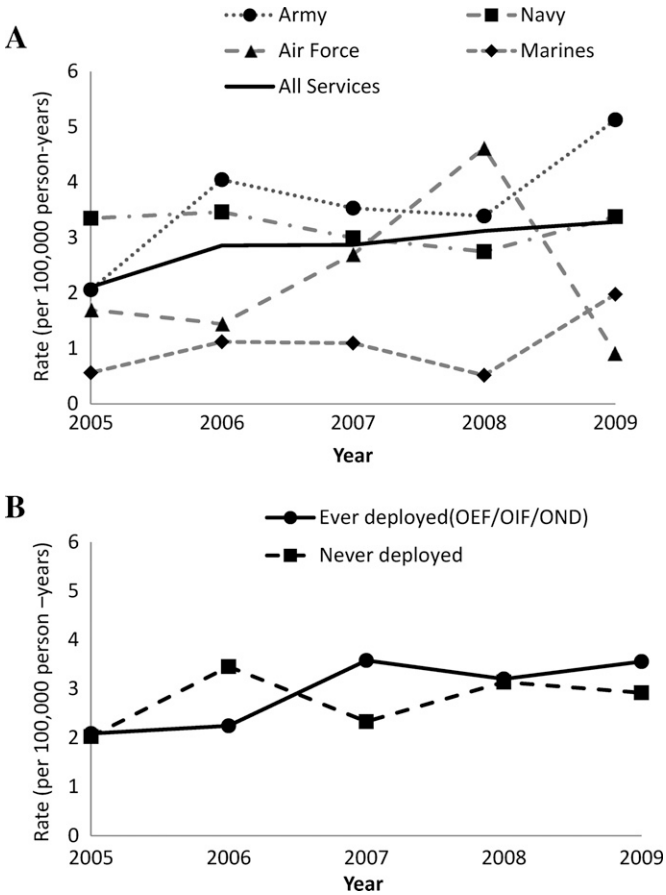

FIGURE 1. Annual rates of emphysema (ICD-9 492) by (A) branch of service and (B) deployment history, Defense Medical Surveillance System data, active duty military 2005–2009.

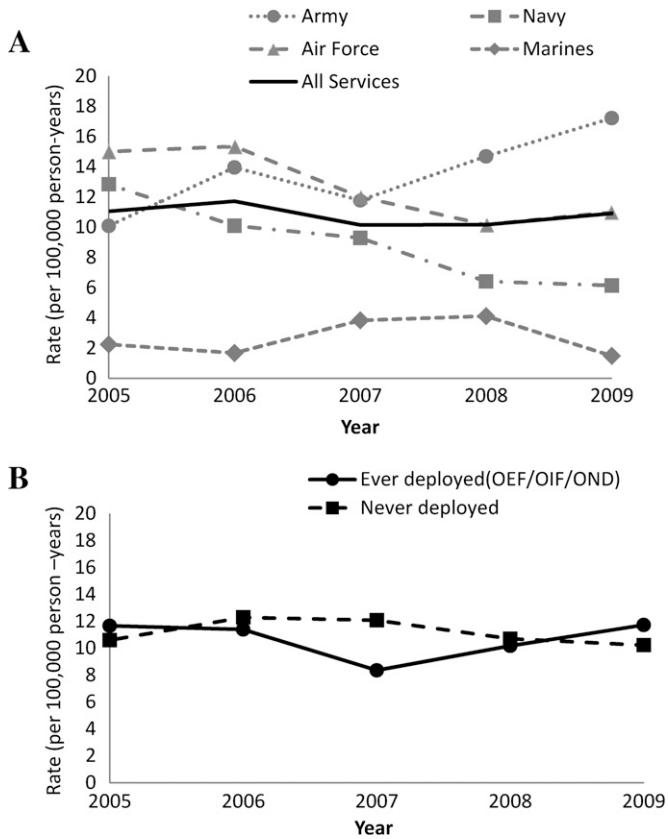

FIGURE 2. Annual rates of chronic airway obstruction (ICD-9 496) by (A) branch of service and (B) deployment history, Defense Medical Surveillance System data, active duty military 2005–2009.

although rates among Air Force and Navy personnel decreased significantly ($p < 0.045$). Rates of chronic airway obstruction encounters did not differ significantly between deployed and nondeployed personnel ($p = 0.846$).

DISCUSSION

There is ongoing concern that environmental exposures during recent deployments to SWA may be exacerbating preexisting pulmonary disease and causing chronic pulmonary symptoms and/or disease in deployed personnel.[8] Although there has been documentation of increased respiratory symptoms among deployed personnel, there is relatively little data regarding the relationship between deployment and chronic lung disease. Several retrospective studies have provided some data on asthma,[5,6] but none have evaluated COPD. This study is the first investigation for a possible association between deployment and COPD.

There are demonstrated increases in nonspecific pulmonary symptoms related to deployment exposures. During an evaluation of the health effects of the Kuwait oil fires of 1991 among U.S. troops, Army survey research found an increase in reported symptoms of upper respiratory tract irritation, shortness of breath, and cough associated with proximity to the Kuwaiti oil fires. The effects from this exposure were generally short lived and resolved after leaving Kuwait.[9] Further survey research 5 years after the First Gulf War noted a modest association between self-reported symptoms of asthma and bronchitis in a cohort of 1,560 veterans based on oil-fire proximity, but no association was observed when using modeled, rather than self-reported exposure measures.[10] The most recent data from the Millennium Cohort Study conducted by the U.S. Navy also documented increased respiratory symptoms but an equal rate of either asthma or chronic bronchitis at 1% in both deployed and nondeployed cohorts.[3] Further evaluation of this cohort is planned to further evaluate chronic lung diseases.

This investigation is one of many initial efforts by the DoD to identify links between deployment and lung disease. Specifically, the study aimed to establish the relationship between deployment and chronic lung disease (COPD in this case). This study suggests two significant conclusions. First, with a chronic obstructive lung disease such as COPD, there is no evidence of increased rates of diagnosis postdeployment. Rather, nearly half (48%) of the personnel identified as having COPD based on chart review did not deploy and 13% were diagnosed predeployment. Second, and perhaps more importantly, careful review of ICD-9 codes (in this study specifically COPD and emphysema) identified that many patients did not meet established criteria based on the published guidelines that include symptoms, cigarette smoking, and spirometric determination of airways obstruction.[7]

In our study, only 65% of patients in this cohort had a documented history of tobacco use. Interestingly, the number of pack-years of smoking was similar for those who deployed and those who did not deploy. Other studies have shown increased tobacco use in deployed personnel.[11,12] It is possible that personnel who deployed in this study did increase their tobacco usage and this would not be reflected in exclusively looking at pack-years. Obstruction on PFTs was not seen in 33% of these patients with an obstructive pulmonary diagnosis. Even among documented smokers, only 54% had spirometry consistent with obstruction. The number of obstructed patients in the nondeployed and deployed groups was similar, suggesting no association between deployment and higher rates of airways obstruction. Disease severity based on FEV_1 % predicted was also similar between groups. A prospective analysis of those deployers vs. nondeployers and more in-depth evaluation of severity of obstruction would be helpful, but was not a part of this retrospective study design. Despite a young population, α-1-antitrypsin levels were obtained in only 24% of the personnel (and the mean levels were within normal limits; Table II).

It is concerning that many of the personnel in this study were labeled with a diagnosis of COPD/emphysema despite often times an incomplete workup. This may be a consequence of an electronic medical record system in which a diagnosis must be selected for coding. Furthermore, only half of the personnel were ever seen in a subspecialty clinic. Although this may not be an issue in an older established population with multiple risk factors for COPD, it is problematic in a younger population in which the differential diagnosis should be broadened (e.g., α-1 antitrypsin deficiency, asthma). The misdiagnosis or overdiagnosis of COPD in the military population also has multiple potential career implications (deployment restriction, physical profiles, and possible nonretainability).

Although this study suggests that there is not an increased rate of COPD among personnel deployed to SWA or worsening lung disease, there are several limitations. One difficulty in evaluating COPD and increased respiratory symptoms in deployed service members is disentangling any physical effects of deployment itself, exposure to environmental hazards, and smoking behaviors. There is an overall higher rate of tobacco use in the military and increased use specifically during deployment.[11] In a survey of soldiers deployed to Iraq, 52% of males and 42% of females reported that they were using tobacco products before deployment. This increased to 58% of males and 52% of females reporting use of tobacco during deployment. Additionally, 25% of males and 48% of females reported increasing their use of tobacco during deployment.[12] The study is retrospective and limited primarily to active duty patients seen in the DoD medical system. It does not report reservist or veteran data and may not reflect all characteristics of COPD in military personnel. Although many patients were likely misdiagnosed with COPD based on ICD-9 codes, it is also quite possible that many may, in fact, have developed COPD and been labeled with an alternative pulmonary diagnosis. Furthermore,

by definition COPD is a chronic disease, and it is possible that manifestations of the disease have not occurred yet in some deployed personnel. The demonstration of airways obstruction on pulmonary function tests is essential to the diagnosis of COPD, but can be seen in a variety of other obstructive pulmonary diseases. Future prospective evaluation of this population could include repeat PFTs and assessment of medication use (i.e., increased inhaler prescription, usage, etc.). Finally, given the few number of patients that were deployed with a pre-existing diagnosis of COPD (n = 25), this study cannot determine if deployment truly worsens COPD without more longitudinal data. On the basis of this limited retrospective review, there does not appear to be an association between deployment to SWA and COPD in active duty military personnel.

REFERENCES

1. Smith TC, Heller JM, Hooper TI, Gackstetter GD, Gray GC: Are Gulf War veterans experiencing illness due to exposure to smoke from Kuwaiti oil well fires? Examination of Department of Defense hospitalization data. Am J Epidemiol 2002; 155: 908–17.
2. Smith TC, Corbell TE, Ryan MAK, Heller JM, Gray GC: In-theater hospitalizations of U.S. and allied personnel during the 1991 Gulf War. Am J Epidemiol 2004; 159: 1064–76.
3. Smith B, Wong CA, Smith TC, Boyko EJ, Gacksetter GS, Ryan MA: Newly reported respiratory symptoms and conditions among military personnel deployed to Iraq and Afghanistan: a prospective population-based study. Am J Epidemiol 2009; 170: 1433–42.
4. Sanders JW, Putnam SD, Frankart C, et al: Impact of illness and non-combat injury during Operations Iraqi Freedom and Enduring Freedom (Afghanistan). Am J Trop Med Hyg 2005; 73: 713–9.
5. Roop S, Niven A, Calvin B, Bader J, Zacher L: The prevalence and impact of respiratory symptoms in asthmatics and nonasthmatics during deployment. Mil Med 2007; 172(12): 1264–9.
6. Szema AM, Peters MC, Weissinger KM, Gagliano CA, Chen JJ: New-onset asthma among soldiers serving in Iraq and Afghanistan. Allergy Asthma Proc 2010; 31: e67–71.
7. Global Strategy for the Diagnosis, Management and Prevention of COPD: Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2011. Available at http://www.goldcopd.org/; accessed October 9, 2013.
8. Weese CB, Abraham JH: Potential health implications associated with particulate matter exposure in deployed settings in southwest Asia. Inhal Toxicol 2009; 21: 291–6.
9. Petruccelli BP, Goldenbaum M, Scott B, et al: Health effects of the 1991 Kuwait oil fires: a survey of US army troops. J Occup Environ Med 1999; 41: 433–9.
10. Lange JL, Schwartz DA, Doebbeling BN, Heller JM, Thorne PS: Exposures to the Kuwait oil fires and their association with asthma and bronchitis among Gulf War veterans. Environ Health Perspect 2002; 110: 1141–6.
11. Smith B, Ryan M, Wingard D, et al: Cigarette smoking and military deployment, a prospective evaluation. Am J Prev Med 2008; 35(6): 539–46.
12. DiNicola AF, Seltzer DM: Tobacco product usage in deployed male and female military personnel. Mil Med 2010; 175: vii–viii.