CHEST

Military Service and COPD Risk

To the Editor:

Occupational exposures account for 15% of the population-attributable risk of COPD. This estimate is based on a robust number of population-based studies across multiple occupations.[1] Military service, however, has not been considered as an occupational contributor to COPD risk. Such military service is potentially important because it involves multiple traditional work-related exposures, especially inorganic dust inhalation.[2]

Methods

We analyzed data from US military service rosters from operations beginning in 2001 in Iraq, Afghanistan, and surrounding countries in the region. We previously used this roster to link prior military service to autoimmune rheumatologic disease outcomes through Veterans Affairs (VA) medical record linkages.[3] This study was approved by the San Francisco VA Health Care System and the University of California San Francisco Institutional Review Boards (#17-23248). Military data included branch of service (Army, Navy, Air Force, Coast Guard, or Marine Corps) and numeric military occupation codes (MOCs). We estimated inorganic dust exposure during military service using the MOCs, applying a job exposure matrix (JEM) we developed for analysis of this cohort.[3] The JEM categorizes military duties as likely (high probability), somewhat likely (moderate probability), or not likely (low probability) to involve inorganic dust exposure, based on the final but not necessarily longest-held MOC.

Clinical data from the VA system included outpatient- and inpatient-associated diagnostic codes. Diagnoses noted at any time from VA enrollment (post-military discharge) through September 30, 2018, were considered. Veterans with COPD were identified based on *International Classification of Diseases, Ninth Revision* (*ICD-9*), and *International Classification of Diseases, Tenth Revision* (*ICD-10*), codes (*ICD-9*, 491, 492, and 496; *ICD-10*, J41, J43, and J44) requiring at least two encounters with these codes at least 30 days apart and at least one prescription for a medication commonly prescribed for COPD (bronchodilators and corticosteroids). We did not require a COPD code to be the primary diagnosis associated with the encounter. Medical records were used to assign ever-smoker status on the basis of a previously validated approach.[4] Those who lacked data to categorize smoking status were excluded. To reduce misclassification bias, we also excluded all veterans coded with an asthma diagnosis (*ICD-9*, 493; *ICD-10*, J45) from the main analyses but added them back for a sensitivity analysis.

Military roster or VA clinical data sources were used to identify age, sex, and race/ethnicity. Unadjusted logistic regression modeling without smoking stratification estimated risk of COPD associated with inorganic dust exposure by JEM as a dichotomous variable (low vs moderate/high exposure) and moderate and high exposure as separate indicator variables. We also re-estimated the unstratified models including interaction terms for exposure and smoking status. To account for correlation within members of the same branch of military service, generalized estimating equations were used to model COPD risk. Adjusted models also controlled for age at first VA encounter, race/ethnicity (White non-Hispanic vs all else), and sex, and were stratified according to smoking status (ever smokers vs never smokers). For all models, we estimated inorganic dust exposure risk for combined moderate/high JEM exposure and for moderate and high exposure as separate indicator variables. Each veteran contributed only one observation to the data set.

Results

There were 722,352 veterans potentially eligible for inclusion. Most exclusions were based on officer military status, duration of service < 2 years, or < 90 days of VA health care. In addition, 43,492 were missing smoking status, and 10,495 had a diagnosis of asthma. Thus, 427,591 were included in the final analysis (Fig 1). The mean age at study entry was relatively young; follow-up extended the upper quartile of age by a decade (Table 1). The JEM categorized 44% as having inorganic dust exposure, divided nearly equally between moderate vs high likelihood. There were 1,728 (0.4%) veterans with a COPD diagnosis, with a median age of first diagnosis of 40 years (only 25% were aged > 47 years). There was a 25% increase in the odds of COPD (OR, 1.25; 95% CI, 1.22-1.28) associated with dust exposure (Table 2). In additional unstratified analyses, smoking*exposure interaction terms were statistically significant (for moderate and high likelihood combined and for high likelihood, $P < .05$; for moderate likelihood, $P < .10$). Among ever smokers, taking into account service branch and covariates, moderate or high likelihood of exposure to inorganic dust in military service was associated with a 23% increased odds of COPD (OR, 1.23; 95% CI, 1.15-1.31), while among never smokers, the odds of COPD were not elevated (OR, 0.94; 95% CI, 0.87-1.01). Estimated ORs were similar when persons with asthma concomitant with COPD were added back to the analysis (data not shown).

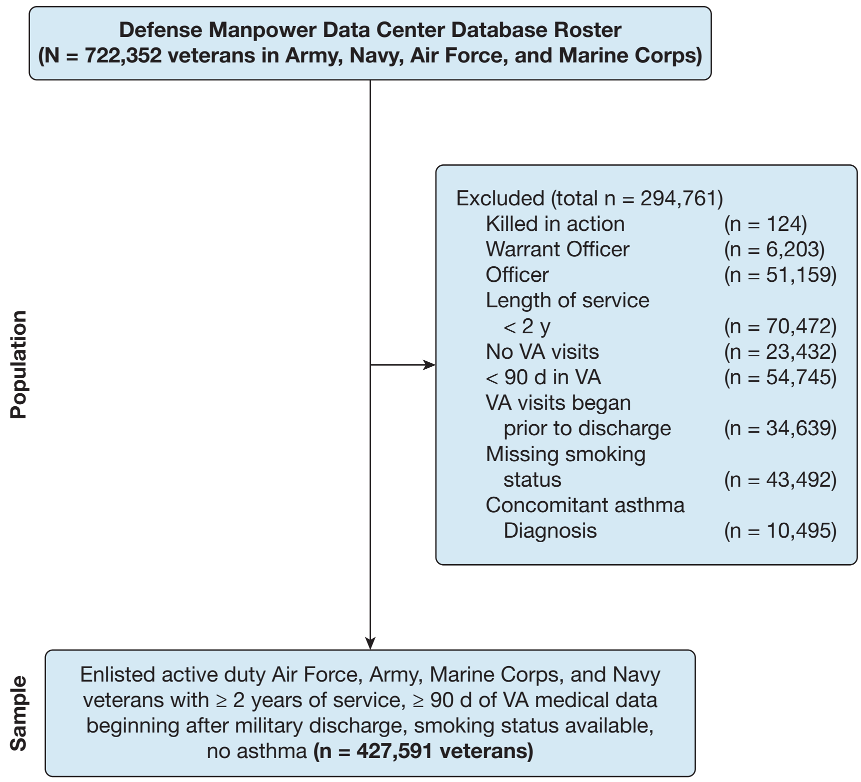

Figure 1 – *Subject exclusions yielding final study group (N = 427,591). VA = Veterans Affairs.*

Discussion

Among a large cohort of US military veterans of relatively young age, we observed modestly elevated but discernibly increased odds of COPD associated with inorganic dust exposure in military occupations. These findings are consistent with an expansive biomedical literature supporting a substantive role of occupational exposures in the etiology of COPD.[1,5-7] This analysis also adds to an emerging appreciation that the occupational aspects of military service should be considered for their potential adverse health effects.[2] We could not quantify the extent of smoking exposure and thus were limited to considering ever smoking across a range of potential cumulative intensities. Smoking exposure misclassification could account for similar risk estimates for high dust exposure stratified according to smoking status; risk attenuation among never smokers argues against misclassification. Based on other studies, the interaction between smoking and occupational exposure for COPD seems to be additive rather than multiplicative[8]; we did observe a statistical interaction in unstratified modeling. A key study limitation is the lack of spirometric data to additionally define COPD. An analysis of VA data, however, showed that multiple visits associated with COPD diagnostic codes and COPD medication use were predictive of COPD confirmed by spirometry, supporting the definition we used in this study.[9]

The prevalence of COPD in this study is small, consistent with a relatively young cohort. Other data suggest that smoking intensity among recent US military veterans is light, which might also lead to a lower prevalence of COPD.[10] Our reliance on a JEM to assign inorganic exposure avoids recall bias. The JEM, however, did not account for other vapors, gas, or fume exposure. This approach is based on the final military occupation and thus also has the further limitation of not having more detailed occupational data that might be available from questionnaire data or direct industrial hygiene measurement. We also did not consider military environmental exposures that may very well be risk factors for later lung disease (eg, from dust storms or burn pit combustion byproducts), nor could we link to other databases such as the Veterans Affairs Airborne Hazards and Open Burn Pit Registry. In addition, although we included length of service in our adjusted models, we did not analyze deployment duration. Furthermore, these findings based on US military veterans may not be generalizable to other nations' military services.

TABLE 1] Subject Characteristics

Characteristic	Final Data Set (N = 427,591)
Male	377,102 (88.2)
Age at first VA encounter, mean ± SD (range), y	29.9 ± 7.3 (19-65)
Age at last VA encounter, mean ± SD (range), y	37.0 ± 8.0 (20-76)
Race/ethnicity	
White	270,807 (63.3)
Non-White	
Black	81,643 (19.1)
Hispanic	50,512 (11.8)
Asian/Pacific Islander	13,440 (3.1)
Other	11,189 (2.6)
Years of military service, median (IQR)	4.3 (3.2-8.2)
Service branch	
Army	207,413 (48.5)
Air Force	52,464 (12.3)
Marine Corps	88,949 (20.8)
Navy	78,765 (18.4)
Education level	
Less than high school	3,284 (0.8)
High school diploma	388,294 (90.8)
Postsecondary education	36,013 (8.4)
Smoking status	
Ever	289,956 (67.8)
Never	137,635 (32.2)
Dust exposure in military occupation	
Low/no exposure	240,364 (56.2)
Any exposure greater than low	187,227 (43.8)
Moderate exposure	94,862 (22.2)
High exposure	92,365 (21.6)
Years of VA observation, median (IQR)	6.7 (4.7-9.4)
No. of visits, median (IQR)	21 (9-48)
COPD[a]	1,728 (0.4)
Median age at first VA COPD diagnosis (IQR), y	40 (32-47)

Data are presented as No. (%) unless otherwise indicated. IQR = interquartile range; VA = Veterans Affairs.
[a]COPD definition: ≥ 2 visits at least 30 days apart with International Classification of Diseases, Ninth Revision, codes 491, 492, and 496 or International Classification of Diseases, Tenth Revision, codes J41, J43, and J44, and at least 1 prescription for a COPD medication.

In summary, military occupation was associated with a modest estimated increase in the odds of COPD in this analysis of US veterans. Military service should be

TABLE 2] Logistic Regression Models of COPD Risk Associated With Dust Exposure in Military Occupations

		Risk of COPD		
		Unadjusted Models (Unstratified)	Adjusted Models Smokers (Ever)	Adjusted Models Nonsmokers
Dust Exposure	Exposure	OR (95% CI)	OR (95% CI)	OR (95% CI)
None/low exposure	240,364 (56.2%)	(Referent)	(Referent)	(Referent)
Moderate/high exposure	187,227 (43.8%)	1.25 (1.22-1.28)	1.23 (1.15-1.31)	0.94 (0.87-1.01)
Moderate exposure level	94,862 (22.2%)	1.22 (1.14-1.30)	1.19 (1.09-1.29)	0.98 (0.81-1.17)
High exposure level	92,365 (21.6%)	1.27 (1.16-1.40)	1.27 (1.09-1.47)	0.89 (0.79-1.002)

All results from general estimating equation models accounting for military branch; adjusted models include age at first Veterans Affairs health care encounter, sex, race/ethnicity (White vs non-White), and years of military service.

considered by clinicians in evaluating patients' occupational histories.

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