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Epidemiology of asthma-related disability in the U.S. Armed Forces: 2007–2012

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Abstract

Objective: To characterize the demographic, disability and deployment characteristics of U.S. Armed Forces personnel with an asthma-related disability discharge, which includes separation (without benefits) and retirement (with disability benefits). **Methods:** Incidence rates for personnel evaluated for disability discharge and/or disability retired due to asthma and due to all other causes of disability discharge were calculated per 100,000 active duty enlisted service members by year. Multivariate logistical regression was used to examine the associations between disability retirement and several demographic and disability characteristics of service members evaluated for asthma-related disability discharge versus those evaluated for any other non-respiratory condition for each branch of military service. **Results:** Service members evaluated for disability discharge related to asthma most often do not have comorbidity and are disability retired rather than separated, with rates of disability retirement increasing over time. Groups with a significantly higher incidence of evaluation for asthma-related disability include females, individuals who entered the military prior to the age of 20, non-Whites, and those with a history of deployment to Iraq or Afghanistan. The characteristic most associated with the odds of disability retirement was a history of deployment. **Conclusions:** New-onset asthma occurring after military entry often causes occupational impairment in service members, especially in those that have been deployed to Iraq or Afghanistan.

Keywords

Asthma, adult-onset, asthma, occupational, deployment, military, comorbidity, disability evaluation

History

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Introduction

Asthma is a major public health issue in the United States with high economic costs and high rates of health care use, lost productivity, morbidity, and disability [1–4]. This chronic lung disease has been increasing in prevalence over the past decade in the United States, affecting approximately 19 million adults [1,2,5]. An estimated 10% to 25% of adult asthma incidence cases are attributable to occupational exposures [6], and adult asthmatics have a 70% higher risk of long-term, all-cause work disability than non-asthmatics [7]. Additionally, adult asthmatics have also been shown to require significantly more hospitalization, sick leave, welfare, and disability benefits versus non-asthmatics [3,8,9].

Members of the U.S. Armed Forces are often first diagnosed with asthma as adults, and there has been an excess of new-onset asthma in service members returning from military operations in Iraq and Afghanistan [10–12]. Consequently, respiratory conditions are among the most common disability types among military personnel evaluated for disability [13]. Additionally, asthma itself is the fourth most commonly evaluated

disability condition in Air Force personnel evaluated for disability discharge [13]. Asthma has also been identified as the most common cause of respiratory-related disability retirement among women and non-deployed men in the Army [14].

Two risk factors for asthma in the general U.S. adult population, being female or Black, are also risk factors for asthma-related hospitalization in military personnel as well as for respiratory-related military discharge [1,15–18]. Risk factors for asthma-related hospitalization specific to service members include being enlisted or in the Army [16]. Several studies have found that service members deployed to combat zones in the Middle East have higher rates of new-onset asthma and other respiratory symptoms than non-deployers, but specific risk factors for deployment-related asthma remain unclear due to a deployed service member's potential exposure to multiple environmental and occupational hazards [11,12,19–22]. Additionally, deployment has also been significantly associated with the initiation and recidivism of smoking, another well-known risk factor for asthma [23].

Research on disability in the military has historically focused on musculoskeletal conditions [24–27]. Contemporary research of disability in the military has increasingly focused on psychiatric and neurological disability [28,29] and has described the relationship between deployment and disability [30]. Niebuhr et al. [14] reported that respiratory conditions

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were a leading cause of disability retirement in the Army. To date, no additional research has attempted to characterize the epidemiology of disability due to respiratory conditions in general or due to asthma specifically.

The primary purpose of this study is to provide an epidemiologic framework of disability due to asthma in the military by describing the characteristics, correlates, and temporal trends of asthma-related disability and by identifying comorbid medical conditions associated with asthma. A better understanding of the epidemiology of disabling asthma in the military is necessary to identify high-risk populations that may be targeted for interventions to decrease the asthma-related burden on military personnel and their healthcare systems, and to increase the military readiness of service members in both early and late career. Since current asthma disqualifies an individual from entering military service, this study may also provide insight into risk factors for new-onset asthma severe enough to negatively affect job performance in the military as well as in the civilian workplace.

Methods

A cross-sectional analysis of the disability records of Army, Navy, Marine Corps and Air Force service members was performed to characterize the epidemiology of asthma disability in the U.S. Armed Forces. This study was performed under a minimal risk human use protocol reviewed and approved by the Walter Reed Army Institute of Research Institutional Review Board.

The Department of Defense's Disability Evaluation System (DES) has the authority for determining whether a service member's medical conditions render him/her unable to continue military duty and, if discharged, for providing compensation equitable to his/her level of impairment in earning capacity [31]. If the service member no longer meets retention standards, the DES assigns a medical code, based on the Veterans Affairs Schedule for Rating Disabilities (VASRD), to each disabling medical condition. Affixed to each VASRD code is a disability rating that reflects the amount of compensable entitlement and is expressed as a percent between 0% and 100%. The disability ratings for each individual medical condition are used to calculate a total disability rating from which a final disposition is derived. Service members receiving a total disability rating between 0% and 20% are generally separated with a one-time severance payment, while those receiving a rating of 30% or greater are eligible for disability retirement benefits, which include lifetime disability payments, medical care, and use of military facilities [31].

Study population

All active duty enlisted Army, Navy, Marine Corps and Air Force personnel evaluated for disability discharge by the U.S. Army Physical Disability Agency (PDA), the Secretary of the Navy Council of Review Boards (CORB) or the Air Force Personnel Center (AFPC) between October 1, 2006 and September 30, 2012 were eligible for inclusion in this cross-sectional study. Military officers were excluded from this study because more than 90% of the military population evaluated for disability are enlisted [13], and any inferences based on the results would statistically apply to the enlisted population only.

Eligible service members were categorized into two groups, asthma and all other, based on the service member's medical conditions during his/her initial disability evaluation. The VASRD was used to identify each service member's medical conditions. The asthma grouping was identified using the VASRD code indicating asthma (6602). The "all other" group included service members evaluated for any other non-respiratory condition. Individuals were excluded from the all other grouping if ever evaluated for any respiratory condition, which included VASRD codes ranging from 6501 to 6847. Individuals from both groups were excluded if their condition was not considered to be disabling at the most recent evaluation.

All service members who are discharged with a disability related to asthma, have been deemed by the PDA, CORB or AFPC to have asthma that was either caused or exacerbated by military service [31]. Active asthma is considered disqualifying at the time of enlistment, though some members may have a history of asthma that was reliably diagnosed and symptomatic prior to, but not after, their 13th birthday [32] and service members are discharged without a disability rating if they have symptomatic asthma early in service [33,34]. Therefore, all of the adults in this study have either adult-onset asthma or a history of asthma as a child that, prior to referral for disability evaluation, was asymptomatic as an adult.

In the Army, Navy and Marine Corps, a service member is referred for disability evaluation if his or her service-connected asthma lasts for more than six to twelve months and significantly interferes with the performance of duties related to his or her military duties or training [33,34]. In addition, the service member will be disability evaluated if the drug therapy needed to control the asthma presents medical hazards or complications, or if frequent monitoring is required [34]. For the Air Force, active duty Airmen with asthma symptoms are required to be automatically evaluated for disability and for some occupations, such as aviator, the use of medications is prohibited [35]. Disability ratings for asthma may be based on physician-initiated pulmonary function tests measuring residual function as well as a consideration on the amount of drug therapy or medical care needed for asthma control [33,34]. For example, a service member may be disability retired if drug therapy is needed on a daily basis or if the asthmatic requires repetitive medical care in order to successfully perform military duties [33,34].

Data sources

The U.S. Army PDA and the U.S. Air Force Personnel Center provided disability evaluation data on Army and Air Force personnel, respectively, while the U.S. Navy CORB provided data for Navy and Marine Corps personnel. Data included case demographic characteristics (age, race, and sex), medical review date, disposition results and date, VASRD codes and disability ratings. The U.S. Air Force Personnel Center did not provide case demographic characteristics; these data were retrieved from entry or loss records provided by the Defense Manpower Data Center, Seaside, California (DMDC). The DMDC also provided entry dates, separation dates, deployment characteristics, and counts of total force strength by year, service and demographic characteristics.

Service members may be evaluated for disability more than once, particularly if they have condition that may change in severity over time and are temporarily disability retired. All demographic variables were obtained from the record with the earliest evaluation date, while final disposition, disability ratings, and medical conditions were collected from the most recent disability record. Due to the large number of individual medical codes, closely related conditions were grouped into general medical condition categories. For example, the general medical condition category for arthritis includes osteoarthritis, rheumatoid arthritis, arthritis due to joint infection, or any other type of arthritis.

Age at entry was categorized into the following age groupings: younger than 20 years; between 20 and 24 years; between 25 and 29 years; and, 30 years and older. Since few service members younger than 20 years are evaluated for disability, age at first disability evaluation was categorized as younger than 25 years; between 25 and 29 years; and, 30 years and older. Race was categorized into White, Black and other. Service members receiving a disability rating of 30% or higher were categorized as disability retired. All overseas deployments in support of conflicts in Iraq and Afghanistan between October 1, 2001 and September 30, 2012 were included. Service members were categorized as deployed if deployed at any time during the study period including deployments occurring prior to or after the service member's first disability evaluation. Deployment frequency was categorized based on the total number of deployments occurring over the service member's military term of service.

Analysis

Service-specific incidence rates of disability evaluation and retirement related to asthma and the all other group were calculated per 100,000 active duty enlisted service members by year. The denominator was based on yearly total force strength counts. Year of evaluation and retirement were based on the fiscal year of the service member's initial disability evaluation. The Cochran–Armitage test for linear trend was utilized to investigate the relationship between year versus disability evaluation and disability retirement for the asthma and the all other disability group.

For asthma disability cases, incidence rates of disability evaluation were calculated by service, demographic characteristics, and deployment count per 100,000 active duty enlisted service members using total force strength counts from years 2007 to 2012. Additional rates were calculated for retirement versus separation and the presence of a comorbid conditions per 1,000 active duty enlisted service members evaluated for disability during the entire study period. Incidence rate ratios and 95% confidence intervals were calculated in order to compare incidence rates for all demographic, deployment and disability characteristics.

Frequency distributions were performed to identify the general medical condition categories for the most common comorbid conditions present in service members evaluated for an asthma-related disability. Service members with more than one comorbid condition within the same general medical condition category were counted only once per general medical condition category.

Bivariate and multivariate logistic regression models were generated to compute unadjusted and adjusted odds ratios assessing associations between disability retirement (*i.e.* permanent or temporary) and several demographic and deployment characteristics. The adjusted regression models controlled for deployment count, sex, age at entry and race. All statistical analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC).

Results

The Air Force had the highest rates of asthma disability with an overall rate of 80 Airmen being evaluated for asthma-related disability per 100,000 Airmen (Table 1). The Army had the second highest rates of asthma disability, with an overall rate of 49. In the test for linear trend, rates of asthma disability increased significantly over time in the Marine Corps and Air Force, but remained constant for the Army and Navy. Rates of medical retirement related to asthma significantly increased over time for the Army, Marine Corps and Air Force. The highest overall rates of asthma-related medical retirement were seen in the Air Force (55) and Army (38). In comparison, rates of disability evaluation and medical retirement significantly increased over time in those evaluated for any other non-respiratory condition.

Table 2 lists service-specific incidence rates and rate ratios for demographic and military service characteristics for asthma-related disability evaluation. The rate of asthma-related disability evaluation in females was approximately double the rate of males in the Army (incident rate ratio (IRR) = 1.87; 95% confidence interval (95% CI) = 1.65–2.13), Navy (IRR = 2.21; 95% CI = 1.49–3.27), and Air Force (IRR = 2.26; 95% CI = 2.01–2.55). Those who entered the military while still in their teenage years had more than four times the rate of asthma-related disability evaluation than any other age category in all services. Service members aged 25 to 29 years at their first disability evaluation had significantly higher rates than service members under 25 years of age in both the Army (IRR = 1.45; 95% CI = 1.28–2.13) and Navy (IRR = 2.74; 95% CI = 1.79–4.21). Conversely, the rate of disability evaluation for asthma decreased as age at first disability evaluation increased for the Air Force. In the Army Blacks had a significantly higher rate of evaluation for disability related to asthma than Whites (IRR = 1.23; 95% CI = 1.09–1.39) and Air Force (IRR = 1.43; 95% CI = 1.25–1.64). In addition, the “Other” race had significantly higher rates than Whites in the Army (IRR = 1.35; 95% CI = 1.08–1.70) and Marine Corps (IRR = 2.64; 95% CI = 1.88–3.71). In all services, history of deployment was associated with significantly higher rates of asthma-related disability evaluation, with those deployed once having the highest rates.

Table 3 describes the rates and rate ratios for asthma-related discharge type (medical retirement versus separation) and presence of a comorbid condition per 1,000 disability evaluated service members. The Air Force had the highest rates of medical retirement (55) and separation (25), yet the Navy had the lowest rates of asthma-related medical retirement (7) and separation (3). For all services, two to three times more service members were disability retired than separated for asthma. Significantly more asthma cases were evaluated for asthma only, rather than evaluated for asthma plus a comorbid condition, in all services.

Table 1. Rate of disability evaluation and retirement over time by service and disability type (rate per 100,000 active duty enlisted service members).

	Army						Navy						Marine Corps						Air Force					
	Asthma			Other			Asthma			Other			Asthma			Other			Asthma			Other		
	n	Rate	n	Rate	n	Rate	n	Rate	n	Rate	n	Rate	n	Rate	n	Rate	n	Rate	n	Rate	n	Rate		
Evaluation																								
2007	228	53	6,572	1,517	26	9	1,408	501	22	13	1,444	866	68	26	1,057	401								
2008	227	50	7,263	1,607	17	6	1,333	484	25	14	1,446	811	180	70	1,895	734								
2009	237	52	8,231	1,796	19	7	1,247	458	18	10	1,562	857	149	57	1,572	597								
2010	199	43	7,074	1,514	17	6	1,251	463	26	14	1,607	887	277	105	1,861	706								
2011	201	43	7,086	1,528	12	4	1,207	452	56	31	1,910	1,066	327	124	1,997	758								
2012	243	54	8,870	1,983	29	11	2,004	767	58	33	3,107	1,756	255	97	2,109	799								
Overall	1,335	49	45,096	1,657	120	7	8,450	519	205	19	11,076	1,040	1,256	80	10,491	666								
Trend (Z statistic)	−0.79		10.90**		0.19		10.35**		5.60**		25.71**		12.30**		16.33**									
Retirement																								
2007	100	23	1,122	259	13	5	652	232	11	7	638	383	14	5	435	165								
2008	134	30	2,196	486	11	4	632	230	14	8	602	338	116	45	1,010	391								
2009	191	42	4,004	874	15	6	663	244	10	5	681	373	112	43	802	305								
2010	178	38	4,166	892	8	3	622	230	19	10	673	371	205	78	992	377								
2011	183	39	4,162	898	12	4	686	257	52	29	891	497	222	84	1,110	422								
2012	236	53	5,388	1,205	26	10	1,196	458	52	29	1,694	957	199	75	1,460	553								
Overall	1,022	38	21,038	773	85	5	4,451	274	158	15	5,179	486	868	55	5,809	369								
Trend (Z statistic)^	7.12**		53.80**		2.15*		13.96**		7.53**		24.10**		13.17*		21.26**									

p value: * <0.05, ** <0.0001.

Table 2. Demographic and military service characteristics of service members disability evaluated for asthma by service (rate per 100,000 active duty enlisted service members).

	Army				Navy				Marine Corps				Air Force			
	<i>n</i>	Rate	IRR	95% CI	<i>n</i>	Rate	IRR	95% CI	<i>n</i>	Rate	IRR	95% CI	<i>n</i>	Rate	IRR	95% CI
Sex																
Male (ref)	1,041	44.0	1.00	—	85	6.2	1.00	—	185	18.6	1.00	—	771	60.8	1.00	—
Female	293	82.5	1.87	1.65-2.13	35	13.7	2.21	1.49-3.27	20	28.3	1.52	0.96-2.41	422	137.5	2.26	2.01-2.55
Age at First Evaluation																
<25 (ref)	545	48.1	1.00	—	34	4.9	1.00	—	137	19.8	1.00	—	619	102.4	1.00	—
25-29	481	69.6	1.45	1.28-1.63	54	13.5	2.74	1.79-4.21	55	26.7	1.35	0.99-1.85	352	86.9	0.85	0.74-0.97
30+	307	34.2	0.71	0.62-0.82	32	6.0	1.23	0.75-1.99	12	7.3	0.37	0.20-0.66	121	21.4	0.21	0.17-0.25
Age at Entry																
<20	404	216.3	4.84	4.22-5.54	39	36.6	4.13	2.72-6.26	119	75.4	5.18	3.89-6.89	490	570.0	7.33	6.43-8.37
20-24 (ref)	423	44.7	1.00	—	52	8.9	1.00	—	78	14.7	1.00	—	403	77.7	1.00	—
25-29	168	24.3	0.54	0.45-0.65	17	4.2	0.48	0.28-0.83	6	2.9	0.20	0.09-0.46	46	11.4	0.15	0.11-0.20
30+	113	12.6	0.28	0.23-0.35	10	1.9	0.21	0.11-0.42	1	0.6	0.04	0.01-0.30	122	21.6	0.28	0.22-0.34
Missing	227	17%	—	—	2	1.7%	—	—	1	0.5%	—	—	195	15.5%	—	—
Race																
White (ref)	902	48.3	1.00	—	71	8.6	1.00	—	136	16.4	1.00	—	811	72.0	1.00	—
Black	351	59.4	1.23	1.09-1.39	26	8.0	0.93	0.60-1.46	23	19.9	1.21	0.78-1.89	271	103.2	1.43	1.25-1.64
Other	82	65.4	1.35	1.08-1.70	23	7.8	0.92	0.57-1.47	44	43.3	2.64	1.88-3.71	95	88.0	1.22	0.99-1.51
Deployed																
No (ref)	514	26.2	1.00	—	71	5.2	1.00	—	118	13.3	1.00	—	769	59.4	1.00	—
Yes	821	107.6	4.10	3.67-4.58	49	19.0	3.66	2.55-5.27	87	48.9	3.67	2.79-4.85	487	173.8	2.93	2.61-3.28
Deployment Frequency																
0 (ref)	514	26.2	1.00	—	71	5.2	1.00	—	118	13.3	1.00	—	769	59.4	1.00	—
1	517	133.9	5.10	4.52-5.76	30	26.0	5.00	3.27-7.67	60	63.9	4.80	3.52-6.55	280	251.9	4.24	3.70-4.86
2+	304	80.6	3.07	2.67-3.54	19	13.3	2.57	1.55-4.27	27	32.1	2.41	1.59-3.67	207	122.4	2.06	1.77-2.40

Ref: Reference Group; IRR: Incident Rate Ratio; 95% CI: 95% Confidence Interval.

Ref: Reference Group; IRR: Incident Rate Ratio; 95% CI: 95% Confidence Interval.

	Army			Navy			Marine Corps			Air Force		
	<i>n</i>	Rate	IRR	95% CI	<i>n</i>	Rate	IRR	95% CI	<i>n</i>	Rate	IRR	95% CI
Retired	313	5.7	1.00	—	35	2.9	1.00	—	47	3.4	1.00	—
	1,022	18.7	3.27	2.88-3.71	85	7.0	2.43	1.64-3.60	158	11.3	3.36	2.43-4.66
Comorbidity	815	14.9	1.00	—	93	7.6	1.00	—	161	11.5	1.00	—
	520	9.5	0.64	0.57-0.71	27	2.2	0.29	0.19-0.45	44	3.1	0.27	0.20-0.38

Musculoskeletal conditions and psychological disorders were common comorbidities in asthma disability cases (Table 4). Dorsopathies, arthritis and limitations of motion were the most common comorbid conditions related to the musculoskeletal system, while posttraumatic stress disorder (PTSD) and mood disorders were the most common psychological disorders. In addition, 10% to 26% of asthma cases who had concurrent condition in the Navy, Marine Corps and Air Force had a condition within the restrictive lung disease category, which included sleep apnea, sarcoidosis, diaphragm paralysis, pectus excavatum/carinatum, pleural effusion, traumatic chest wall defect, and post-surgical residuals from lung surgery.

No consistent patterns were seen for any service in the odds of disability retirement related to asthma (Table 5). Females were significantly more likely to be retired for asthma-related disability in the Air Force (adjusted odds ratio (AOR) = 1.77; 95% CI = 1.34–2.34). Soldiers that entered the Army between the ages of 25 and 29 had higher odds of asthma-related disability retirement versus those aged 20 to 24 (AOR = 1.72; 95% CI = 1.05–2.84). All other age at entry categories in every service were not significantly associated with disability retirement. Race was not significantly associated with asthma-related disability retirement in any service. The odds of disability retirement increased as the number of deployments increased for the Army and the Air Force.

Discussion

Historically, research on disability in the military has centered on musculoskeletal, psychological and neurological conditions. Yet, respiratory conditions, led by asthma, are a prominent cause of disability evaluation and medical retirement in the Army and Air Force. This cross-sectional study on members of the U.S. Armed Forces extends previous studies of disability in the military by providing data on the epidemiology of disability related to asthma and by identifying potential areas for future research on new-onset adult asthma in the military.

Service members discharged for asthma were two to three times more likely to be retired than separated in this study and significantly more asthma cases were evaluated for asthma only. This finding is in contrast to other research which has shown asthma is often reported with comorbidities [36,37] and that comorbidities are common within the disability retired population [13,28,29]. The lower prevalence of comorbid conditions among asthma cases in this population taken together with prior evidence of high comorbidity associated with asthma in other populations suggest that asthma, rather than a comorbid condition, is the main reason service members in this population are referred for disability evaluation. Further, the higher likelihood of disability retirement among asthma-related disability cases, in the absence of comorbid disability, indicates that asthma itself causes a high level of occupational impairment in this population.

The most common comorbidities evaluated among asthma cases were musculoskeletal conditions (arthritis and dorsopathies) and psychological disorders (PTSD and mood disorders). These conditions are also among the most common conditions in service members evaluated for any disability [13],

and therefore may be more a result of military service than related to asthma. Nonetheless, previous research on both service members and civilians has noted that asthma is associated with an increased likelihood of psychiatric disorders, including anxiety disorders, mood disorders and PTSD [38,39].

In this study, 30% of Soldiers and Marines had comorbid PTSD, which is higher than the prevalence of PTSD in the entire population evaluated for disability for the Army (18%) and Marine Corps (14%). In addition, 9% of Soldiers and 10% of Airmen evaluated for asthma-related comorbidity had a mood disorder, which is also slightly higher than the prevalence of mood disorders in the overall disability population in the Army (6%) and Air Force (9%). Interventions and screening for comorbid psychological disorders in those service members presenting with asthma symptoms may be important in improving the health outcomes in this population.

The demographic characteristics associated with asthma in previous studies were similarly associated with asthma-related disability discharge in this study. Females had a significantly higher rate of asthma-related disability evaluation in all services. Significantly higher rates of evaluation for disability related to asthma were also observed in Black Soldiers and Airmen, but not among Black Sailors and Marines. Females and Blacks have higher rates of asthma in the adult civilian population [1] and being female or Black was associated with an increased risk of disability discharge related to any respiratory condition in a study of U.S. Soldiers [18].

Although the data presented here show females and Blacks have higher rates of asthma-related disability evaluation, no increased odds of asthma-related disability retirement was observed by race or sex in any service, with the exception of female Airmen. The discrepancy between the incidence of disability evaluation related to asthma and disability retirement in females and Blacks indicates females and Blacks who are evaluated for disability related to asthma have less severe asthma and receive lower disability ratings. Further research is necessary to determine whether the less severe asthma observed in the female and Black population is the result of sub-clinical asthma that existed prior to service and if the pathogenesis of adult-onset asthma is different in Blacks and females than in other segments of the military population.

Rates of disability evaluation were more than four times higher for those entering the military as a teenager when compared to those entering in their early twenties. Although this finding is in concordance with prior research stating that incidence rates of asthma among active duty service members were highest in those under 20 years [10], the four-fold increase in the rate of evaluation for disability discharge needs further examination. Additional pre-screenings for asthma as well as programs on asthma management targeted for young recruits may help decrease the number of early career asthma-related disability retirements in this population.

The Air Force had the highest rates of asthma-related disability evaluation and disability retirement. These higher rates could be related to the Air-Force-specific medical retention standards which require Airmen with asthma of any degree to be evaluated for disability [35]. Whereas, in the Army, Navy, and Marine Corps, a service member is referred for disability evaluation only if the asthma interferes with his or her military duty or training, or requires repetitive medical care or drug

Table 4. Most common comorbid disability condition categories in asthma disability cases by service.

	Army		Navy		Marine Corps		Air Force			
	N	%	N	%	N	%	N	%		
Dorsopathies	177	34.0	7	25.9	PTSD	16	36.4	Dorsopathies	53	21.2
PTSD	148	28.5	4	14.8	Dorsopathies	7	15.9	Arthritis	30	12.0
Arthritis	85	16.4	2	7.4	Restrictive lung disease	6	13.6	Mood disorder	26	10.4
Limitation of motion of joint	68	13.1	2	7.4	Limitation of motion of joint	5	11.4	Limitation of motion of joint	24	9.6
Mood disorder	47	9.0	2	7.4	Chronic obstructive pulmonary disease	4	9.1	Restrictive lung disease	24	9.6
Total Individuals		520		27	Total Individuals		44	Total Individuals		250

PTSD: Posttraumatic stress disorder.

Table 5. Crude and adjusted odds ratios for disability retirement in asthma disability cases.

	Army				Navy				Marine Corps				Air Force			
	cOR	95% CI	aOR	95% CI	cOR	95% CI	aOR	95% CI	cOR	95% CI	aOR	95% CI	cOR	95% CI	aOR	95% CI
Sex																
Male (ref)	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—
Female	1.12	0.82-1.53	1.30	0.92-1.82	1.04	0.44-2.48	1.30	0.51-3.28	1.21	0.38-3.82	1.58	0.48-5.19	1.48	1.14-1.93	1.77	1.34-2.34
Age at Entry																
<20	0.75	0.54-1.02	0.71	0.52-0.99	—	—	—	—	—	—	—	—	0.86	0.65-1.14	0.79	0.60-1.05
20-24 (ref)	1.00	—	1.00	—	—	—	—	—	—	—	—	—	1.00	—	1.00	—
25-29	1.74	1.07-2.83	1.72	1.05-2.84	—	—	—	—	—	—	—	—	1.40	0.70-2.78	1.49	0.74-3.02
30+	1.64	0.93-2.88	1.53	0.86-2.73	—	—	—	—	—	—	—	—	1.33	0.85-2.08	1.11	0.70-1.77
Missing	0.74	0.51-1.07	0.60	0.41-0.89	—	—	—	—	—	—	—	—	2.51	1.63-3.87	1.86	1.06-3.26
Race																
White (ref)	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—
Black	1.24	0.92-1.67	1.21	0.88-1.66	0.63	0.24-1.61	0.50	0.18-1.38	3.64	0.81-16.30	3.61	0.79-16.52	0.84	0.63-1.12	0.86	0.64-1.17
Other	1.45	0.82-2.54	1.24	0.69-2.22	1.41	0.46-4.32	1.32	0.42-4.08	1.18	0.53-2.63	1.11	0.48-2.53	0.79	0.50-1.23	0.74	0.46-1.17
Deployment Count																
0 (ref)	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—	1.00	—
1	1.92	1.45-2.55	2.11	1.58-2.83	1.12	0.44-2.82	1.11	0.43-2.83	1.88	0.88-4.03	2.03	0.93-4.44	1.91	1.40-2.61	1.92	1.38-2.68
2+	3.33	2.27-4.88	3.69	2.48-5.48	2.56	0.68-9.66	3.04	0.77-12.01	10.96	1.43-83.87	10.88	1.41-84.17	3.29	2.20-4.93	3.72	2.37-5.83

Ref: Reference Group; cOR: Crude Odds Ratio; 95% CI: 95% Confidence Interval; aOR: Adjusted Odds Ratio.

* Age at entry was excluded in the regression models for the Navy and Marine Corps due to an insufficient population size.

therapy [33,34]. Nonetheless, future research is needed to better describe the populations most at risk of asthma in Air Force personnel.

Deployment, specifically deployment count, was associated with high rates of asthma-related disability evaluation and increased odds of medical retirement. This finding is consistent with prior research indicating that service members deployed overseas, particularly to the Middle East, have high rates of asthma [11,12]. However, research examining associations between asthma and deployment or deployment-related exposures have been inconsistent [11,12,21,40,41]. Further evaluation examining the relationship between disabling asthma and deployment is needed in order to apply proper interventions and health policy changes. Additionally, future research is needed to identify additional risk factors for asthma-related disability in U.S. military personnel, including occupation, smoking status, and deployment-related occupational and environmental exposures.

The main strengths of this study are the large study population and the comprehensive data capture for each study subject, which includes data from service entry, deployment, and disability evaluation. The biggest study limitation, other than the descriptive nature of the study design, is the lack of data on other known correlates of adult-onset asthma that were not included in this study, most notably smoking status and childhood history of asthma. Other limitations stem from the ascertainment of the study population. Instead of assigning *International Classification of Diseases, Ninth Revision* (ICD-9) codes, the military disability system employs the VASRD, whose main function is to assign fair compensation based on the level of occupational impairment and are not clinical diagnoses.

Further, an individual was categorized as deployed if deployed at any time during the study period and therefore assessment on whether a service member's asthma was caused or aggravated by deployment-related exposures could not be completed. The results of this study may not be generalizable to the U.S. adult civilian population because service members are predominately healthy young adult males that have equal access to comprehensive health care resources. In addition, these conclusions may not be generalizable to military officers since they often have different exposures as well as occupations which have different medical accession and retention standards than enlisted service members.

This study describes the epidemiology of asthma-related disability in service members, who typically enter military service as young, healthy adult males that are asymptomatic for asthma. Therefore, the results of this study explains the burden of asthma and identifies possible risks for the development of new-onset asthma which becomes so severe that a service member can no longer successfully perform their occupational duties. The findings of this study may be of interest to health care providers who serve military or veteran populations as they highlight that asthma, even in the absence of comorbidities, can cause a high level of occupational impairment and that rates of asthma-related medical retirement are increasing over time. Furthermore, this study also identified several potential areas for future research on new-onset adult asthma which may be relevant to asthma researchers.

Conclusions

This study adds knowledge to current asthma research by demonstrating that service members evaluated for disability related to asthma are more often disability retired than separated, are evaluated for asthma alone rather than with a comorbidity, and deployment is most associated with the odds of disability retirement. Rates of asthma-related disability retirement have been increasing over time and may continue to increase as the military continues deploying troops overseas. Because this study shows that asthma often causes occupational impairment in members of the U.S. Armed Forces, continued policies and interventions designed to prevent or properly manage new-onset asthma could aid in maintaining military readiness.

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Declaration of interest

The authors report that there are no conflicts of interest. The authors alone are responsible for the content and writing of the article. The views expressed are those of the authors and should not be construed to represent the positions of the Department of the Army or Department of Defense. All authors are employees of, or contracted to, the United States Army.

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