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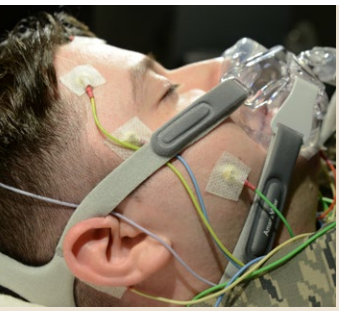

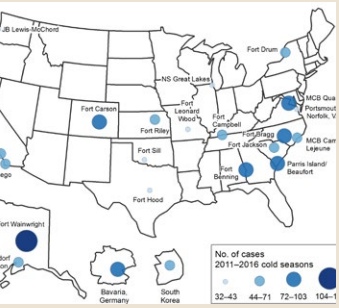

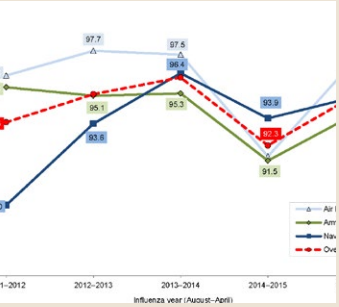

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Obstructive Sleep Apnea and Associated Attrition, Active Component, U.S. Armed Forces, January 2004–May 2016

Amy E. Rogers, MD, MPH (LCDR, USN); Shauna Stahlman, PhD, MPH; Devin J. Hunt, MS; Gi-Taik Oh, MS; Leslie L. Clark, PhD, MS

Obstructive sleep apnea (OSA) is a growing health concern in both civilian and military populations. Individuals who suffer from OSA have increased rates of cardiovascular disease, chronic fatigue, motor vehicle accidents, cognitive impairment, and post-traumatic stress disorder. Data from the Defense Medical Surveillance System (DMSS) were utilized to examine the incidence of OSA and associated attrition from service in active component military members from 1 January 2004 through 31 May 2016. The study identified 223,731 incident cases of OSA with an overall incidence rate of 139.2 per 10,000 person-years, between 2004 and 2015. Rates increased more than 3-fold between 2004 and 2015. In 2015, 48.1% of all incident cases of OSA were diagnosed in the last year of service. The high percentage of cases diagnosed prior to separation from service is concerning because OSA is a treatable and partially preventable disease. OSA represents a large health and economic burden for the armed services and yet there are persistent research gaps in appropriate screening and prevention strategies to improve both individual health and mission performance.

Obstructive sleep apnea (OSA) is defined clinically as the complete or near complete cessation of airflow during sleep due to the obstruction of the upper airway. Individuals with OSA may suffer symptoms such as snoring, gasping for breath during sleep, insomnia, headaches, and daytime fatigue. Individuals who suffer from OSA have increased rates of motor vehicle accidents, cardiovascular disease (including stroke and high blood pressure), diabetes, and cognitive impairment.[1]

Appropriate diagnosis and treatment of OSA is important for managing the burden of disease. The American Academy of Sleep Medicine's standard for diagnosis of OSA is by polysomnography, which captures the number of obstructive events per hour, known as the apnea-hypopnea index (AHI). The standard treatment option for OSA is with continuous positive airway pressure (CPAP) at night. Other treatment options include surgical interventions and intensive lifestyle interventions targeting weight loss, smoking cessation, and eliminating the use of sedating substances.

OSA is a prevalent and costly disease in the U.S., with 27% of men and 11% of women aged 30–70 years suffering from OSA.[2] The prevalence of OSA has been rising and is associated with changing obesity prevalence, as obesity is a risk factor for OSA.[3] The prevalence of OSA also increases with increasing age.[1] In the U.S. in 2000, the estimated annual economic cost of moderate to severe OSA in terms of OSA-related traffic/workplace accidents and loss of work productivity ranged from $67 billion to $165 billion.[4]

Rising incidence and prevalence of OSA have also been reported in the U.S. active duty military and veteran populations. New diagnoses of OSA among service members in the active component increased nearly 5-fold between 2001 and 2009.[5] Alexander et al. reported a 6-fold increase in sleep disorder diagnoses between 2000 and 2009 in a cross-sectional study of veterans receiving care at Veterans Health Administration facilities.[6]

The increasing rates of OSA diagnoses have resulted in significant costs to both the Department of Defense (DoD) and the Department of Veterans Affairs (VA) due to the associated Military Disability Benefit (MDB) for OSA, treatment costs, and associated adverse health conditions. A diagnosis of OSA requiring a CPAP machine is classified as a 50% Military Disability Rating. It is estimated that the VA's yearly compensation costs for OSA will exceed $1 billion due to the MDB alone.[7] The true cost to the DoD and VA is likely underestimated, as diagnosis and treatment are only 3% of the total economic burden of OSA.[4] The proportion of hidden costs including loss of work productivity and comorbid medical conditions may be even higher in the DoD population, compared to civilian populations, because of the unique military mission utilizing expensive equipment and the dangerous situations in which service members must operate.

Untreated OSA is an important military healthcare concern and may adversely affect the military mission and the service members' long-term health. Service members may delay seeking medical care for OSA because it is a disqualifying condition for certain military occupations. Military missions often involve sleep deprivation, sleep fragmentation, and physical stressors that may alter OSA presentation and

also delay diagnosis.[8] Untreated OSA can affect the military mission and personal performance, as members may suffer from cognitive impairment, chronic fatigue, post-traumatic stress disorder (PTSD), and other chronic illnesses.[1,8-10]

This analysis reports incident OSA diagnoses and attrition in the active component of the U.S. Armed Forces over a 12-year surveillance period (2004–2015) as well as examining time to separation from military service after an incident OSA diagnosis. This report also provides information on the burden of disease in military subpopulations and the association of obesity with OSA.

TABLE 1. ICD-9/ICD-10 diagnostic codes for obstructive sleep apnea, obesity, and chronic insomnia[a]

Obstructive sleep apnea	ICD-9 code	ICD-10 code
Sleep apnea, unspecified	780.51, 780.57	G47.30
Obstructive sleep apnea, adult, pediatric	327.23	G47.33
Other sleep apnea	780.53	G47.39
Obesity		
Obesity, unspecified	278	E66.09, E66.8, E66.9
Morbid obesity	278.01	E66.01
Body mass index 30–39, adult	V85.3	Z68.3
Body mass index ≥40, adult	V85.4	Z68.4
Obesity due to excess calories		E66.0
Morbid obesity with alveolar hypoventilation		E66.2
Drug-induced obesity		E66.1
Chronic insomnia		
Insomnia not due to substance or known physiological condition		F51.0
Transient insomnia	307.41	F51.02 F51.09
Persistent insomnia	307.42	F51.03, F51.01
Organic insomnias	327.00–327.02	F51.04 F51.05 G47.01
Insomnia		G47.0
Other organic insomnias	327.09	G47.09
Insomnia, unspecified	780.52	G47.00

[a]Not caused by obstructive sleep apnea

METHODS

The surveillance period for this report was 1 January 2004 through 31 May 2016. The surveillance population included all individuals who served in the active component of the Army, Navy, Air Force, or Marine Corps at any time during the surveillance period. All data used to identify incident cases of OSA were derived from records routinely maintained in the Defense Medical Surveillance System (DMSS). These records include both ambulatory encounters and hospitalizations of active component members of the U.S. Armed Forces in military and civilian (if reimbursed through the Military Health System) treatment facilities.

For surveillance purposes, an incident case of OSA was defined as two or more ambulatory visits occurring within 90 days, or a hospitalization, with an ICD-9/ICD-10 diagnostic code indicative of OSA in any diagnostic position **(Table 1)**. Incident cases were identified during the period between 1 January 2004 and 31 December 2015. Individuals who had received a diagnosis of OSA prior to 1 January 2004 were excluded as prevalent cases. Each individual could be counted as an incident case only once during the surveillance period. Following the incident diagnosis, an OSA case could no longer contribute person-time to the analysis (i.e., person-time was censored at the time of OSA diagnosis). Incidence rates were stratified by demographic and military characteristics, including service branch, sex, race/ethnicity, age, rank, occupation as identified by the DoD primary occupation code, time in service, number of times the individual had been deployed (as recorded in the Contingency Tracking System of the Defense Manpower Data Center), marital status, and obesity status. To calculate obese person-time during the surveillance period, individuals were counted as obese during each calendar year that they had a diagnosis of obesity in any diagnostic position for any medical encounter.

Time to separation from service among OSA-diagnosed service members was compared to non-OSA-diagnosed service members using survival analysis. For the purpose of this type of analysis, incident cases of OSA-diagnosed service members comprised services members who met the surveillance case definition for incident OSA between 1 January 2004 and 31 December 2014. A control cohort (or sample) of non-OSA-diagnosed service members was selected from all eligible controls for each case (i.e., 1:1 match) and matched on sex, age (within 1 year of the matched case) and time in service (within 1 year). Individuals were classified as obese if they received a diagnosis of obesity in any diagnostic position during any medical encounter within 1 year prior to or 1 year following an incident diagnosis of OSA. Individuals with a diagnosis of chronic insomnia were excluded from both matched samples because the diagnosis may be a marker for undiagnosed OSA or future diagnosis of OSA. Chronic insomnia was defined as two or more ambulatory care visits within 90 days of each other or a hospitalization, with a diagnosis of insomnia in any diagnostic position **(Table 1).**

Matched pairs were followed from the day of OSA diagnosis until separation from service, death, or the end of the surveillance period (31 May 2016). The follow-up period for members of the non-OSA comparison sample started on the same date as the incident OSA diagnosis of their respective matched cases. The two matched samples were compared for differences in race, obesity, military occupation, rank, and total time in service, using the Pearson chi-square test. Cox proportional hazards regression was used to compare separation rates between the OSA and non-OSA groups after adjusting for occupation, sex, age, race/ethnicity, obesity, grade, time in service, and service branch. All analyses were performed using SAS/STAT© software, version 9.4 (2014, SAS Institute, Cary, NC).

RESULTS

During the period 1 January 2004 through 31 December 2015, there were 223,731 incident diagnoses of OSA among active component service members, with a 12-year incidence rate of 139.2 cases per 10,000 person-years (p-yrs). The annual incident rate was 3.3-fold higher in 2012 (202.4 per 10,000 p-yrs), compared to 2004 (47.1 per 10,000 p-yrs). Between 2012 and 2015, incidence rates appeared to reach a steady state with a range from 196.9 to 202.4 per 10,000 p-yrs. The highest annual incidence rate was in 2012 with 202.4 cases per 10,000 p-yrs **(Figure 1, Table 2)**. Within the eight demographic characteristics examined, incidence rates of OSA were highest in those who were aged 40 years or older; male; black, non-Hispanic; obese; in the Army; married; had more than one prior deployment; or had completed 18 years or more of service. Overall incidence rates of OSA were lowest in service members who were younger than 25 years of age; white, non-Hispanic; Marines; air crew; and in those with less than 5 years of service or no prior deployments **(Table 2, Figure 2).**

The incidence rate among individuals aged 40 years or older was more than 3-fold higher in 2015 compared to 2004 **(Figure 3).** Individuals serving 18 or more years had a 3-fold higher incidence rate of OSA in 2015, compared to 2004. The 12-year incidence rate in service members serving 18 years or more was more than 2-fold higher than those with 11–17 years of service **(Figure 4).** The annual incidence rates for the Army rose steadily from 2008 to 2015 and were higher during this period than the rates of the other services. **(Figure 5).** The category of pilot/air crew consistently had the lowest incidence rates, compared to all other occupations **(Figure 6).**

Service members with diagnoses of obesity had an overall incidence rate (841.6 per 10,000 p-yrs) that was higher than the OSA rates for any of the other characteristics examined. In 2015, service members with obesity diagnoses had an incidence rate of OSA (1049.1 cases per 10,000 p-yrs) that was more than 5-fold higher than the rate among those without an obesity diagnosis (167.1 cases per 10,000 p-yrs) **(Table 2, Figure 7).**

Time-to-separation analysis

Incident diagnoses of OSA recorded within 12 months of separation from the active component ranged from a low of 36% of all diagnoses made in 2008 to a high of 48% in 2014 **(Figure 8).** Survival analysis examining time to separation in OSA-diagnosed service members, stratified by occupation, showed that pilot/air crew had the fastest rate of separation following OSA diagnosis, compared to other occupations. Healthcare service members had the slowest rate of separation following OSA diagnosis, compared to other occupations. In pilot/air crew, 50% of all cases were diagnosed less than a year prior to leaving service, whereas in healthcare occupations, 50% of all cases were diagnosed around 2 years prior to leaving service **(Figure 9).**

There were 208,080 service members in each of the OSA-diagnosed and OSA-non-diagnosed groups. The OSA-diagnosed group was significantly more likely to be obese ($p<.0001$) and enlisted ($p<.0001$). Characteristics of the study and comparison samples are shown in **Table 3.**

At around 2.5 years following diagnosis, the survival curves crossed, demonstrating a violation of the proportional hazards assumption **(Figure 10).** However, the two groups had very similar survival trends. A time-dependent analysis of the survival curves indicated that individuals who served less than 2.5 years following OSA diagnosis had a faster rate of separation, compared to non-OSA-diagnosed service members after adjusting for potential confounders, and slower separation rates after 2.5 years **(data not shown).**

FIGURE 1. Crude annual incidence rates of obstructive sleep apnea, active component, U.S. Armed Forces, 2004–2015

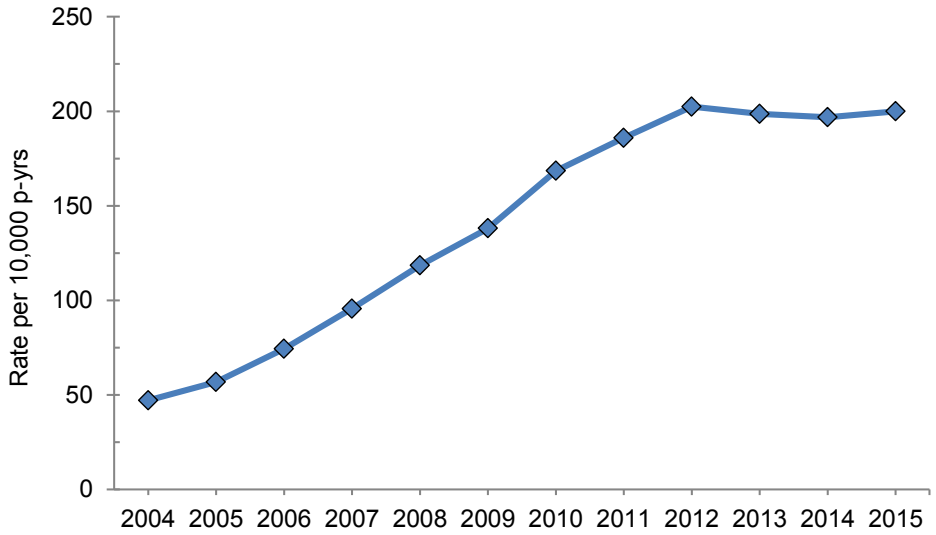


TABLE 2. Incident diagnoses and incidence rates of obstructive sleep apnea, active component, U.S. Armed Forces, January 2004–December 2015

	Total 2004–2015		2004		2005		2006		2007		2008		2009	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	223,731	139.2	6,588	47.1	7,733	56.8	10,026	74.4	12,800	95.6	15,980	118.5	18,906	138.0
Service														
Army	107,766	177.9	1,913	39.2	2,588	53.7	3,862	78.9	5,102	101.5	7,115	136.8	8,663	162.6
Navy	48,818	126.0	1,871	51.1	2,021	57.1	2,608	76.3	3,438	104.9	4,065	127.1	4,825	152.0
Air Force	52,489	135.0	2,570	69.7	2,774	79.7	3,093	91.2	3,647	111.8	3,863	122.3	4,257	133.7
Marine Corps	14,658	64.9	234	13.3	350	19.7	463	26.0	613	33.7	937	48.7	1,161	57.8
Sex														
Male	208,183	152.1	6,141	51.6	7,206	62.0	9,367	81.4	11,952	104.4	14,961	129.6	17,649	150.7
Female	15,548	65.1	447	21.3	527	26.3	659	33.4	848	43.7	1,019	52.5	1,257	63.5
Race/ethnicity														
White, non-Hispanic	125,791	126.7	3,974	45.5	4,464	52.5	5,707	67.6	7,070	84.2	8,796	104.0	10,430	121.4
Black, non-Hispanic	52,447	200.0	1,595	62.9	1,947	81.8	2,576	113.2	3,362	152.9	4,145	190.2	4,827	221.0
Other	45,493	129.1	1,019	37.5	1,322	48.3	1,743	62.9	2,368	84.9	3,039	106.9	3,649	125.0
Age														
<20	640	5.9	48	4.3	47	4.8	52	5.4	56	5.8	68	6.9	57	6.2
20–24	17,834	33.1	696	14.3	699	14.9	764	16.5	991	21.8	1,232	27.0	1,467	31.7
25–29	31,981	84.3	793	27.5	900	30.7	1,253	42.0	1,511	49.9	1,942	62.1	2,312	70.5
30–34	32,418	134.6	821	41.1	969	49.5	1,177	61.7	1,484	78.4	1,834	96.1	2,214	112.4
35–39	51,718	282.9	1,628	95.3	1,835	111.7	2,406	148.1	3,124	193.7	3,814	239.2	4,629	293.0
40+	89,140	569.3	2,602	180.6	3,283	231.7	4,374	316.7	5,634	421.0	7,090	539.8	8,227	622.9
Rank														
Officer	40,692	152.2	1,150	51.1	1,462	65.5	1,894	85.8	2,303	105.5	2,888	132.6	3,353	151.4
Enlisted	183,039	136.6	5,438	46.3	6,271	55.1	8,132	72.1	10,497	93.7	13,092	115.8	15,553	135.5
Military occupation														
Combat-specific	27,106	123.4	410	24.9	599	36.1	855	49.6	1,231	68.2	1,871	99.1	2,232	113.9
Armor/motor transport	9,655	156.2	251	44.6	283	51.7	394	74.1	533	99.7	666	122.5	853	152.8
Pilot/air crew	6,144	99.3	169	30.2	219	39.8	292	55.4	318	62.8	369	74.9	538	106.8
Repair/engineering	66,287	141.7	2,272	53.7	2,501	60.9	3,108	77.8	3,888	100.0	4,741	124.2	5,520	143.2
Communications/intelligence	56,354	157.4	1,812	56.0	2,167	68.7	2,713	88.1	3,488	114.8	4,226	139.2	4,936	162.6
Health care	22,385	164.3	740	63.8	837	73.3	1,182	104.6	1,411	126.2	1,609	145.4	1,804	161.3
Other/unknown	35,800	118.5	934	36.0	1,127	45.8	1,482	59.2	1,931	77.4	2,498	96.2	3,023	113.4
Deployments														
2+	105,100	232.5	953	45.0	1,505	56.0	2,548	82.7	4,150	116.4	6,155	158.7	8,389	196.9
1	65,152	132.4	2,210	46.4	2,627	55.8	3,478	75.2	4,375	96.2	5,330	119.0	5,970	134.8
0	53,479	80.6	3,425	48.2	3,601	57.8	4,000	69.3	4,275	81.1	4,495	87.7	4,547	90.9
Time in service (years)														
18+	101,838	596.6	3,259	186.6	4,052	241.4	5,310	333.5	6,880	448.9	8,567	580.2	9,855	689.0
11–17	45,920	175.5	1,260	55.3	1,420	64.5	1,739	80.6	2,194	102.8	2,705	126.2	3,356	153.1
5–10	44,290	111.5	1,083	34.5	1,217	37.8	1,641	50.4	2,088	63.8	2,621	78.0	3,249	93.3
Less than 5	31,683	40.7	986	14.5	1,044	16.0	1,336	20.6	1,638	25.4	2,087	32.1	2,446	37.1
Marital status														
Married	178,375	203.5	5,108	69.5	6,133	83.2	8,021	108.7	10,349	140.6	12,901	174.5	15,286	203.3
Single	45,356	62.0	1,480	22.3	1,600	25.6	2,005	32.8	2,451	40.7	3,079	50.6	3,620	58.6
Obesity status[b]														
Yes	37,200	841.6	854	230.7	1,206	316.4	1,494	489.5	1,823	657.8	2,225	721.0	2,623	776.6
No	186,531	119.3	5,734	42.1	6,527	49.3	8,532	64.7	10,977	83.7	13,755	104.4	16,283	121.9

[a]Rate per 10,000 person-years

[b]1 year prior to or 1 year following incident diagnosis of OSA

TABLE 2 (cont.). Incident diagnoses and incidence rates of obstructive sleep apnea, active component, U.S. Armed Forces, January 2004–December 2015

	Total 2004–2015		2010		2011		2012		2013		2014		2015	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	223,731	139.2	23,210	168.5	25,429	186.0	27,032	202.4	26,052	198.6	25,164	196.9	24,811	199.9
Service														
Army	107,766	177.9	11,143	205.5	12,721	235.2	13,656	261.9	13,879	277.0	13,472	281.6	13,652	298.9
Navy	48,818	126.0	5,241	166.9	5,503	177.3	6,043	199.2	5,096	167.6	3,924	127.7	4,183	135.2
Air Force	52,489	135.0	5,454	170.2	5,405	170.1	5,379	170.0	5,133	162.7	5,783	188.6	5,131	174.4
Marine Corps	14,658	64.9	1,372	68.5	1,800	90.7	1,954	100.6	1,944	101.7	1,985	106.8	1,845	102.2
Sex														
Male	208,183	152.1	21,632	183.9	23,574	202.2	25,150	221.3	24,196	217.5	23,404	216.6	22,951	219.6
Female	15,548	65.1	1,578	78.5	1,855	91.9	1,882	94.5	1,856	93.2	1,760	89.0	1,860	94.9
Race/ethnicity														
White, non-Hispanic	125,791	126.7	12,926	150.3	14,339	169.2	15,355	186.8	14,839	186.4	14,145	185.4	13,746	188.5
Black, non-Hispanic	52,447	200.0	5,604	257.2	5,829	271.5	5,946	285.8	5,669	276.3	5,501	271.7	5,446	274.3
Other	45,493	129.1	4,680	156.3	5,261	172.5	5,731	187.6	5,544	178.5	5,518	176.5	5,619	179.4
Age														
<20	640	5.9	72	8.6	52	6.6	48	6.0	45	5.1	39	4.6	56	6.6
20–24	17,834	33.1	1,779	38.4	2,097	46.3	2,228	51.5	2,036	48.0	1,828	43.8	2,017	49.3
25–29	31,981	84.3	3,162	93.1	3,924	113.1	4,429	130.1	4,047	123.6	3,821	121.5	3,887	128.6
30–34	32,418	134.6	2,953	144.9	3,667	175.0	4,278	202.6	4,230	200.9	4,446	214.0	4,345	214.9
35–39	51,718	282.9	5,347	346.9	5,591	376.8	6,083	423.2	5,811	417.8	5,785	427.2	5,665	431.4
40+	89,140	569.3	9,897	745.6	10,098	769.4	9,966	779.8	9,883	801.4	9,245	782.0	8,841	795.4
Rank														
Officer	40,692	152.2	4,065	180.2	4,333	190.4	4,545	200.0	4,856	214.8	4,900	219.4	4,943	227.6
Enlisted	183,039	136.6	19,145	166.2	21,096	185.1	22,487	202.9	21,196	195.2	20,264	192.1	19,868	194.1
Military occupation														
Combat-specific	27,106	123.4	2,836	141.4	3,102	155.0	3,491	178.5	3,522	190.9	3,434	194.0	3,523	206.5
Armor/motor transport	9,655	156.2	1,005	183.1	1,231	236.4	1,314	277.7	1,209	259.5	990	216.5	926	212.0
Pilot/air crew	6,144	99.3	620	120.9	707	136.9	716	138.1	723	141.1	710	141.3	763	156.6
Repair/engineering	66,287	141.7	6,908	175.0	7,567	193.0	8,195	216.8	7,349	194.1	7,246	192.3	6,992	189.3
Communications/intelligence	56,354	157.4	5,803	194.1	6,109	205.3	6,466	220.3	6,314	221.7	6,151	221.3	6,169	228.5
Health care	22,385	164.3	2,318	201.0	2,430	213.6	2,488	216.3	2,630	227.4	2,502	218.4	2,434	219.6
Other/unknown	35,800	118.5	3,720	142.3	4,283	164.7	4,362	171.6	4,305	171.9	4,131	175.2	4,004	175.8
Deployments														
2+	105,100	232.5	10,963	242.9	12,806	273.5	14,691	320.7	14,631	338.6	14,408	364.1	13,901	390.2
1	65,152	132.4	7,043	163.9	7,495	178.7	7,609	197.8	6,802	197.3	6,244	201.6	5,969	215.4
0	53,479	80.6	5,204	104.9	5,128	106.9	4,732	96.0	4,619	86.4	4,512	78.8	4,941	81.3
Time in service (years)														
18+	101,838	596.6	11,469	819.1	11,262	836.9	11,034	855.0	10,577	855.9	9,922	828.5	9,651	843.4
11–17	45,920	175.5	4,213	191.5	4,990	225.4	5,850	264.3	5,976	272.1	6,203	287.6	6,014	289.3
5–10	44,290	111.5	4,230	121.4	5,344	151.2	6,040	175.3	5,664	171.9	5,577	175.3	5,536	180.9
Less than 5	31,683	40.7	3,298	49.3	3,833	58.3	4,108	64.2	3,835	60.0	3,462	55.4	3,610	58.9
Marital status														
Married	178,375	203.5	18,561	243.2	20,258	266.5	21,325	288.9	20,706	290.6	20,091	290.3	19,636	297.0
Single	45,356	62.0	4,649	75.7	5,171	85.2	5,707	95.5	5,346	89.2	5,073	86.5	5,175	89.3
Obesity status[b]														
Yes	37,200	841.6	2,749	1035.7	3,779	1122.4	5,072	1175.0	5,259	1111.3	5,267	1117.8	4,849	1049.1
No	186,531	119.3	20,461	151.5	21,650	162.3	21,960	169.9	20,793	164.4	19,897	161.6	19,962	167.1

[a]Rate per 10,000 person-years

[b]1 year prior to or 1 year following incident diagnosis of OSA

FIGURE 2. Crude incidence rates of obstructive sleep apnea, by demographic and military characteristics, active component, U.S. Armed Forces, 2004–2015

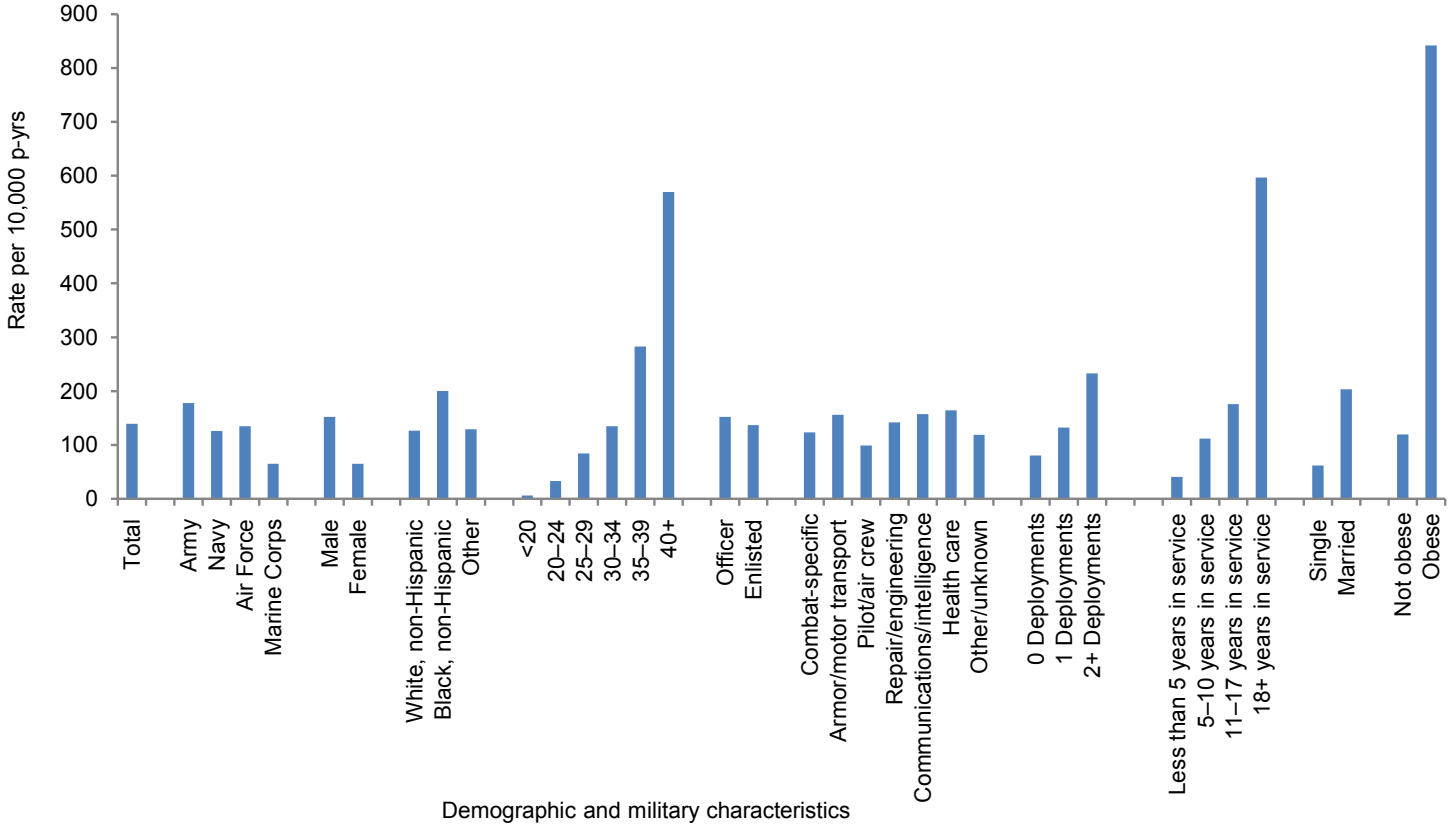
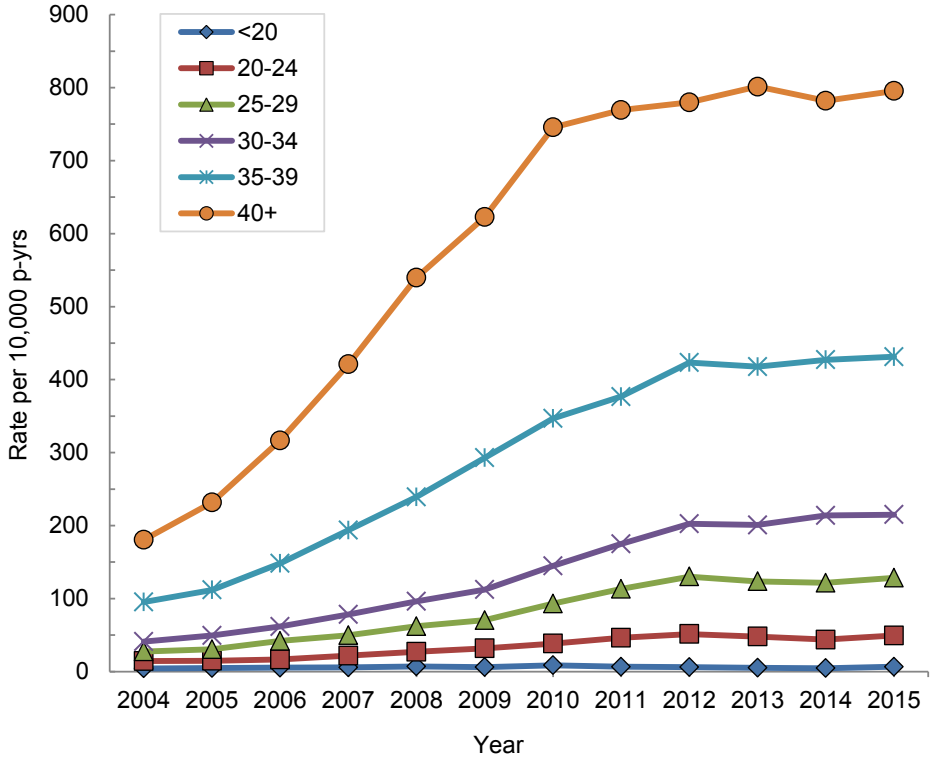


FIGURE 3. Annual incidence rates of obstructive sleep apnea, by age group and calendar year, active component, U.S. Armed Forces, 2004–2015



EDITORIAL COMMENT

This report documents the incidence of OSA and time to separation following OSA diagnosis, among multiple military and demographic subgroups. Overall OSA incidence rates were more than 3-fold higher in 2012, compared to 2004, with similar rates between 2012 and 2015. Age-specific incidence rates for individuals aged 30 years or older increased through 2015, with the 30- to 34-year-old age group having a more than 4-fold higher incidence in 2015, compared to 2004. A previous *MSMR* article examining incidence of OSA from 2000 through 2009 showed continuous rising incidence with no leveling off identified.[5] The rise in incidence during this period may have been attributed to improving physician awareness, availability of sleep study centers, changes in demographics of the population, and patient awareness

FIGURE 4. Annual incidence rates of obstructive sleep apnea, by length of service (years) and calendar year, active component, U.S. Armed Forces, 2004–2015

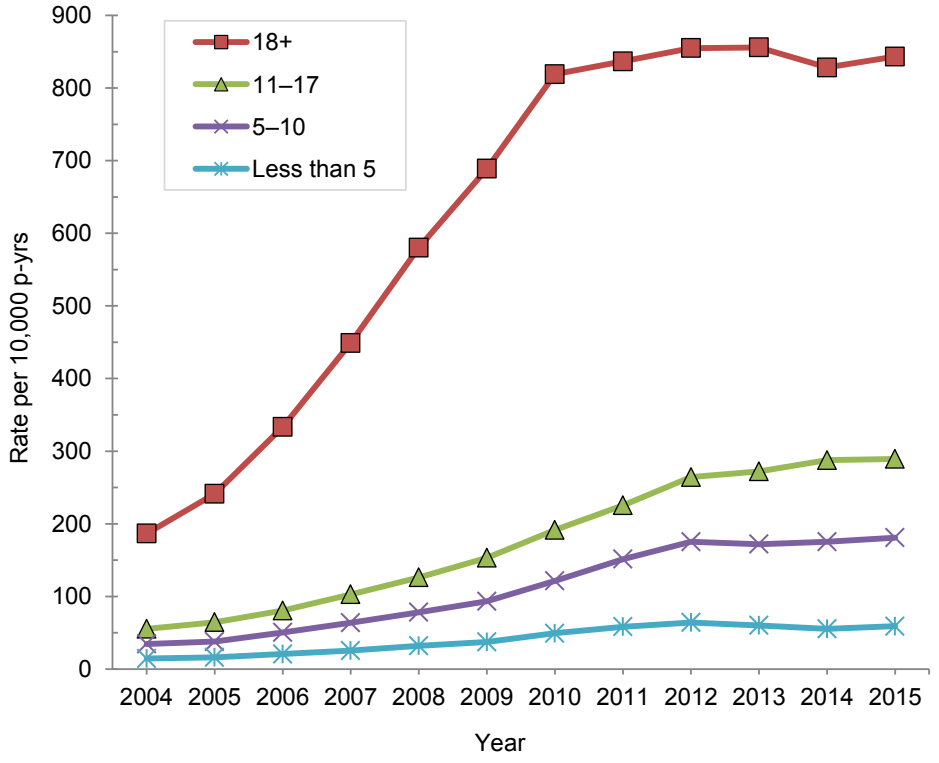
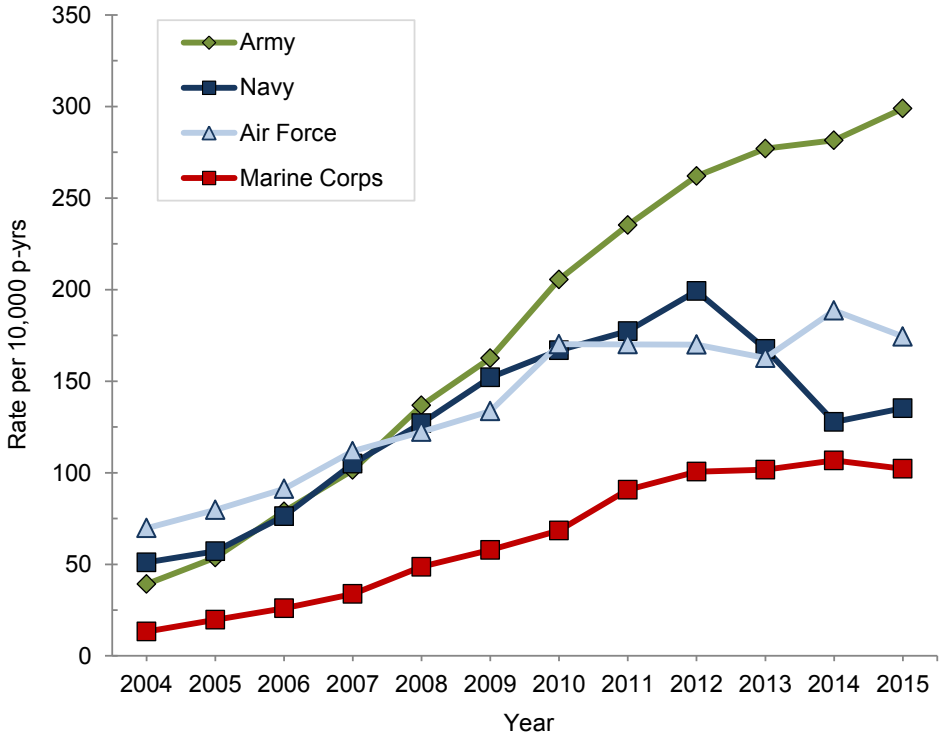


FIGURE 5. Annual incidence rates of obstructive sleep apnea, by service branch and calendar year, active component, U.S. Armed Forces, 2004–2015



or financial incentive through the MDB. Rising obesity rates in the military and increased post-deployment screening for fatigue and PTSD may also have contributed to the higher frequency of OSA referrals and diagnoses.

This report demonstrated a strong association of obesity diagnosis and OSA, with obese service members having a 6-fold higher 12-year incidence of OSA, compared to non-obese members. Obesity is a growing concern for the military as self-reported obesity increased from 5% in 1995 to 12.7% in 2008.[11] However, obesity is a modifiable risk factor and a target for OSA treatment and prevention. Studies have shown that a 10% weight reduction can reduce AHI episodes by almost half, and these effects can be long-lasting.[12,13] Intensive multicomponent behavioral interventions for obesity are a recommendation graded "B" by the U.S. Preventive Services Task Force, and prevention programs targeting obesity should be supported by the military to reduce the OSA-associated disease burden.

Surprisingly, rates of separation from the military were similar for the OSA- and non-OSA-diagnosed groups, with OSA-diagnosed individuals even appearing to have better retention after 2.5 years following diagnosis. Although there are both medical and financial benefits to seeking OSA diagnosis, a subset of service members may delay care until separation from military service. This study showed there was a prominent increase in diagnosis prior to separation, with almost 50% of cases in 2015 diagnosed within 12 months of leaving active service. Individuals serving more than 18 years, nearing service time qualification for retirement, had a more than 2-fold higher incidence, compared to those who served 11–17 years, suggesting that retirement may be an influencing factor. This is consistent with a previous *MSMR* article reporting 88% of aviation retirees having a first-time diagnosis within a year of retirement.[14] Military occupation also may influence when individuals seek care. For example, pilot/air crew

FIGURE 6. Annual incidence rates of obstructive sleep apnea, by occupation and calendar year, active component, U.S. Armed Forces, 2004–2015

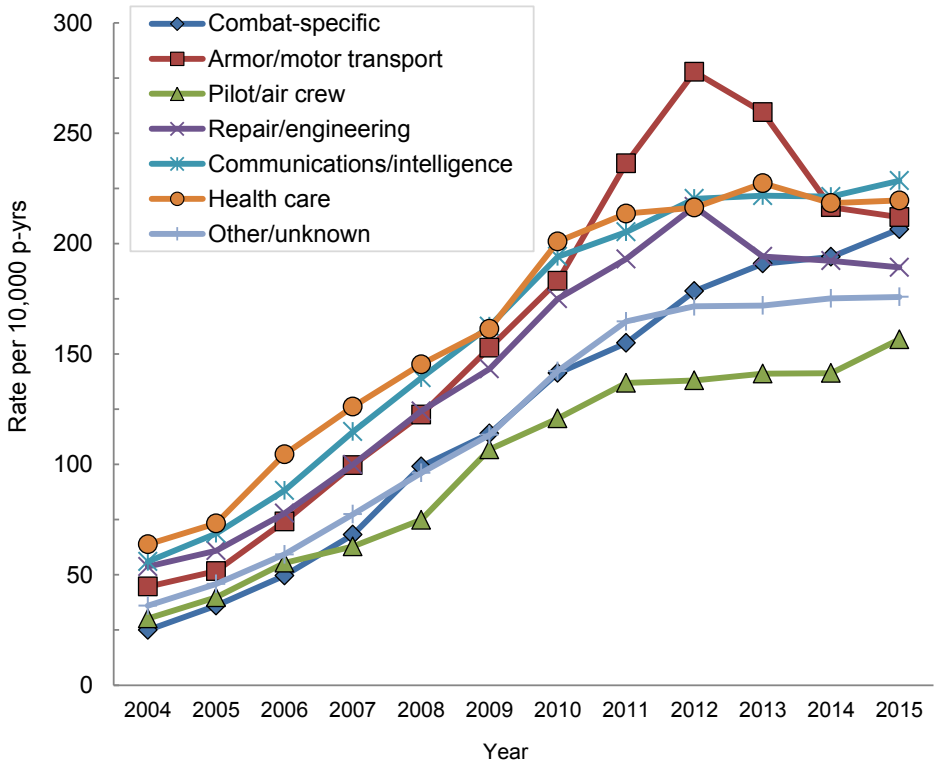
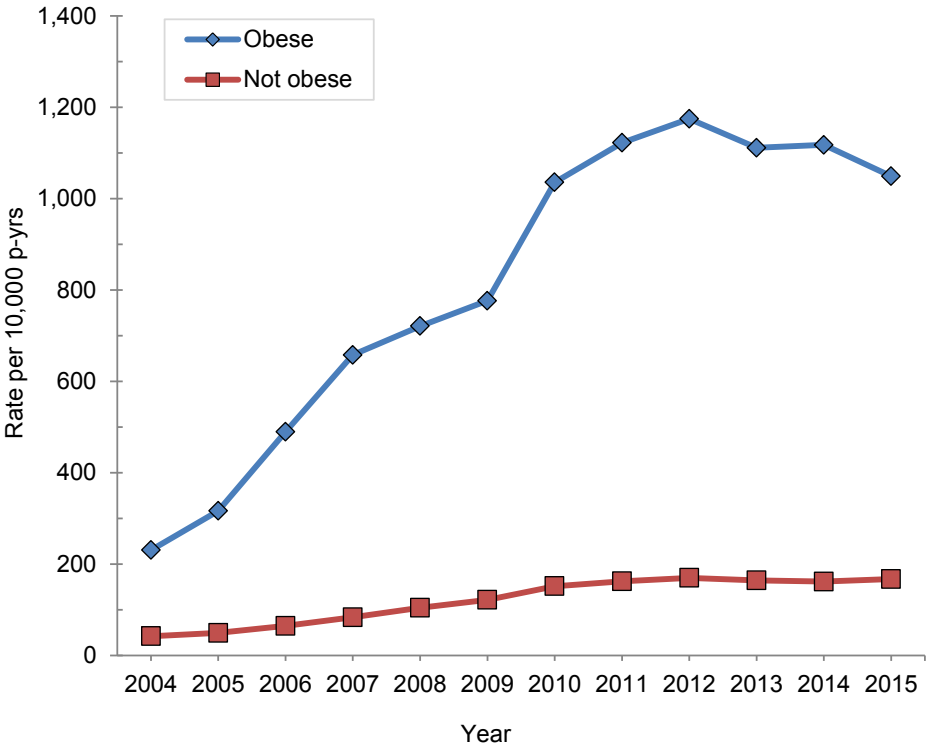


FIGURE 7. Annual incidence rates of obstructive sleep apnea, by obesity status and calendar year, active component, U.S. Armed Forces, 2004–2015



had the lowest 12-year incidence rate of OSA and also had the fastest rate of separation following OSA diagnosis. OSA is disqualifying for aviators, but a waiver is available for Naval air crew if patients show 90% CPAP compliance and appropriate weight management or weight loss. This may influence aviators to delay seeking diagnosis, even if symptomatic, until the end of their career. The possibility of symptomatic air crew delaying diagnosis is concerning, because air crew may be suffering from chronic fatigue. A future study examining aviation mishaps and subsequent diagnosis of OSA in air crew may identify whether undiagnosed OSA has objective effects on military missions.

There were several limitations to this study. First, conditions of interest for this report might have been erroneously diagnosed or miscoded. Identification of OSA cases relied on ICD-9 or ICD-10 codes recorded in the medical record and neither the diagnosis nor the severity of OSA were confirmed by record review or polysomnography data. Similarly, the classification of service members as obese relied on diagnostic codes recorded in the medical record. Reliance on provider-assigned clinical diagnoses can be problematic in assessing the incidence or prevalence of a condition for several reasons. For example, when calculating the rate of OSA among obese individuals, obese person-time was calculated for each year that an individual had a diagnosis for obesity in their medical record, which may have underestimated person-time and thereby overestimated OSA incidence for this group. In addition, service members affected by either OSA or obesity who do not seek care or who receive care that is not documented in medical encounters archived in DMSS were not identified in these analyses. This exclusion likely resulted in an underestimation of the incidence or prevalence of the condition. Finally, findings related to temporal trends need to also take into account factors such as changes in diagnostic procedures, awareness of the condition, medical coding practices and changes in clinical practice that may have

FIGURE 8. Annual percentages of incident obstructive sleep apnea diagnoses within 12 months of separation from active component, U.S. Armed Forces, 2004–2014

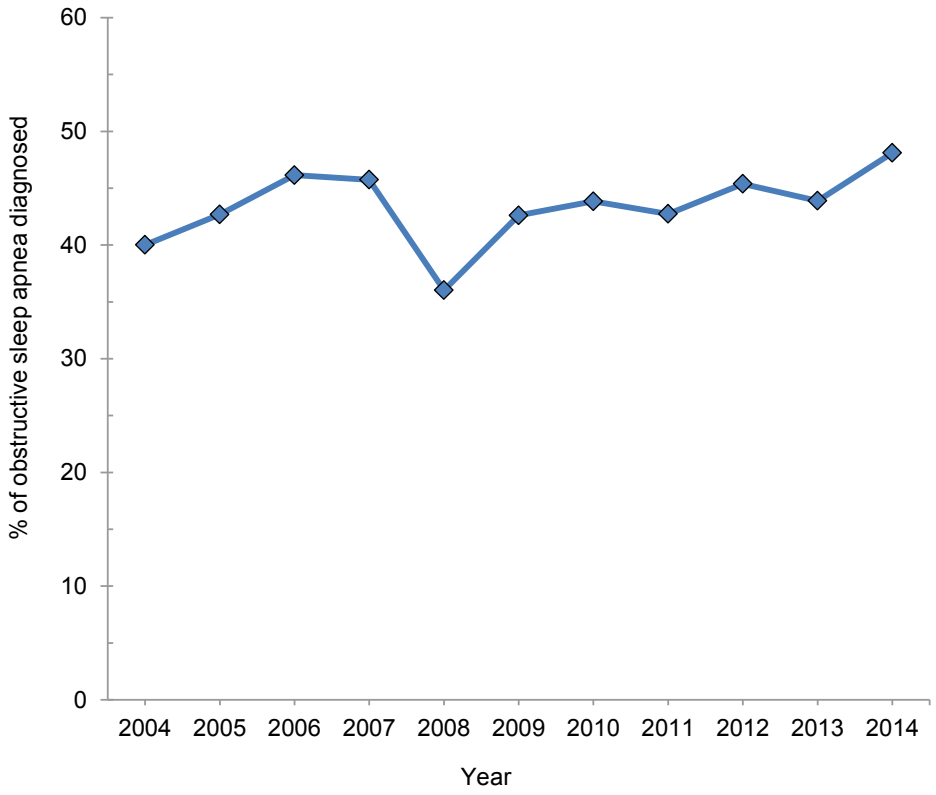
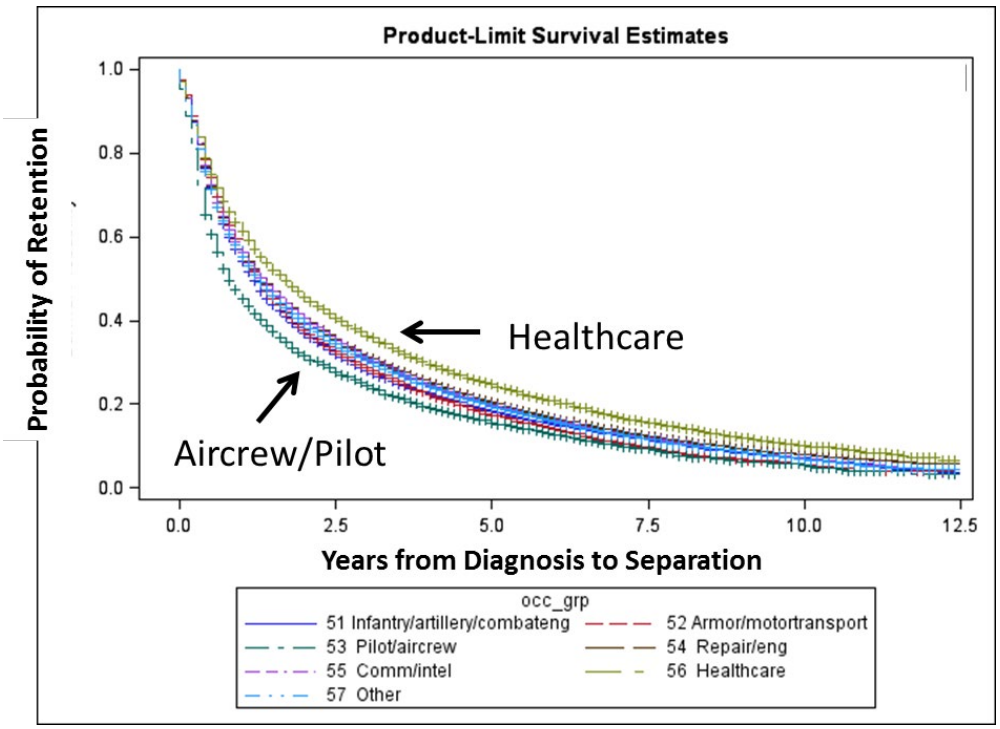


FIGURE 9. Time from obstructive sleep apnea diagnosis to separation, by occupation, active component, U.S. Armed Forces, January 2004–May 2016



occurred during the course of the surveillance period. For example, increased awareness of OSA may have increased the number of service members seeking care for the condition or resulted in increased screening for the condition, which would subsequently increase the number of cases diagnosed. In these analyses, there was an observed 9% drop in 2008 in the percentage of cases diagnosed within 12 months of separation. However, it is unclear why this decrease occurred.

OSA is a costly disease associated with multiple chronic illnesses, but it is treatable and partially preventable. With both the military healthcare system and VA needing to control costs, OSA should be a target for public health campaigns and prevention efforts. Lifestyle intervention programs for weight loss could improve workforce productivity and lower healthcare utilization. However, additional research is needed to determine the most cost-effective treatment method. Improved screening, referral, and treatment have been recommended for individuals who may suffer from PTSD and depression, in whom OSA-associated fatigue and poor sleep quality can exacerbate symptoms.[15] In addition, utilization of the STOP-Bang questionnaire may help primary care providers to screen high-risk individuals and identify those whose symptoms warrant referral for further evaluation.[16] Together, these interventions may help service members to live healthier lives and provide their optimal performance while in service.

Acknowledgments: The authors thank Terrence Lee, PhD, MPH, for assisting with original protocol guidance.

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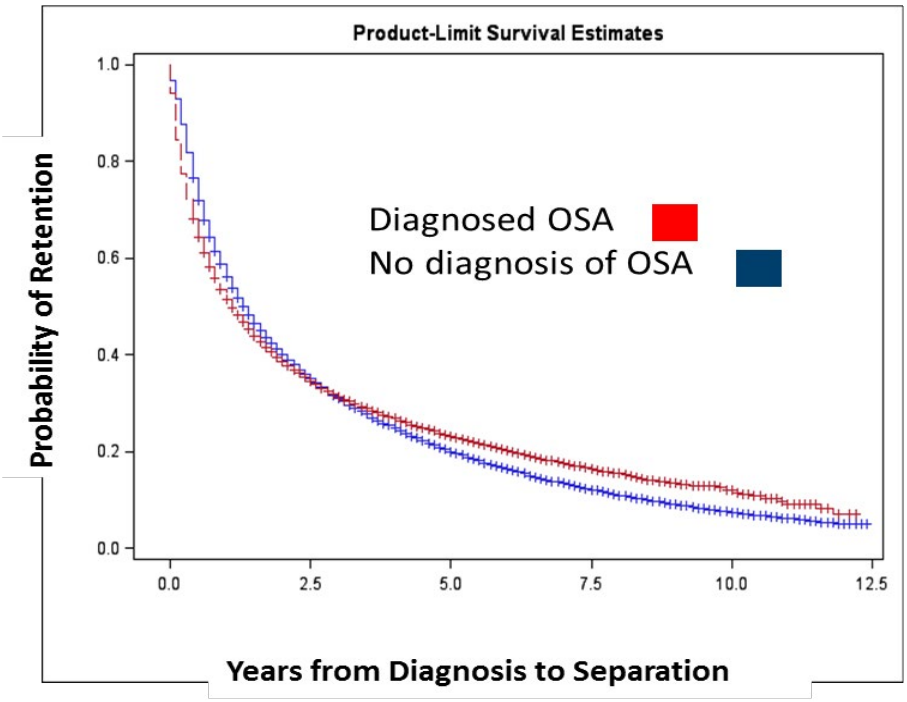
TABLE 3. Demographics of matched 1:1 patients with and without obstructive sleep apnea (at time of OSA diagnosis of matched pair), active component, U.S. Armed Forces, 2004–2015

	Obstructive sleep apnea				
	Yes		No		
	N	%	N	%	P value
Total	208,080	100.0	208,080	100.0	
Race					
White, non-Hispanic	116,506	56.0	137,601	66.1	<.0001
Black, non-Hispanic	49,080	23.6	34,218	16.4	
Other	42,494	20.4	36,261	17.4	
Obesity					
Yes	44,270	21.3	11,660	5.6	<.0001
No	163,810	78.7	196,420	94.4	
Military occupation					
Combat	35,011	16.8	46,230	22.2	<.0001
Health care	20,949	10.1	19,178	9.2	
Other	152,120	73.1	142,672	68.6	
Rank					
Enlisted	168,359	80.9	150,158	72.2	<.0001
Officer	39,716	19.1	57,922	27.8	
Unknown	5	0	0	0	
Length of total service (years)[a]					
Less than 5	16,695	8.0	22,771	10.9	<.0001
5–10	33,935	16.3	33,226	16.0	
11–17	40,443	19.4	48,006	23.1	
18+	117,007	56.2	104,077	50.0	

[a]Total service = time in service from entry date until separation, death, or end of surveillance period

FIGURE 10. Survival curves by obstructive sleep apnea diagnosis status, active component, U.S. Armed Forces, 2004–2014



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Update: Cold Weather Injuries, Active and Reserve Components, U.S. Armed Forces, July 2011–June 2016

Francis L. O'Donnell, MD, MPH (COL, USA, Ret.); Stephen B. Taubman, PhD

From July 2015 through June 2016, a total of 447 members of the active (n=383) and reserve (n=64) components had at least one medical encounter with a primary diagnosis of cold injury. The numbers of affected individuals in both components were the lowest since the 2011–2012 cold season, when the total was 394. In the active component, the service-specific incidence rates for each of the four services were lower than the respective rates for the previous (2014–2015) cold season. Frostbite was the most common type of cold injury. During the five cold seasons in the surveillance period (2011–2016), rates tended to be higher among service members who were in the youngest age groups; female; black, non-Hispanic; or in the Army. The numbers of cold injuries associated with service in Iraq and Afghanistan have fallen precipitously in the past four cold seasons and included just 11 cases in the most recent year.

U.S. military members are often assigned to, and perform duties in, cold weather climates where they may be exposed to cold and wet environments. Such conditions pose the threat of hypothermia, frostbite, and non-freezing cold injury such as immersion foot. The human physiologic responses to cold exposure preserve core body temperature, but those responses may not be sufficient to prevent hypothermia if heat loss is prolonged. Moreover, those responses include constriction of the peripheral (superficial) vascular system, which may result in non-freezing injuries or hasten the onset of actual freezing of tissues (frostbite). Traditional measures to counter the dangers associated with cold environments include minimizing loss of body heat and protecting superficial tissues through such means as protective clothing, shelter, physical activity, and nutrition.

Military training or mission requirements in cold and wet weather may place service members in situations where they may be unable to be physically active, find warm shelter, or change wet or damp clothing.[1,2] Military history has well documented the toll of cold weather injuries, and for many years the U.S. Armed Forces have developed and improved robust training, doctrine, procedures, and protective equipment and clothing to counter the threat from cold environments.[1,3,4] Although these measures are highly effective, cold injuries continue to affect hundreds of service members each year.[5] Continuous surveillance of these injuries is essential to inform additional steps needed to reduce the impact of cold weather on service members' health and their mission accomplishment.

This update summarizes frequencies, rates, and correlates of risk of cold injuries among members of active and reserve components of the U.S. Armed Forces during the past 5 years.

METHODS

The surveillance period was 1 July 2011 through 30 June 2016. The surveillance population included all individuals who served in an active or reserve component of the U.S. Armed Forces at any time during the surveillance period. For analysis purposes, "cold years" or "cold seasons" were defined by 1 July through 30 June intervals so that complete cold weather seasons could be represented in year-to-year summaries and comparisons.

For this analysis, the Defense Medical Surveillance System (DMSS) and the Theater Medical Data Store (which maintains records of medical encounters of service members deployed to Southwest Asia and the Middle East) were searched for records of inpatient and outpatient care for the diagnoses of interest (frostbite, immersion injury, hypothermia, and "other specified/unspecified effects of reduced temperature"). A case was defined by the presence of an ICD-9 or ICD-10 code for one of the cold injuries in the first diagnostic position of a record of health care **(Table 1)**. The Military Health System (MHS) converted to the ICD-10 coding system on 1 October 2015. Because the ICD-10 system provides many more specific diagnostic codes for the cold injuries of interest than did ICD-9 (249 codes vs. 8 codes), the cases in this analysis were defined by consolidating the different coding systems in the manner shown in **Table 1**. It should be noted that the former category of "immersion foot" now encompasses "immersion foot and hand" because the ICD-10 coding system provides a specific code for such injuries of the hand. Cases of cold injuries were also sought in the DMSS records of cases identified via electronic notifications of so-called reportable medical events (RMEs). The DoD guidelines for RMEs require the reporting of cases of frostbite, hypothermia, and immersion foot, but not "other specified/unspecified effects of reduced temperature."[6] Cases of chilblains are not included in this report because the condition is common, infrequently diagnosed, usually mild in severity, and thought to have minimal medical, public health, or military impacts.

TABLE 1. ICD-9/ICD-10 diagnostic codes for cold weather injuries

	ICD-9 codes	ICD-10 codes
Frostbite	991.0, 991.1, 991.2, 991.3	T33.***A, T34.***A
Immersion foot and hand	991.4	T69.0**A
Hypothermia	991.6	T68.XXXA
Other and unspecified	991.8, 991.9	T69.8XXA, T69.9XXA

*Wild card; codes with any characters in those positions should be included.

To estimate the number of unique individuals who suffered a cold injury each cold season and to avoid counting follow-up healthcare encounters after single episodes of cold injury, only one cold injury per individual per cold season was included. In summaries of the incidence of the different types of cold injury diagnoses, one of each type of cold injury per individual per cold season was included. For example, if an individual was diagnosed with more than one type of cold injury in a single cold season, each of those different types of injury would be counted in the tally of injuries. If a service member had multiple medical encounters for cold injuries on the same day, only one encounter was used for analysis (hospitalizations were prioritized over reportable events which were prioritized over ambulatory visits). Annual incidence rates of cold injuries (per 100,000 person-years [p-yrs] of service) were estimated only for the active component because the start and end dates of all active duty service periods of reserve component members were not available. The number of cold injuries was summarized by the location at which the service member was treated for the cold injury as identified by the Defense Medical Information System Identifier (DMISID) recorded in the medical record of the cold injury. This differs from the method used to aggregate cold injuries by location in last year's summary in which the location of injury was determined by the unit zip code of the service member at the time of the cold injury. Because cold injuries may be sustained during field training exercises, temporary duty, or other instances where a service member may not be located at his/her usual duty station, it was felt that DMISID was a better proxy for the location of the cold injury. Parent DMISID was used to roll up cold injuries by location for the purposes of this summary.

RESULTS

2015–2016 cold season

From July 2015 through June 2016, a total of 447 members of the active (n=383) and reserve (n=64) components had at least one medical encounter with a primary diagnosis of cold injury. The numbers of affected individuals in both the active and reserve components were the lowest since the 2011–2012 cold season, when the total was 394. By using only one cold injury diagnosis per individual during the cold season, the overall incidence rate for all active component service members in 2015–2016 (29.5 per 100,000 p-yrs) was 23% lower than the rate (38.2 per 100,000 p-yrs) for the 2014–2015 cold season but slightly higher than the rates for the first two seasons of the surveillance period. In 2015–2016, the service-specific incidence rates for each of the four services (Army, Navy, Air Force, and Marine Corps) were lower than the respective rates during the previous (2014–2015) cold season **(Table 2, Figure 1)**.

The 255 active component Army service members who received at least one diagnosis of a cold injury (rate: 53.1 per 100,000 p-yrs) during the 2015–2016 cold season accounted for 66.6% of active component members affected among all services. The 74 members of the Marine Corps diagnosed with a cold injury represented 19.3% of all affected service members. Navy service members (n=19) had the lowest service-specific rate of cold injuries during the 2015–2016 cold season (rate: 5.8 per 100,000 p-yrs) **(Table 2, Figure 1)**.

When all injuries were considered—not just the numbers of individuals affected—frostbite was the most common type of cold injury (n=146 or 36.8% of all cold injuries) among active component service members in 2015–2016. In the Air Force, 45.9% of all cold injuries were frostbite, whereas in the other services, the proportions of cases of frostbite ranged from 38.7% (Army) to 26.7% (Marine Corps) **(Tables 3a–3d)**. For the Navy and Air Force, the 2015–2016 numbers and rates of frostbite injuries in active component service members were the lowest of the past 5 years. For immersion injuries, the Army number of cases and the incidence rate for 2015–2016 were higher than any of the prior 4 years. Although the number of immersion injury cases in the Marine Corps decreased by 78% from the anomalously high count during the 2014–2015 cold season, cases and rates of hypothermia among Marines increased in 2015–2016 and were the highest of the 5-year surveillance period **(Table 3d)**.

Five cold seasons: July 2011–June 2016

During the 5-year surveillance period, overall rates of cold injuries in the active component were higher in females than in males mainly because of the striking difference between the rates for female (rate: 75.4 per 100,000 p-yrs) and male (rate: 50.3 per 100,000 p-yrs) service members in the Army. In the other three services, the rates in females were less than 10% higher than the male rates. In all the services, females had higher rates of frostbite and lower rates of immersion injury than did males **(Tables 3a–3d)**.

In all of the services, overall rates of cold injuries were higher among black, non-Hispanic service members than among those of other race/ethnicity groups. In particular, within the Army and Marine Corps, rates of cold injuries were approximately twice as high in black, non-Hispanic service members as in white, non-Hispanic or "other" race/ethnicity groups **(Tables 3a–3d)**. Additionally, black, non-Hispanic service members had incidence rates of cold injuries greater than the rates of other race/ethnicity groups in nearly every military occupational category during 2011–2016 **(data not shown)**.

Rates of cold injuries were higher among the youngest service members (less than 20 years old) and generally declined with each succeeding older age group. Enlisted members of the Army, Navy, and Air Force had higher rates than officers, but the opposite was true in the Marine Corps **(Tables 3a–3d)**.

TABLE 2. Any cold injury (one per person per year), by service and component, U.S. Armed Forces, July 2011–June 2016

	Army		Navy		Air Force		Marine Corps		All services	
Active component	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
All years (2011-2016)	1,336	51.5	152	9.5	293	18.3	447	46.6	2,228	33.0
Jul 2011–Jun 2012	187	33.5	23	7.2	70	21.3	57	28.5	337	24.0
Jul 2012–Jun 2013	246	45.7	21	6.7	57	17.3	67	34.3	391	28.4
Jul 2013–Jun 2014	377	72.4	48	15.0	78	23.9	112	57.9	615	45.2
Jul 2014–Jun 2015	271	54.6	41	12.8	53	17.0	137	73.7	502	38.2
Jul 2015–Jun 2016	255	53.1	19	5.8	35	11.3	74	40.1	383	29.5
Reserve component										
All years (2011–2016)	285		13		42		61		401	
Jul 2011–Jun 2012	39		4		6		8		57	
Jul 2012–Jun 2013	46		0		11		15		72	
Jul 2013–Jun 2014	92		4		7		14		117	
Jul 2014–Jun 2015	61		3		12		15		91	
Jul 2015–Jun 2016	47		2		6		9		64	
Overall, active and reserve										
All years (2011–2016)	1,621		165		335		508		2,629	
Jul 2011–Jun 2012	226		27		76		65		394	
Jul 2012–Jun 2013	292		21		68		82		463	
Jul 2013–Jun 2014	469		52		85		126		732	
Jul 2014–Jun 2015	332		44		65		152		593	
Jul 2015–Jun 2016	302		21		41		83		447	

[a]Rate per 100,000 p-yrs

FIGURE 1. Annual incidence rates of cold injuries, by service, active component, U.S. Armed Forces, July 2011–June 2016

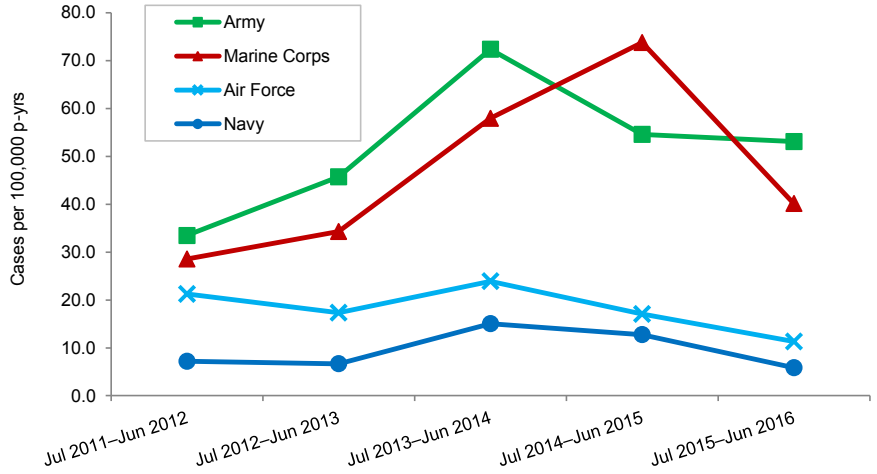
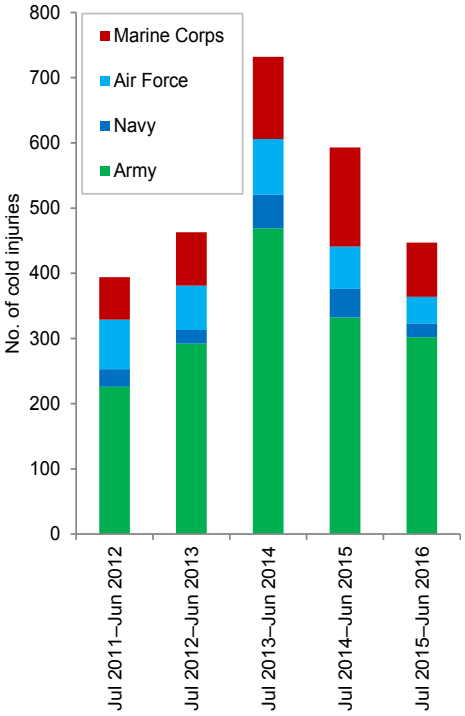


FIGURE 2. Annual numbers of cold injuries, by service and cold season, active and reserve components, U.S. Armed Forces, July 2011–June 2016



In the Army, Air Force, and Marine Corps, rates were highest among service members in infantry/artillery/combat engineering–related occupations **(Tables 3a, 3c, 3d)**.

During the 5-year surveillance period, the 2,629 service members who were affected by any cold injury included 2,228 from the active component and 401 from the reserve component. Of all affected reserve component members, 71.1% (n=285) were members of the Army **(Table 2)**. Overall, soldiers accounted for the majority (61.7%) of all cold injuries affecting active and reserve component service members **(Figure 2)**.

TABLE 3a. Diagnoses of cold injuries, one per type per person per year, active component, U.S. Army, July 2011–June 2016

	Frostbite		Immersion injury		Hypothermia		Unspecified		All cold injuries	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	679	26.2	188	7.2	199	7.7	330	12.7	1,396	53.8
Sex										
Male	541	24.2	172	7.7	177	7.9	236	10.6	1,126	50.3
Female	138	38.6	16	4.5	22	6.1	94	26.3	270	75.4
Race/ethnicity										
White, non-Hispanic	285	18.4	98	6.3	117	7.6	146	9.4	646	41.8
Black, non-Hispanic	287	53.6	52	9.7	39	7.3	129	24.1	507	94.6
Other	107	20.9	38	7.4	43	8.4	55	10.7	243	47.4
Age										
<20	62	43.4	24	16.8	19	13.3	56	39.2	161	112.6
20–24	295	39.2	89	11.8	92	12.2	142	18.9	618	82.1
25–29	145	23.3	46	7.4	53	8.5	61	9.8	305	49.1
30–34	87	19.9	21	4.8	21	4.8	35	8.0	164	37.5
35–39	50	16.2	5	1.6	9	2.9	16	5.2	80	25.9
40–44	23	11.1	2	1.0	3	1.4	15	7.2	43	20.7
45+	17	13.7	1	0.8	2	1.6	5	4.0	25	20.2
Rank										
Enlisted	615	29.2	147	7.0	165	7.8	294	13.9	1,221	57.9
Officer	64	13.2	41	8.4	34	7.0	36	7.4	175	36.0
Occupation										
Infantry/artillery/combat eng.	234	35.4	99	15.0	95	14.4	90	13.6	518	78.3
Armor/motor transport	33	40.3	2	2.4	7	8.6	8	9.8	50	61.1
Repair/engineering	126	23.7	20	3.8	31	5.8	60	11.3	237	44.6
Comm/intel	157	24.7	38	6.0	37	5.8	88	13.8	320	50.3
Health care	39	14.9	7	2.7	8	3.0	29	11.1	83	31.6
Other	90	21.4	22	5.2	21	5.0	55	13.1	188	44.6
Cold year (Jul–Jun)										
2011–2012	99	17.7	14	2.5	27	4.8	55	9.8	195	34.9
2012–2013	138	25.7	42	7.8	25	4.6	53	9.9	258	48.0
2013–2014	204	39.2	46	8.8	55	10.6	89	17.1	394	75.6
2014–2015	135	27.2	18	3.6	55	11.1	75	15.1	283	57.0
2015–2016	103	21.4	68	14.2	37	7.7	58	12.1	266	55.4

*Rate per 100,000 person-years

Of all active component service members who were diagnosed with a cold injury (n=2,200), 166 (7.5% of the total) were affected during basic training. The Army (n=67) and Marine Corps (n=91) accounted for 95.2% of all basic trainees who suffered a cold injury **(data not shown)**. Additionally, during the surveillance period, 62 service members affected with cold injuries (2.8% of the total) were hospitalized, and most of the hospitalized cases were members of either the Army (n=38) or Marine Corps (n=23) **(data not shown)**.

Cold injuries in Iraq and Afghanistan

During the 5-year surveillance period, 238 cold injuries were diagnosed and treated in Iraq and Afghanistan. Of these, half (n=118) were frostbite; 57 (24%) were immersion injuries; 22 (9%) were hypothermia; and 41 (17%) were "unspecified" cold injuries. Cold injuries most often occurred in deployed service members who were male (n=198; 83%); white, non-Hispanic (n=124; 52%); aged 20–24 years (n=114; 48%); in the Army (n=165; 69%); enlisted grade (n=217; 91%); and in infantry/artillery/combat engineering–related occupations (n=74; 31%). Of all 238 cold injuries during the surveillance period, 89% occurred in the first 3 years. There were 38 cold injuries during July 2013 through June 2014, only 14 during July 2014 through June 2015, and 11 during July 2015 through June 2016 **(data not shown)**.

Cold injuries by location

Twenty-two military locations were associated with at least 30 incident cold

TABLE 3b. Diagnoses of cold injuries, one per type per person per year, active component, U.S. Navy, July 2011–June 2016

	Frostbite		Immersion injury		Hypothermia		Unspecified		All cold injuries	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	69	4.3	25	1.6	31	1.9	31	1.9	156	9.8
Sex										
Male	48	3.6	21	1.6	31	2.3	27	2.0	127	9.6
Female	21	7.5	4	1.4	0	0.0	4	1.4	29	10.4
Race/ethnicity										
White, non-Hispanic	31	3.8	10	1.2	14	1.7	14	1.7	69	8.4
Black, non-Hispanic	18	7.4	3	1.2	7	2.9	7	2.9	35	14.4
Other	20	3.7	12	2.2	10	1.9	10	1.9	52	9.7
Age										
<20	20	23.2	4	4.6	2	2.3	4	4.6	30	34.8
20–24	14	2.8	12	2.4	9	1.8	12	2.4	47	9.4
25–29	18	4.5	5	1.2	14	3.5	6	1.5	43	10.7
30–34	9	3.5	2	0.8	2	0.8	2	0.8	15	5.8
35–39	4	2.2	1	0.5	3	1.6	4	2.2	12	6.5
40–44	3	2.9	1	1.0	0	0.0	3	2.9	7	6.7
45+	1	1.6	0	0.0	1	1.6	0	0.0	2	3.2
Rank										
Enlisted	63	4.7	24	1.8	27	2.0	28	2.1	142	10.7
Officer	6	2.2	1	0.4	4	1.5	3	1.1	14	5.2
Occupation										
Infantry/artillery/combat eng.	4	3.8	1	0.9	2	1.9	2	1.9	9	8.5
Armor/motor transport	4	6.5	4	6.5	4	6.5	2	3.2	14	22.7
Repair/engineering	21	3.1	5	0.7	8	1.2	9	1.3	43	6.3
Comm/intel	9	3.4	2	0.8	3	1.1	3	1.1	17	6.5
Health care	8	4.4	3	1.6	5	2.7	6	3.3	22	12.0
Other	23	7.5	10	3.2	9	2.9	9	2.9	51	16.6
Cold year (Jul–Jun)										
2011–2012	10	3.1	4	1.3	5	1.6	4	1.3	23	7.2
2012–2013	7	2.2	5	1.6	6	1.9	4	1.3	22	7.0
2013–2014	33	10.3	0	0.0	12	3.8	6	1.9	51	16.0
2014–2015	13	4.0	10	3.1	5	1.6	13	4.0	41	12.8
2015–2016	6	1.8	6	1.8	3	0.9	4	1.2	19	5.8

*Rate per 100,000 person-years

injuries (one per person) among active and reserve component service members during the 5-year surveillance period. The locations with the highest 5-year counts of incident injuries were Fort Wainwright, AK (n=138); Parris Island/Beaufort, SC (103); Fort Carson, CO (94); Fort Benning, GA (94); Bavaria (Vilseck/Grafenwoehr), Germany (86); MCB Quantico, VA (86); and Fort Bragg, NC (81). During the 2015–2016 cold season, the numbers of incident cases of cold injuries were higher at just six of the 22 locations, compared to the previous 2014–2015 cold season. The most noteworthy increase was found at the Army's bases at Vilseck and Grafenwoehr, Germany (whose health care comes from the Army's Bavaria Medical Department Activity) where there were 48 total cases treated. Of that total, 28 cases (24 immersion injuries and four cases of superficial frostbite) had their encounters during February 9–11, 2016. **Figure 3** shows the numbers of cold injuries during 2015–2016 and the median numbers of cases for the previous 4 years for those locations that had at least 30 cases during the past 5 years. For 16 of the 22 installations, the numbers of cases in 2015–2016 were at or below the median counts for the previous 4 years. The large increase in cases at Vilseck/Grafenwoehr represents the only instance of a location where the year's case count was much greater than the

TABLE 3c. Diagnoses of cold injuries, one per type per person per year, active component, U.S. Air Force, July 2011–June 2016

	Frostbite		Immersion injury		Hypothermia		Unspecified		All cold injuries	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	183	11.4	31	1.9	42	2.6	47	2.9	303	18.9
Sex										
Male	148	11.4	30	2.3	34	2.6	29	2.2	241	18.5
Female	35	11.5	1	0.3	8	2.6	18	5.9	62	20.4
Race/ethnicity										
White, non-Hispanic	109	10.3	24	2.3	30	2.8	33	3.1	196	18.5
Black, non-Hispanic	33	15.3	3	1.4	7	3.3	9	4.2	52	24.2
Other	41	12.5	4	1.2	5	1.5	5	1.5	55	16.7
Age										
<20	12	18.3	9	13.7	3	4.6	3	4.6	27	41.2
20–24	87	19.6	8	1.8	14	3.1	19	4.3	128	28.8
25–29	47	11.1	8	1.9	15	3.5	13	3.1	83	19.6
30–34	14	4.8	2	0.7	6	2.0	6	2.0	28	9.5
35–39	15	7.2	3	1.4	2	1.0	3	1.4	23	11.1
40–44	7	6.0	1	0.9	0	0.0	1	0.9	9	7.7
45+	1	1.9	0	0.0	2	3.7	2	3.7	5	9.3
Rank										
Enlisted	157	12.2	29	2.3	36	2.8	37	2.9	259	20.1
Officer	26	8.2	2	0.6	6	1.9	10	3.2	44	13.9
Occupation										
Infantry/artillery/combat	8	75.3	0	0.0	0	0.0	0	0.0	8	75.3
Armor/motor transport	2	17.3	0	0.0	1	8.7	0	0.0	3	26.0
Repair/engineering	62	11.9	8	1.5	10	1.9	13	2.5	93	17.9
Comm/intel	35	9.4	4	1.1	7	1.9	7	1.9	53	14.2
Health care	9	5.8	0	0.0	3	1.9	4	2.6	16	10.3
Other	67	12.5	19	3.6	21	3.9	23	4.3	130	24.3
Cold year (Jul–Jun)										
2011–2012	40	12.1	8	2.4	13	3.9	9	2.7	70	21.3
2012–2013	33	10.0	8	2.4	9	2.7	10	3.0	60	18.2
2013–2014	52	15.9	8	2.5	8	2.5	12	3.7	80	24.5
2014–2015	41	13.2	3	1.0	4	1.3	8	2.6	56	18.0
2015–2016	17	5.5	4	1.3	8	2.6	8	2.6	37	12.0

*Rate per 100,000 person-years

median of recent years. **Figure 4** displays the geographical distribution of the locales that have had the most cases in the last 5 years and depicts the numbers of cases for each.

EDITORIAL COMMENT

Overall incidence rates of cold injuries in U.S. service members declined during the most recent two winters after having peaked in winter 2013–2014 when much of the eastern U.S. experienced much colder-than-average weather attributed to a weakening of the polar vortex.[5] For the Navy and Air Force, the rates of all cold injuries in 2015–2016 were the lowest of any year of the surveillance period. The 2015–2016 rates for the Army and Marine Corps were lower than the rates for the previous 2 years but still higher than the rates for the first 2 years of the surveillance period.

Frostbite was the most common type of cold injury for service members in all the services except for the Marine Corps, in which hypothermia was the most common in 2015–2016. Factors associated with increased risk of cold injury in previous years were again noted during the most recent cold season. Rates of cold injuries were higher among service members who were the youngest (less than 20 years old), female, enlisted, and of black,

TABLE 3d. Diagnoses of cold injuries, one per type per person per year, active component, U.S. Marine Corps, July 2011–June 2016

	Frostbite		Immersion injury		Hypothermia		Unspecified		All cold injuries	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	114	11.9	150	15.6	110	11.5	86	9.0	460	48.0
Sex										
Male	98	11.0	148	16.7	100	11.3	78	8.8	424	47.7
Female	16	22.7	2	2.8	10	14.2	8	11.4	36	51.1
Race/ethnicity										
White, non-Hispanic	54	8.7	109	17.6	60	9.7	52	8.4	275	44.4
Black, non-Hispanic	41	43.2	10	10.5	23	24.2	18	19.0	92	96.9
Other	19	7.8	31	12.7	27	11.1	16	6.6	93	38.2
Age										
<20	20	16.3	66	53.8	31	25.3	15	12.2	132	107.7
20–24	54	12.4	73	16.8	49	11.3	43	9.9	219	50.4
25–29	23	12.0	8	4.2	24	12.5	15	7.8	70	36.5
30–34	14	14.3	1	1.0	4	4.1	11	11.2	30	30.7
35–39	2	3.1	2	3.1	1	1.6	1	1.6	6	9.4
40–44	1	3.0	0	0.0	1	3.0	0	0.0	2	5.9
45+	0	0.0	0	0.0	0	0.0	1	7.2	1	7.2
Rank										
Enlisted	83	9.7	138	16.2	104	12.2	65	7.6	390	45.8
Officer	31	28.9	12	11.2	6	5.6	21	19.6	70	65.3
Occupation										
Infantry/artillery/combat eng.	37	17.4	14	6.6	16	7.5	16	7.5	83	39.0
Armor/motor transport	2	5.0	2	5.0	2	5.0	4	10.0	10	25.1
Repair/engineering	8	3.3	9	3.8	12	5.0	8	3.3	37	15.5
Comm/intel	22	10.4	2	0.9	8	3.8	16	7.6	48	22.7
Health care	45	17.6	123	48.2	72	28.2	42	16.5	282	110.5
Other										
Cold year (Jul–Jun)										
2011–2012	8	4.0	18	9.0	22	11.0	9	4.5	57	28.5
2012–2013	17	8.7	19	9.7	15	7.7	20	10.2	71	36.3
2013–2014	52	26.9	20	10.3	20	10.3	24	12.4	116	60.0
2014–2015	17	9.2	76	40.9	23	12.4	25	13.5	141	75.9
2015–2016	20	10.8	17	9.2	30	16.3	8	4.3	75	40.7

*Rate per 100,000 person-years

non-Hispanic race/ethnicity. Increased rates of cold injuries affected all enlisted and most officer occupations among black, non-Hispanic service members. In particular, rates of frostbite were appreciably higher in black, non-Hispanics. The *MSMR* has previously noted that this latter pattern suggests that other factors such as physiologic differences or previous cold weather experience are possible explanations for increased susceptibility.[5]

The numbers of cold injuries associated with service in Iraq and Afghanistan have fallen precipitously in the past four cold seasons and the 11 cases in the most recent year are the fewest in the surveillance period. This reduction in the number of cases is almost certainly a byproduct of the dramatic decline in the numbers of service members in that region and changes in the nature of military operations there.

The 1 October 2015 MHS adoption of the ICD-10 coding system greatly increased the number of possible diagnostic codes for cold injuries. This increase was especially true for frostbite. Under the now-superseded ICD-9 system, the four possible frostbite codes covered injuries of the face, hand, foot, and other and unspecified sites. The new ICD-10 codes distinguish superficial frostbite injuries from those with tissue necrosis. Within each of

FIGURE 3. Annual number of cold injuries, cold year 2015–2016, and median number of cold injuries, cold years 2011–2015, at locations with at least 30 cold injuries during the surveillance period, active component members, U.S. Armed Forces, July 2011–June 2016

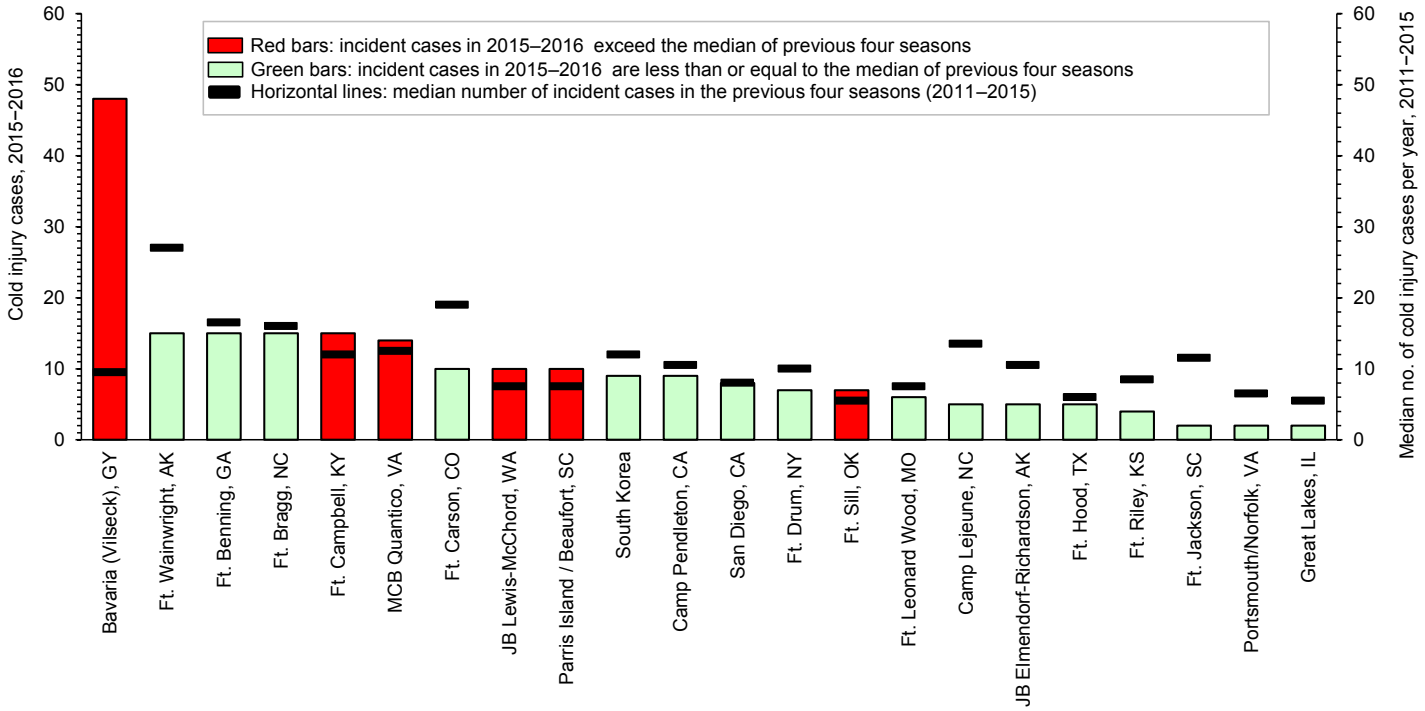
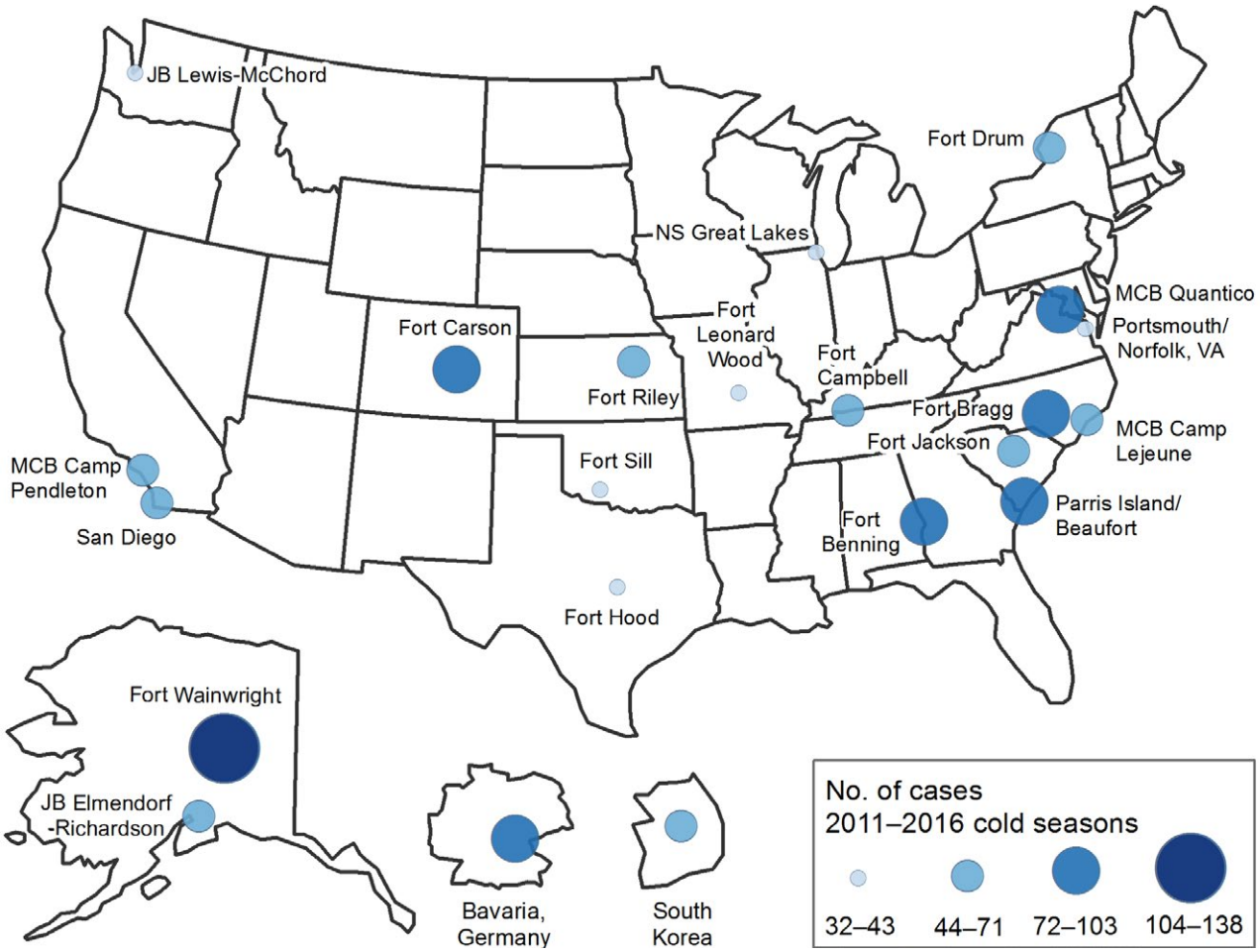


FIGURE 4. Total numbers of cold injuries at locations with at least 30 cold injuries during the surveillance period, active component members, U.S. Armed Forces, July 2011–June 2016



those two categories, it is possible to specify injuries to ear, nose, other part of the head, neck, thorax, abdominal wall, lower back and pelvis, arm, wrist, hand, fingers, hip and thigh, knee and lower leg, ankle, foot, toes, and other and unspecified sites. For certain of these body parts, there are codes that indicate whether the frostbite injury was on the right, left, or unspecified side of the body. Lastly, the final characters of ICD-10 codes permit distinguishing initial health encounters from subsequent ones and from encounters for sequelae. The total of 222 ICD-10 codes for frostbite has the potential for enabling more anatomically specific analyses in the future that may point the way to priorities in preventive strategies. Because the ICD-10 data in this report reflected only 9 months of cold weather injuries, the many diverse ICD-10 codes were aggregated to permit comparison with the ICD-9 codes that were in use for most of the surveillance period.

Policies and procedures are in place to protect service members against cold weather injuries. Modern cold weather uniforms and equipment provide excellent protection against the cold when used correctly. However, in spite of these safeguards, a significant number of individuals within all military services continue to be affected by cold weather injuries each year. It is important that awareness, policies, and procedures continue to be emphasized to reduce the toll of such injuries. In addition, enhancements in protective technologies deserve continued research. It should be noted that this analysis of cold injuries was unable to distinguish between injuries sustained during official military duties (training or operations) and injuries associated with personal activities not related to official duties. To provide for all circumstances that pose the threat of cold weather injury, service members should know well the signs of cold injury and how to protect themselves against such injuries whether they are training, operating, fighting, or recreating under wet and freezing conditions.

The most current cold injury prevention materials are available at http://phc.amedd.army.mil/topics/discond/cip/Pages/default.aspx.

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MSMR's Invitation to Readers

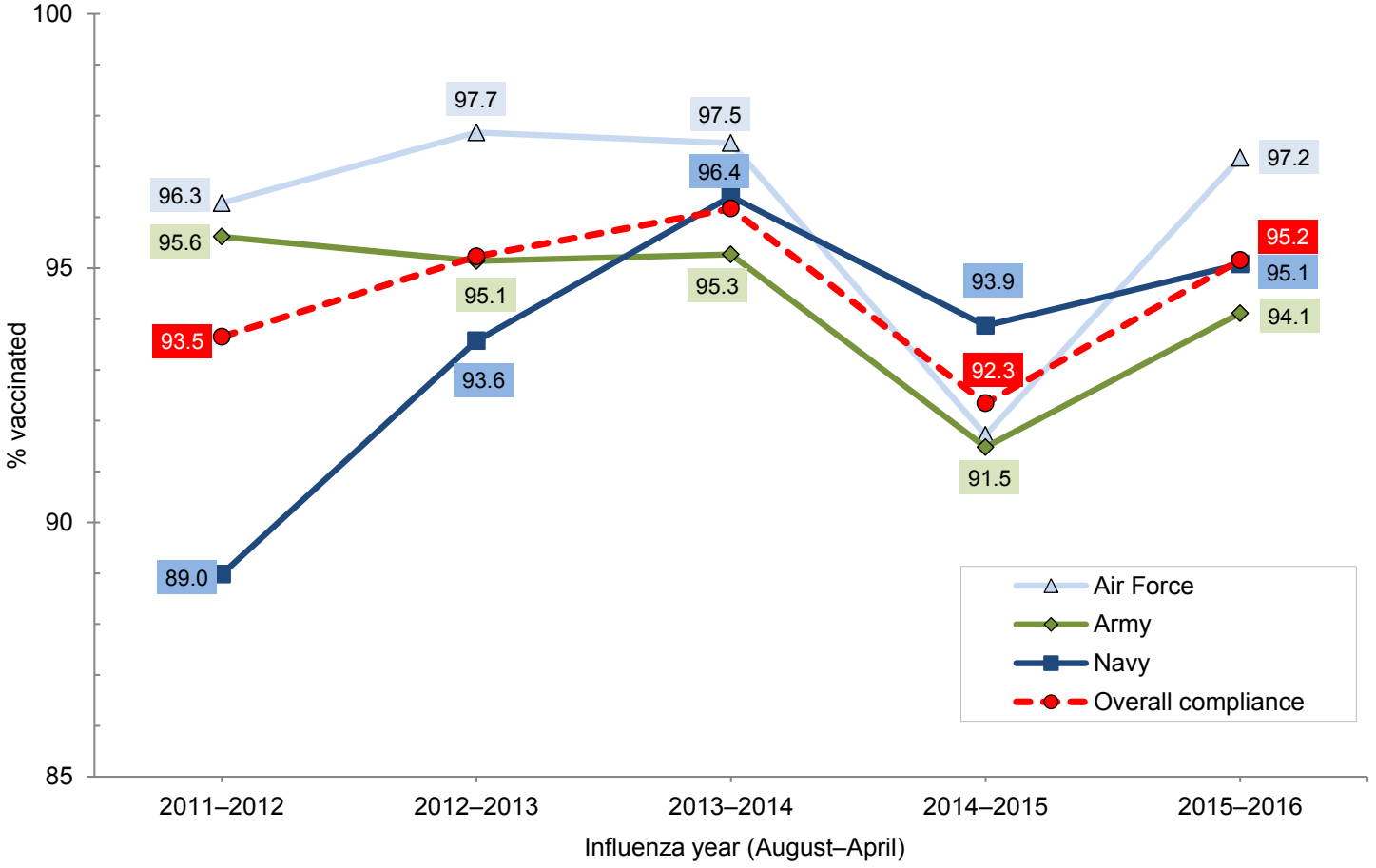
Medical Surveillance Monthly Report (MSMR) invites readers to submit topics for consideration as the basis for future *MSMR* reports. The *MSMR* editorial staff will review suggested topics for feasibility and compatibility with the journal's health surveillance goals. As is the case with most of the analyses and reports produced by Armed Forces Health Surveillance Branch staff, studies that would take advantage of the healthcare and personnel data contained in the Defense Medical Surveillance System (DMSS) would be the most plausible types. For each promising topic, Armed Forces Health Surveillance Branch staff members will design and carry out the data analysis, interpret the results, and write a manuscript to report on the study. This invitation represents a willingness to consider good ideas from anyone who shares the *MSMR*'s objective to publish evidence-based reports on subjects relevant to the health, safety, and well-being of military service members and other beneficiaries of the Military Health System (MHS).

In addition, *MSMR* encourages the submission for publication of reports on evidence-based estimates of the incidence, distribution, impact, or trends of illness and injuries among members of the U.S. Armed Forces and other beneficiaries of the MHS. Information about manuscript submissions is available at www.health.mil/Military-Health-Topics/Health-Readiness/Armed-Forces-Health-Surveillance-Branch/Reports-and-Publications/Medical-Surveillance-Monthly-Report/Instructions-for-Authors.

Please email your article ideas and suggestions to the *MSMR* editorial staff at: dha.ncr.health-surv.mbx.afhs-msmr@mail.mil.

Surveillance Snapshot: Influenza Immunization Among U.S. Armed Forces Healthcare Workers, August 2011–April 2016

FIGURE. Percentage of healthcare specialists and officers with records of influenza vaccination[a] by influenza year (1 August through 30 April) and service, active component, U.S. Armed Forces, August 2011–April 2016



[a]Data source: Immunization records from the Defense Enrollment Eligibility Reporting System (DEERS), which are archived in the Defense Medical Surveillance System (DMSS).

The U.S. Advisory Committee on Immunization Practices recommends that all healthcare personnel be vaccinated against influenza to protect themselves and their patients.[1] The Joint Commission's standard on infection control emphasizes that individuals who are infected with influenza virus are contagious to others before any signs or symptoms appear. The Joint Commission requires that healthcare organizations have influenza vaccination programs for practitioners and staff, and that they work toward the goal of 90% receipt of influenza vaccine. Within the Department of Defense, seasonal influenza immunization is mandatory for all uniformed personnel and for healthcare personnel who provide direct patient care, and is recommended for all others (excluding those who are medically exempt).[2-4] This snapshot covers a 5-year surveillance period (August 2011–April 2016) and depicts the documented percentage compliance with the influenza immunization requirement among active component healthcare personnel of the Army, Navy, and Air Force. During the 2015–2016 influenza season, each of the three services attained greater than 94% compliance among healthcare personnel **(Figure)**. For all services together, the compliance rate was 95.2%. This rate represents a slight increase in immunization rates over the previous year.

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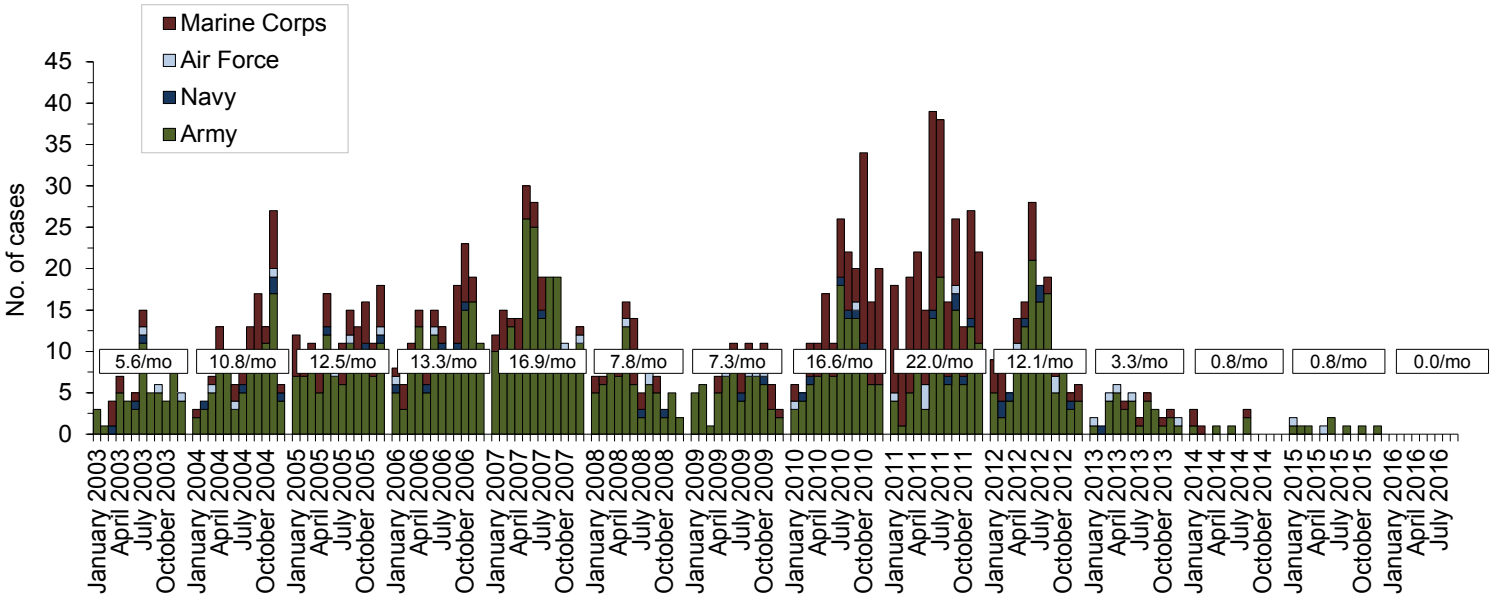
4. Assistant Secretary of Defense (Health Affairs). Addition of Pandemic Influenza Vaccine or Novel Influenza Vaccine to the Policy for Mandatory Seasonal Influenza Immunization for Civilian Healthcare Personnel Who Provide Direct Patient Care in Department of Defense Military Treatment Facilities. Health Affairs Policy Memorandum 11-010, 28 July 2011.

Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003–September 2016 (data as of 25 October 2016)

Amputations[a,b]

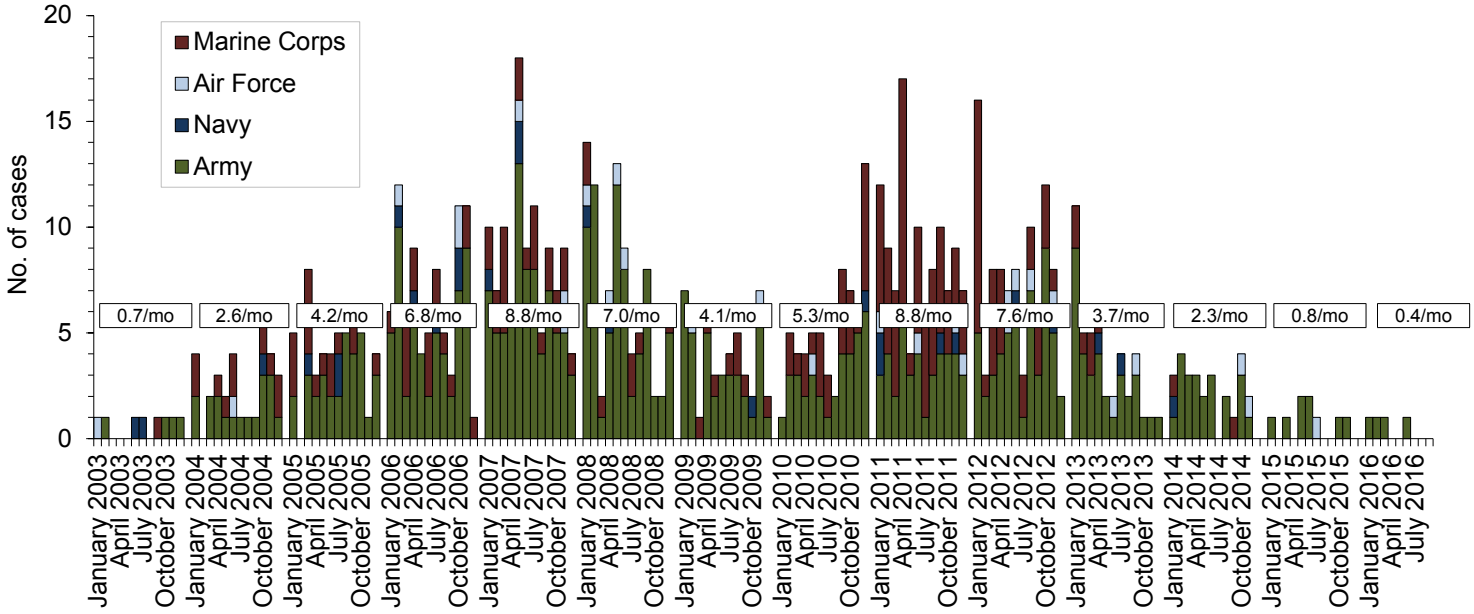


Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: amputations. Amputations of lower and upper extremities, U.S. Armed Forces, 1990–2004. *MSMR*. 2005;11(1):2–6.

[a]Amputations (ICD-10: S48, S58, S684, S687, S78, S88, S980, S983, S989, Z440, Z441, Z4781, Z891, Z892, Z8943, Z8944, Z895, Z896, Z899)

[b]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 365 days of returning from deployment.

Heterotopic ossification[a,b]



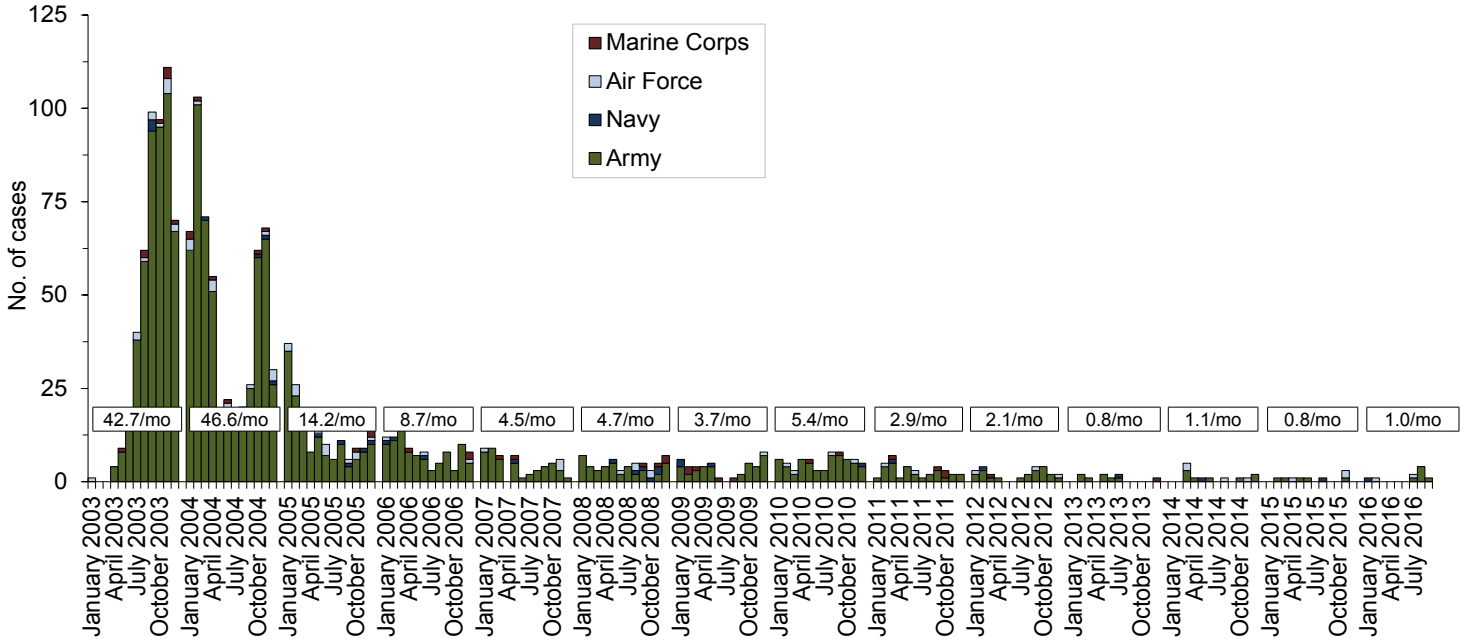
Reference: Army Medical Surveillance Activity. Heterotopic ossification, active components, U.S. Armed Forces, 2002–2007. *MSMR*. 2007;14(5):7–9.

[a]Heterotopic ossification (ICD-10: M610, M614, M615)

[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 365 days of returning from deployment.

Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003–September 2016 (data as of 25 October 2016)

Leishmaniasis[a,b]

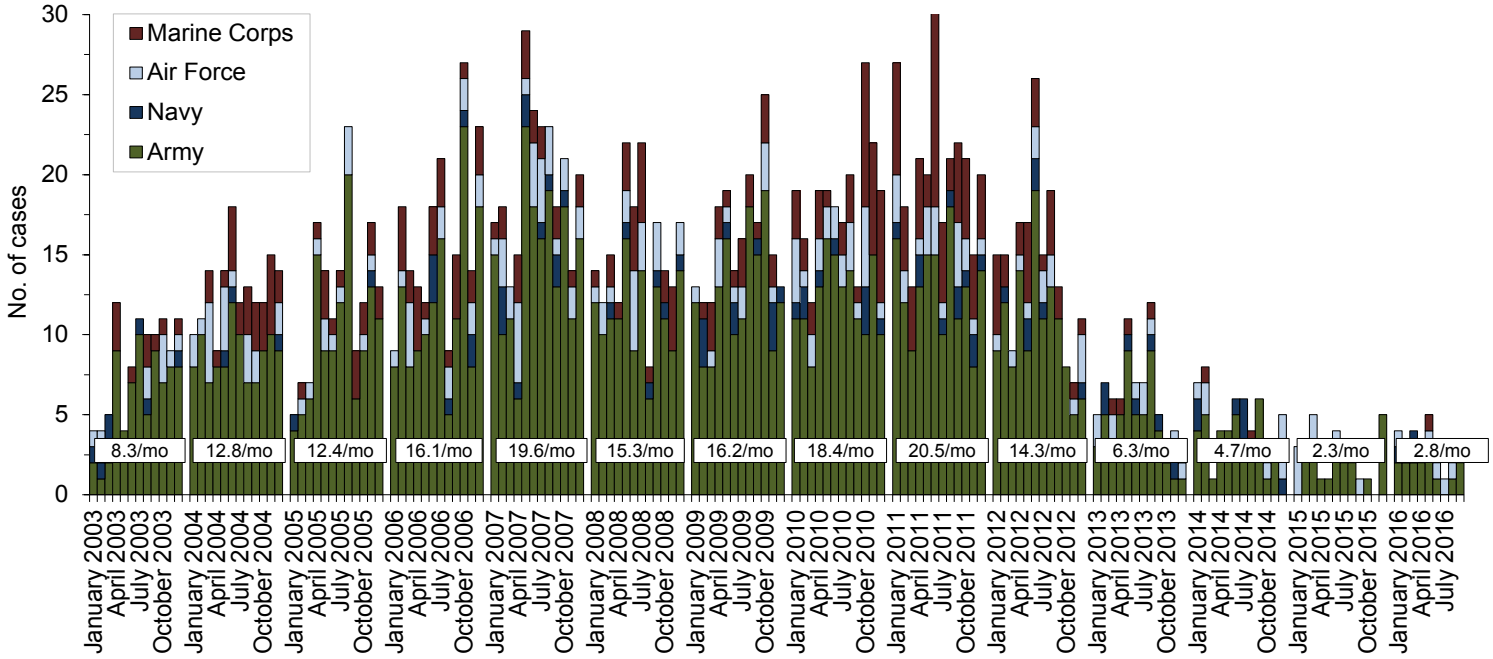


Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: leishmaniasis. Leishmaniasis among U.S. Armed Forces, January 2003–November 2004. *MSMR*. 2004;10(6):2–4.

[a]Leishmaniasis (ICD-10: B55, B550, B551, B552, B559)

[b]Indicator diagnosis (one per individual) during a hospitalization, ambulatory visit, and/or from a notifiable medical event during or after service in OEF/OIF/OND.

Deep vein thrombophlebitis/pulmonary embolus[a,b]



Reference: Isenbarger DW, Atwood JE, Scott PT, et al. Venous thromboembolism among United States soldiers deployed to Southwest Asia. *Thromb Res*. 2006;117(4):379–383.

[a]Deep vein thrombophlebitis/pulmonary embolus (ICD-10: I2601, I2609, I2690, I2699, I801–I803, I808, I809, I822–I824, I826, I82A1, I82B1, I82C1, I8281, I82890, I8290)

[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 90 days of returning from deployment.

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