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Update: Malaria, U.S. Armed Forces, 2010

Malaria is a serious, often life-threatening, mosquito-transmitted parasitic disease. Four *Plasmodium* species are responsible for the overwhelming majority of human malaria infections: *Plasmodium falciparum* (the most deadly), *Plasmodium vivax* (the most common), *Plasmodium ovale*, and *Plasmodium malariae*.

Malaria is endemic in more than 100 countries throughout the tropics and in some temperate regions. In 2008, malaria accounted for 247 million acute illnesses and nearly one million deaths worldwide; most deaths were due to *P. falciparum* infections of young children.[1] Malaria's health and economic impacts are relatively most severe in the poorest and least developed countries – particularly in Africa.

For centuries, malaria has been recognized as a disease of military operational significance.[2,3] U.S. service members are at risk of malaria when they are permanently assigned to endemic areas (such as near the Demilitarized Zone [DMZ] in Korea);[4,5] when they participate in operations in endemic areas (e.g., Afghanistan,[6] Africa,[7] Haiti[8]); and when they visit malarious areas during personal travel. The U.S. military has effective countermeasures against malaria, including chemoprophylactic drugs, permethrin impregnated uniforms and bed nets, and DEET-containing insect repellents. When cases and outbreaks of malaria do occur, they are generally due to non-compliance with indicated chemoprophylactic or personal protective measures.

In the 1990s, there was a general increase in malaria incidence among U.S. service members, primarily due to *P. vivax* infections acquired near the DMZ in Korea.[4,5, 9-11] Since 2001, U.S. service members have been exposed to malaria risk due to *P. vivax* while serving in Southwest and Central Asia (particularly in Afghanistan).[6] Service members who conduct civil-military and crisis response operations in Africa are at risk of malaria due to *P. falciparum*;[7] this risk may have increased since the establishment of the U.S. Africa Command (AFRICOM) in 2007. In 2010, more than 22,000 U.S. military members risked exposure to *P. falciparum* while conducting an earthquake disaster response mission in Haiti.

This report summarizes the malaria experiences of U.S. service members during calendar year 2010 and compares it to recent experience.

Methods:

The surveillance period was January 2002 through December 2010. The surveillance population included active and reserve component members of the U.S. Armed Forces. The Defense Medical Surveillance System was searched to identify reportable medical events and hospitalizations (in military and non-military facilities) that included diagnoses of malaria (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM]: 084). A case of malaria was defined as an individual with (1) a malaria-specific reportable medical event record; (2) a hospitalization record with a primary (first-listed) diagnosis of malaria; (3) a hospitalization record with a non-primary diagnosis of malaria due to a specific *Plasmodium* species (ICD-9-CM: 084.0-084.3); (4) a hospitalization record with a non-primary diagnosis of malaria plus a diagnosis of anemia (ICD-9-CM: 280-285), thrombocyctopenia and related conditions (ICD-9-CM: 287), or malaria complicating pregnancy (ICD-9-CM: 647.4) in any diagnostic position; or (5) a hospitalization record with a non-primary diagnosis of malaria plus diagnoses of signs or symptoms consistent with malaria (as listed in the Control of Communicable Diseases Manual, 18th Edition) in each diagnostic position antecedent to malaria. Malaria diagnoses during outpatient encounters alone (i.e., with none of the above criteria) were not considered case defining for this analysis.

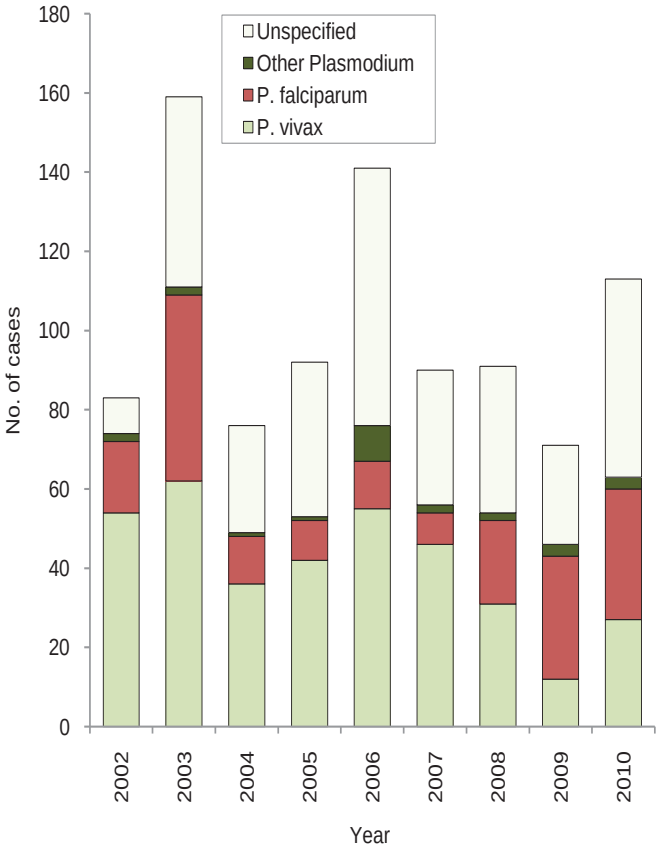
Table 1. Malaria cases by *Plasmodium* species and selected demographic characteristics, U.S. Armed Forces, 2010

	P. vivax	*P. falciparum*	Unspecified or other	Total	Percentage
Total	**27**	**33**	**53**	**113**	**100.0**
Component					
Active	20	29	45	94	83.2
Reserve/Guard	7	4	8	19	16.8
Service					
Army	26	12	42	80	70.8
Navy	0	14	4	18	15.9
Air Force	1	4	1	6	5.3
Marine Corps	0	2	6	8	7.1
Coast Guard	0	1	0	1	0.9
Gender					
Male	27	29	49	105	92.9
Female	0	4	4	8	7.1
Age group					
<20	0	1	2	3	2.7
20-24	10	11	25	46	40.7
25-29	8	9	13	30	26.5
30-34	9	4	6	19	16.8
35-39	0	4	6	10	8.8
40+	0	4	1	5	4.4
Race/ethnicity					
White, non-Hispanic	23	14	38	75	66.4
Black, non-Hispanic	1	12	6	19	16.8
Other	3	7	9	19	16.8

Table 2. Number of malaria cases by geographical location of diagnosis or report and presumed location of acquisition, U.S. Armed Forces, 2010

Location of diagnosis/report	Presumed location of infection acquisition					Total	% of total 2010 cases
	Korea	Afghanistan	Africa	Haiti	Unknown		
Bagram/Camp Lacy, Afghanistan	0	24	0	0	0	24	21.2
Landstuhl, Germany	0	6	4	0	0	10	8.8
Fort Bragg, NC	0	1	0	8	0	9	8.0
Portsmouth, VA	0	0	3	1	1	5	4.4
Seoul, Korea	5	0	0	0	0	5	4.4
Fort Wainwright, AK	0	4	0	0	0	4	3.5
Camp Lejeune, NC	0	1	0	3	0	4	3.5
Naval Station Norfolk, VA	0	0	4	0	0	4	3.5
Fort Carson, CO	0	3	0	0	0	3	2.7
Fort Bliss, TX	1	2	0	0	0	3	2.7
Walter Reed Army Medical Center, DC	0	0	0	0	2	2	1.8
Fort Stewart, GA	0	1	0	0	1	2	1.8
Fort Campbell, KY	0	2	0	0	0	2	1.8
Nellis Air Force Base, NV	0	2	0	0	0	2	1.8
Fort Hood, TX	0	0	1	1	0	2	1.8
Naval Mobile Construction Battalion 7 (location unknown)	0	0	2	0	0	2	1.8
Joint Task Force - Horn of Africa	0	0	2	0	0	2	1.8
Other locations (with 1 case each)	0	12	8	1	7	28	24.8
Total (% of total)	6 (5%)	58 (51%)	24 (21%)	14 (12%)	11 (10%)	113 (100%)	100.0

Figure 1. Malaria cases among U.S. service members, by *Plasmodium* species and calendar year of diagnosis/report, 2002-2010



This summary allowed one episode of malaria per service member per 365-day period. When multiple records documented a single episode, the date of the earliest encounter was considered the date of clinical onset, and the most specific diagnosis was used to classify the *Plasmodium* species.

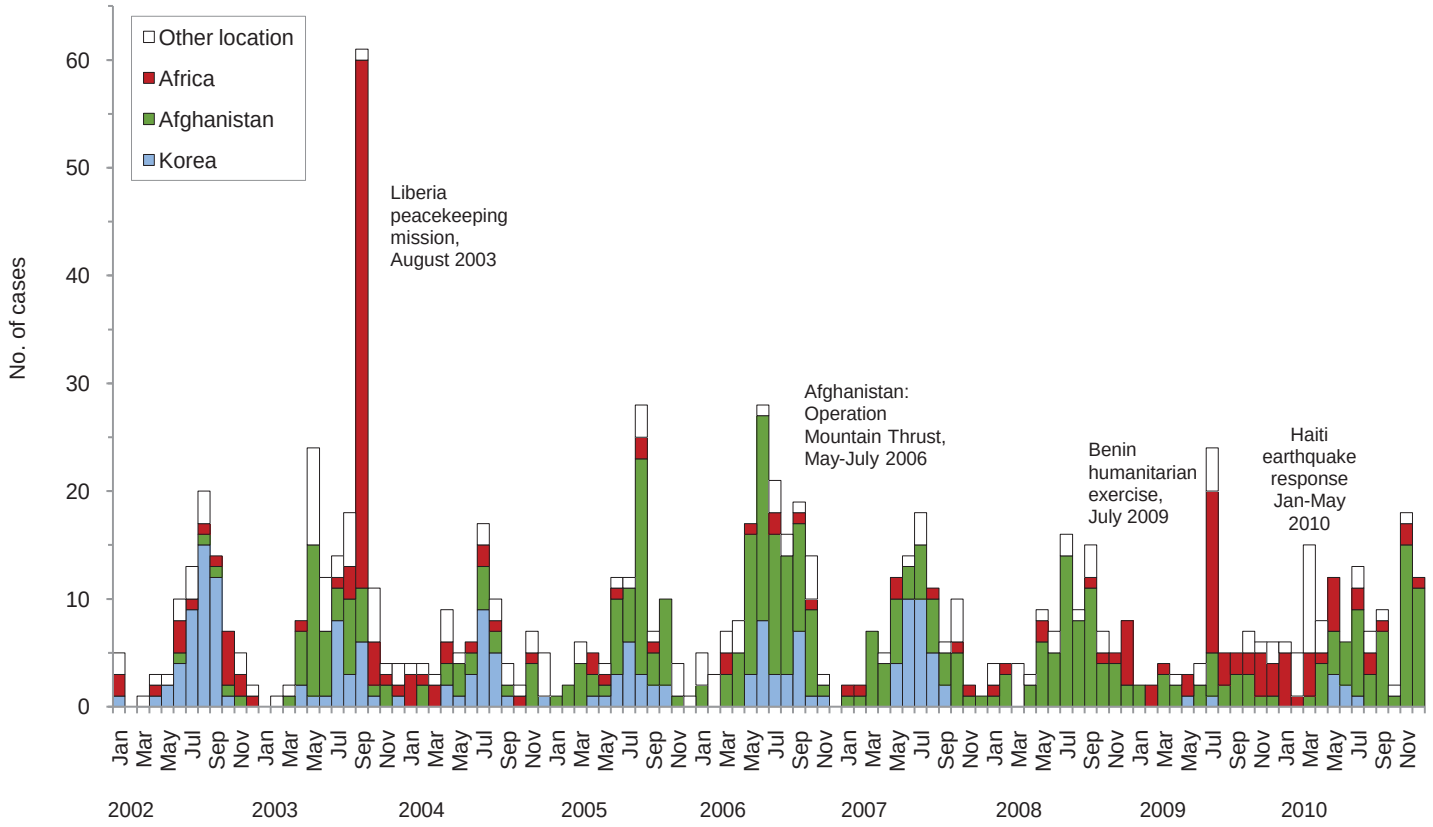
Presumed locations of malaria acquisition were estimated using a hierarchical classification algorithm: (1) cases hospitalized in a malarious country were considered acquired in that country; (2) case reports (submitted as reportable medical events) that listed exposures to malaria endemic locations were considered acquired in those locations; (3) cases diagnosed among service members during or within 30 days of deployment or assignment to a malarious country were considered acquired in that country; (4) cases diagnosed among service members who had been deployed to Afghanistan or Korea within two years prior to diagnosis were considered acquired in those countries; (5) all remaining cases were considered acquired in unknown locations.

Of note, analytic methods used in this report differ from those used in previous malaria summaries. In past reports, only primary (first-listed) diagnoses of malaria were considered case defining, and only one case per individual was included during the entire surveillance period.

Results:

In 2010, 113 U.S. military members were diagnosed and/or reported with malaria. The number of cases in 2010

Figure 2. Malaria among U.S. service members, by estimated location of infection acquisition, 2002-2010



was higher than in six of the eight previous years **(Figure 1)**. More than one-quarter of 2010 cases were caused by *P. falciparum* (n=33, 29%) and slightly fewer than one-quarter by *P. vivax* (n=27, 24%) **(Table 1)**. In 2010, there were more cases attributed to *P. falciparum* than in any year except 2003 and fewer cases attributed to *P. vivax* than in any year except 2009. The responsible agent was "unspecified" for 44 percent (n=50) of 2010 cases **(Figure 1)**.

In 2010, as in prior years, most U.S. military members diagnosed with malaria were males (93%), in the active component (83%), in the Army (71%) and in their 20s (67%) **(Table 1)**. Among service members diagnosed with malaria in 2010, nearly 11 percent (12/113) were born in malaria-endemic countries other than Mexico **(data not shown)**; in comparison, among U.S. military members overall, less than 4 percent were born in malaria-endemic countries other than Mexico.

Of the 113 malaria cases reported in 2010, more than one-half of the infections were considered to have been acquired in Afghanistan (n=58, 51%) and more than one-fifth in Africa (n=24, 22%); fourteen infections (12%) were presumed acquired in Haiti; only six (5%) were presumably acquired in Korea. The remaining eleven malaria cases (10%) had unknown areas of infection acquisition **(Table 2)**. The number of infections considered acquired in Afghanistan and Africa in 2010 were the third and second highest of the nine-year period, respectively.

Of the 24 malaria infections considered acquired in Africa in 2010, 13 were likely acquired in West Africa (Liberia: 7; Ghana, Sierra Leone: 2 each; Cameroon, Nigeria: 1 each); seven were considered acquired in Southern Africa (Comoros: 5; Angola, Mozambique: 1 each); two were considered acquired in the Horn of Africa (Kenya, Djibouti) and two were reported only as "Africa" **(data not shown)**.

None of the 113 service members with malaria infections in 2010 were diagnosed/reported with malaria previously during the nine-year surveillance period. However, six service members diagnosed with malaria between 2002 and 2009 were considered cases more than once during the period. Of these, four individuals were diagnosed with malaria on two separate occasions 13 to 16 months apart; each had served in Afghanistan (n=3) or Korea (n=1). Two other service members were diagnosed with malaria on two separate occasions 30 and 37 months apart, respectively; these individuals had Ghanaian surnames and histories of travel to Ghana **(data not shown)**.

Prior to 2010, malaria cases were diagnosed/reported from more than 40 different medical facilities in the United States, Germany, Afghanistan and Korea. More than one-third of cases were reported from or diagnosed outside the United States **(Table 2)**. Twenty-four cases were treated at/reported from Bagram Air Field in Afghanistan, 10 cases were treated at/reported from Landstuhl Regional Medical

Table 3. Most frequent countries of birth among service members diagnosed with malaria, U.S. Armed Forces, 2002-2010

Birth country	No. of malaria cases in 2002-2010	% of malaria cases 2002-2010 (n=916)
United States	684	74.7
Unknown	82	9.0
Nigeria	25	2.7
Ghana	22	2.4
Puerto Rico	9	1.0
Germany	6	0.7
Guam	6	0.7
Korea	6	0.7
Philippines	6	0.7
Sierra Leone	6	0.7
Cameroon	5	0.5
Cote d'Ivoire	5	0.5
Liberia	5	0.5
Mexico	5	0.5
Togo	4	0.4
All other countries	40	4.4

Center in Germany, and five cases were treated at/reported from Brian Allgood Army Community Hospital in Seoul, Korea. During the year, only two U.S.-based facilities treated/reported at least five cases each: Womack Army Medical Center, Fort Bragg, NC (n=9) and Navy Medical Center Portsmouth, VA (n=5). Twenty-eight medical facilities reported a single case each **(Table 2)**.

In 2010 as in most prior years, most malaria cases diagnosed among U.S. military members were diagnosed in the summer and fall months (July-December); however, in 2010, there was less distinct seasonality than in past years. There were only slightly more cases during the summer and fall (n=61) than the winter and spring months (n=52) **(Figure 2)**. The finding may reflect the relatively higher number and proportion of cases acquired in tropical regions of Africa and Haiti compared to temperate regions of Korea and Afghanistan.

Editorial comment:

In 2010, there were more cases of malaria diagnosed/reported among U.S. military members than in any of the previous three years. The finding reflects increasing acquisition of malaria from Africa since 2007, continuing acquisition from Afghanistan, and 14 cases acquired in Haiti during a large disaster response mission. Of note, Haiti-acquired cases represented one-third of the increase in the number of malaria cases from 2009 to 2010. Afghanistan has been the presumed country of acquisition for 20 to 85 malaria cases each year since 2003. Malaria acquisition from Korea has remained relatively low since 2008; since 2008 compared to recent prior years, there have been remarkably fewer Korea-acquired cases among U.S. military members.

There are significant limitations to the report that should be considered when interpreting the findings. For example, the ascertainment of malaria cases is likely incomplete (e.g., cases treated in deployed or non-U.S. military medical facilities may not be reported or otherwise ascertained). Only malaria infections that resulted in hospitalizations in fixed facilities or were reported as notifiable medical events were considered cases for this report; infections that were treated only in outpatient settings and not reported as notifiable events were not included as cases. Also, the locations of infection acquisition were estimated from reported relevant information. Some cases had reported exposures in multiple malarious areas, and 10 percent of cases had no relevant exposure information.

Of note in this report, 12 percent of all cases during the nine-year surveillance period (including 11 percent of cases in 2010) were born in malaria-endemic countries—particularly Nigeria, Ghana and neighboring West African countries **(Table 3)**. By comparison, less than 4 percent of all individuals who served in the U.S. military during the same period were born in malaria endemic countries. The finding may reflect the risk of malaria among foreign-born service members during personal travels in their countries of origin. Individuals who live in malaria-endemic countries are often unaccustomed to taking chemoprophylactic drugs to prevent malaria; with repeated exposures to malaria parasites, they develop natural immunity to malaria. However, after leaving their countries of origin, foreign-born service members lose their natural immunity over time; as a result, they are more susceptible to malaria during subsequent visits to their homelands. Although the majority of service members diagnosed with malaria since 2002 were U.S.-born, service members born in malarious countries represent an identifiable risk group and an opportunity for strengthened prevention efforts.

As in prior years, in 2010, most malaria cases among U.S. military members were treated at medical facilities remote from malaria endemic areas; of note, more than 40 medical facilities treated any cases, and 28 facilities treated only one case each during the past year. Providers of acute medical care to service members (in both garrison and deployed settings) should be knowledgeable of and vigilant for the early clinical manifestations of malaria — particularly among service members who are currently or were recently in malaria-endemic areas (e.g., Afghanistan, Africa, Korea). Care providers should be capable of diagnosing malaria (or have access to a clinical laboratory that is proficient in malaria diagnosis) and initiating treatment (particularly when falciparum malaria is clinically suspected).

Most important, all military members at risk of malaria should be informed in detail of the nature and severity of the risk; they should be trained, equipped, and supplied to conduct all indicated countermeasures; and they should be closely monitored to ensure compliance. Personal protective measures against malaria include the proper wear of permethrin impregnated uniforms; the use of bed nets and military-issued DEET-containing insect repellent; and compliance with prescribed chemoprophylactic drugs before, during, and after times of exposure in malarious areas.

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Diagnoses of Overweight/Obesity, Active Component, U.S. Armed Forces, 1998-2010

Among respondents to a 2008 survey of health-related behaviors among active duty service members, 64 percent of men and 40 percent of women had body mass indexes (BMIs) above 25 kg/m^2; i.e., they were nominally "overweight." In addition, 13 percent of the 2008 survey respondents were nominally "obese" (BMI>30 kg/m^2); in 1995, fewer than 5 percent of active service members were considered "obese."[1]

To ensure a mission-ready force with a "military appearance," the Department of Defense mandates that each military service implement "body composition programs," including enforcement of weight-for-height standards required for accession and advancement.[2] An increasing proportion of young adults in the general U.S. population do not meet current military weight-for-height standards.[3] Among first-time active duty applicants, exceeding the weight/body fat limit was the most common reason for medical disqualifications from 2004-2009.[4] Among 18-year olds who applied for military service in 2006, 35 percent of males and 28 percent of females had BMIs above 25 kg/m.[5] Of note, the prevalence of overweight may be higher among eighteen-year olds who apply for military service than among those in the general population.[6]

Many active duty military members receive clinical diagnoses of overweight during routine medical examinations and other outpatient medical encounters. This report summarizes numbers and trends of clinical diagnoses indicative of overweight or obesity among active component members of the U.S. Armed Forces during the past 13 years.

Methods:

The surveillance period was January 1998-December 2010. The surveillance population included all individuals who served in the active component of the U.S. military any time during the surveillance period. Records of all outpatient encounters of active component members in fixed U.S. military and some non-military (i.e., purchased care) medical facilities were searched to identify U.S. military members with diagnoses specific for "clinical overweight." An outpatient encounter for clinical overweight was defined as an outpatient encounter with a diagnosis of "overweight" or "obesity" (ICD-9-CM: 280.0 or 278.00-278.02) or an adult BMI above 25 kg/m^2 (ICD-9-CM: V85.2-V85.4) or a pediatric BMI above the 85th percentile for persons up to 20 years of age (ICD-9-CM: V85.53, V85.54).

For each year of the surveillance period, the prevalence of clinical overweight was estimated by dividing the number of service members who received at least one clinical overweight-related diagnosis during an outpatient encounter during the year by the number of individuals who served in the active component of the U.S. Armed Forces any time during the year. Each individual could be considered a "new case" of clinical overweight only once during the surveillance period; service members could then be considered a "previously diagnosed case" during each subsequent year in which a clinical overweight diagnosis was recorded.

Results:

From 1998 to 2010, the number and prevalence of active component members who received at least one overweight/obesity-related diagnosis more than tripled (1998: n=25,766; 1.6%; 2010: n=86,186, 5.3%) **(Table 1, Figure 1)**. In general, annual prevalences of clinical overweight were low and stable from 1998 to 2002 and then increased rapidly from 2003 through 2010 **(Figure 1)**.

Numbers of first time recipients of clinical overweight diagnoses ("new cases") increased each year from 2001 to

Figure 1. Crude overall number and percentage of service members who received an outpatient diagnosis of overweight/obesity, by calendar year, active component, U.S. Armed Forces, 1998-2010

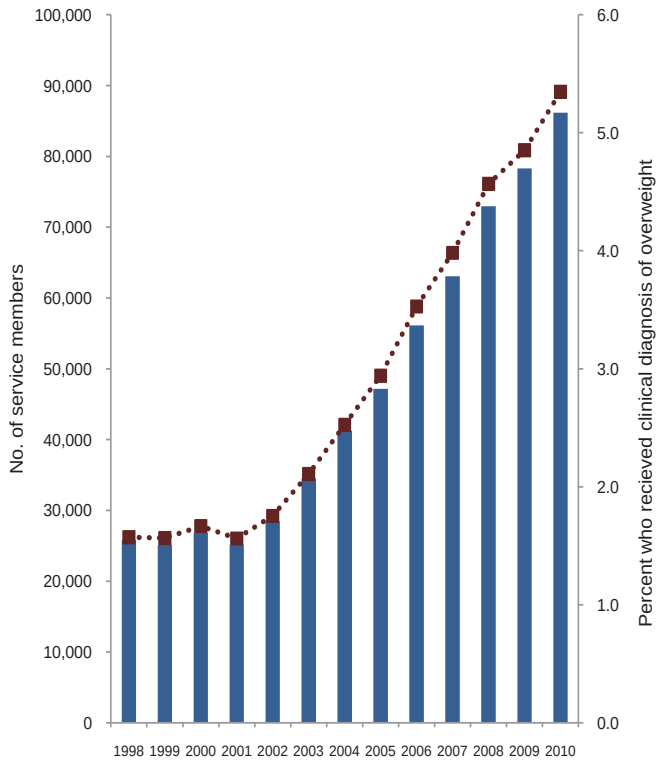


Table 1. Annual number and percentage of service members who received an outpatient diagnosis of overweight/obesity, by calendar year, active component, U.S. Armed Forces, January 1998-December 2010

	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total	25,766	1.6	25,107	1.6	26,849	1.7	25,148	1.6	28,437	1.8	34,489	2.1	41,225	2.5	47,177	2.9	56,126	3.5	63,058	4.0	72,941	4.6	78,298	4.9	86,186	5.3
Service																										
Army	12,727	2.3	11,237	2.1	12,277	2.2	11,432	2.1	12,331	2.2	15,260	2.7	23,464	4.1	24,031	4.3	26,609	4.7	25,462	4.4	29,568	4.9	34,274	5.6	40,440	6.5
Navy	4,499	1.0	3,928	0.9	3,665	0.9	4,209	1.0	4,662	1.1	4,912	1.2	5,846	1.4	8,574	2.1	10,370	2.7	11,579	3.1	13,994	3.8	11,780	3.2	13,740	3.9
Air Force	6,801	1.7	8,648	2.2	9,643	2.5	7,983	2.1	10,162	2.6	12,728	3.2	9,639	2.4	11,535	3.0	15,248	4.0	21,180	5.7	24,254	6.8	26,082	7.3	25,667	7.2
Marine Corps	1,613	0.8	1,152	0.6	1,029	0.5	1,312	0.6	1,021	0.5	1,155	0.6	1,495	0.7	1,891	0.9	2,261	1.1	3,063	1.4	2,963	1.3	3,681	1.6	3,855	1.7
Coast Guard	126	0.3	142	0.4	235	0.6	212	0.5	261	0.6	434	1.0	781	1.8	1,146	2.6	1,638	3.8	1,774	4.0	2,162	4.8	2,481	5.5	2,484	5.6
Sex																										
Male	18,376	1.3	17,870	1.3	19,304	1.4	17,344	1.3	19,787	1.4	23,976	1.7	30,895	2.2	35,620	2.6	42,081	3.1	47,300	3.5	55,064	4.0	60,010	4.3	67,004	4.9
Female	7,390	3.2	7,237	3.1	7,545	3.2	7,804	3.2	8,650	3.5	10,522	4.2	10,330	4.2	11,557	4.9	14,045	6.0	15,758	6.8	17,877	7.7	18,288	7.8	19,182	8.2
Race/ethnicity																										
White, non-Hispanic	13,746	1.4	14,810	1.5	16,446	1.6	15,129	1.5	16,914	1.6	20,129	1.9	23,886	2.3	27,364	2.7	32,772	3.2	37,427	3.7	42,649	4.2	45,721	4.4	50,382	4.9
Black, non-Hispanic	5,768	1.8	5,529	1.8	5,935	1.9	5,776	1.9	6,561	2.1	8,119	2.7	9,754	3.4	10,550	3.8	12,033	4.6	12,876	5.0	14,715	5.7	16,294	6.3	17,582	6.9
Other	6,252	1.9	4,768	1.5	4,468	1.6	4,243	1.5	4,962	1.7	6,241	2.1	7,585	2.5	9,263	3.0	11,321	3.6	12,755	4.0	15,577	4.9	16,283	5.0	18,222	5.4
Age																										
<20	1,938	1.2	1,406	0.8	1,681	0.9	1,415	0.7	1,486	0.8	1,660	0.9	1,395	0.9	2,270	1.6	2,659	1.9	3,710	2.6	4,358	3.0	2,773	2.0	2,467	2.0
20-24	8,846	1.7	7,976	1.6	8,913	1.7	8,366	1.5	9,575	1.7	11,376	2.0	13,171	2.3	13,765	2.4	15,040	2.7	15,850	2.9	18,980	3.4	19,510	3.5	21,379	3.9
25-29	6,195	1.8	6,054	1.9	6,118	1.9	5,598	1.9	6,107	2.0	7,750	2.5	9,299	2.9	10,473	3.2	12,675	3.8	14,144	4.1	16,821	4.7	18,988	5.1	21,059	5.6
30-34	3,444	1.4	3,537	1.5	3,573	1.6	3,433	1.6	3,780	1.7	4,784	2.2	6,194	2.9	7,284	3.4	8,634	4.1	9,711	4.6	11,296	5.3	13,009	6.0	14,560	6.5
35-39	3,369	1.5	3,819	1.7	4,102	1.9	3,762	1.8	4,253	2.1	4,977	2.5	6,193	3.2	7,112	3.9	8,967	4.9	10,245	5.6	11,232	6.2	12,467	7.0	13,586	7.8
40+	1,974	1.3	2,315	1.6	2,462	1.7	2,574	1.8	3,236	2.2	3,942	2.6	4,973	3.1	6,273	4.0	8,151	5.3	9,398	6.2	10,254	6.7	11,551	7.4	13,135	8.3
Marital status																										
Single	9,870	1.5	8,825	1.3	10,008	1.4	9,558	1.3	10,797	1.5	12,646	1.7	14,936	2.1	16,466	2.4	18,271	2.8	20,369	3.1	24,208	3.7	23,073	3.5	24,535	3.8
Married	14,834	1.6	15,094	1.7	15,537	1.9	14,385	1.8	16,262	2.0	20,057	2.4	24,238	2.8	28,303	3.3	34,684	4.0	39,034	4.5	44,532	5.1	50,349	5.7	56,374	6.3
Other	1,062	1.7	1,188	1.9	1,304	2.2	1,205	1.9	1,378	2.3	1,786	3.0	2,051	3.4	2,408	3.9	3,171	5.0	3,655	5.5	4,201	6.0	4,876	6.7	5,277	7.1
Education																										
High school or less	17,158	1.7	14,752	1.5	16,038	1.3	20,105	1.7	22,395	1.9	27,216	2.3	32,440	2.7	36,528	3.1	42,046	3.6	46,827	4.1	54,164	4.7	57,237	4.9	62,303	5.4
College 2+ yr	3,233	0.7	9,316	1.9	8,721	3.1	3,626	1.5	4,319	1.6	5,240	1.9	6,360	2.2	7,981	2.7	10,431	3.3	12,470	3.9	14,469	4.5	16,215	5.2	17,727	5.5
Post college	750	0.7	863	0.9	939	0.9	960	1.0	1,049	1.2	1,122	1.3	1,192	1.3	1,605	1.8	2.489	2.7	2,891	3.2	3,365	3.7	3,541	3.6	4,337	4.2
Unknown	4,625	9.2	176	0.9	1,151	2.8	457	0.5	674	0.7	911	1.1	1,233	1.9	1,063	2.1	1,160	3.6	870	3.2	943	3.3	1,305	3.2	1,819	4.3
Military occupation																										
Combat	3,928	1.4	2,941	1.2	3,065	1.3	2,505	1.1	3,038	1.3	3,426	1.4	5,436	2.2	5,994	2.3	5,856	2.4	6,488	2.7	8,631	3.4	7,899	3.3	8,348	3.5
Health care	3,352	2.5	3,466	2.6	3,278	2.5	3,116	2.4	3,777	2.9	4,105	3.2	4,345	3.3	5,661	4.4	8,493	6.6	8,724	6.8	9,243	7.3	9,862	7.7	10,420	8.0
Other	19,116	1.5	18,700	1.5	20,506	1.6	19,527	1.6	21,622	1.7	26,958	2.1	31,444	2.5	35,522	2.9	41,777	3.4	47,846	3.9	55,067	4.5	60,537	4.8	67,418	5.4

2008 and then were stable through 2010 **(Figure 2)**. However, numbers of service members with clinical overweight diagnoses in years subsequent to their initial diagnoses ("previously diagnosed cases") markedly increased each year from 2001 to 2010. Of all service members diagnosed with overweight/obesity each year, the proportion attributable to previously diagnosed cases sharply and steadily increased throughout the period **(Figure 2)**.

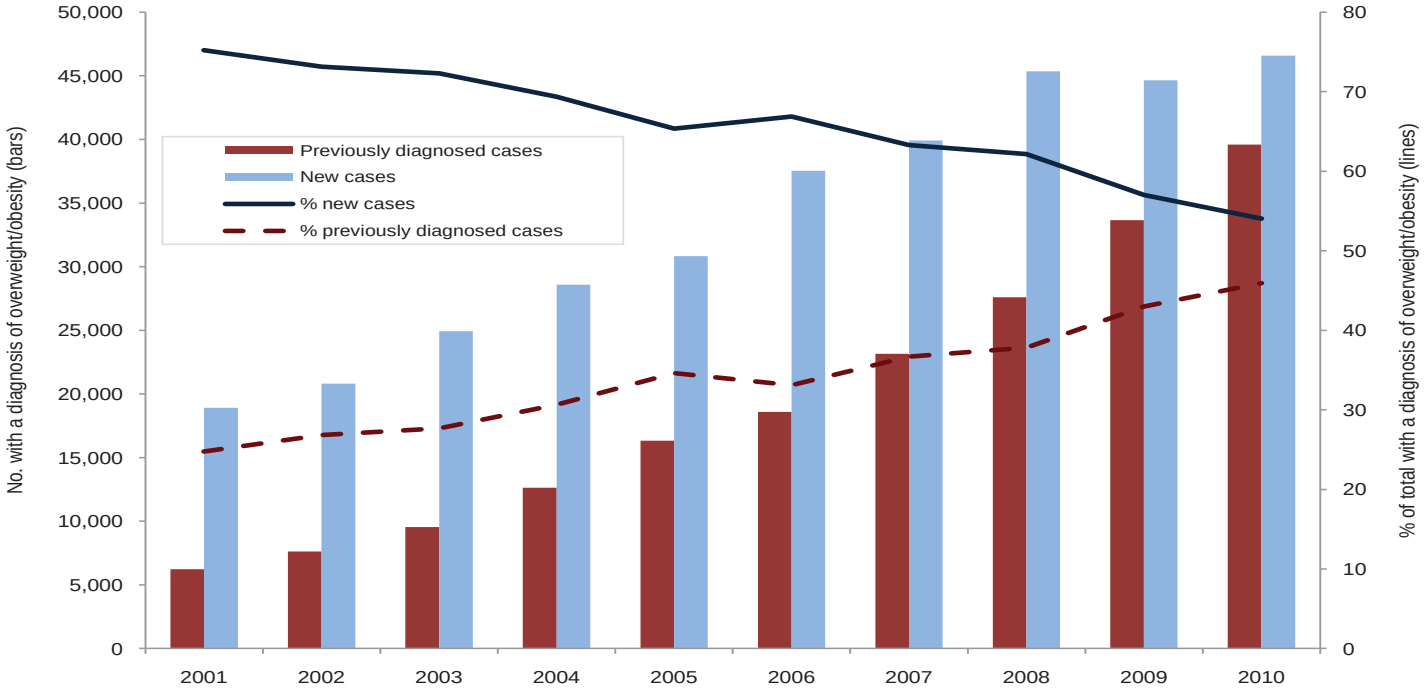
In 2010, the highest subgroup-specific prevalences of clinical overweight were among females (8.2%), health care workers (8.0%), Air Force members (7.2%), and those older than 40 years (8.3%). The lowest prevalences of clinical overweight were among Marines (1.7%) and the youngest aged (<20 years) (2.0%) **(Table 1)**.

From 1998 to 2010, the largest absolute increases in annual prevalences (unadjusted) of clinical overweight were among service members older than 40 years (1998-2010, prevalence difference [PD]: 7.0%), in the Air Force (PD: 5.5%), and with health care occupations (PD: 5.5%). During the period, the smallest absolute increases in clinical overweight were among Marines (PD: 0.9%) and teenaged service members (PD: 0.8%) **(Table 1)**.

During the period, females received clinical diagnoses of overweight approximately twice as often as males **(Table 1)**. Prevalences of clinical overweight markedly increased among females (all age groups) and males (>20 years); however, the largest and most consistent increases were from 2004 to 2010 **(Figures 3a-3b)**.

Between 1998 and 2010 among the Services, the largest absolute increase in the annual prevalence of clinical overweight-related diagnoses was in the Air Force **(Table 1)**; the increase in the Air Force overall reflected increases in all age groups except the youngest **(Figures 4a-d)**. Of interest, following implementation of a new Air Force fitness program ("Fit to Fight") in January 2004, there were sharp but temporary declines in the prevalences of clinical overweight diagnoses among airmen in their teens and twenties **(Figures 4a,b)**; among airmen in their twenties, the prevalence of

Figure 2. Number and percentage of service members with a diagnosis of overweight/obesity, active component, U.S. Armed Forces, 2001-2010



clinical overweight-related diagnoses more than tripled from 2004 (1.8%) to 2009 (6.1%) **(Figures 4b)**.

In each age group (except <20 year olds) of Army and Coast Guard members, prevalences of clinical overweight markedly increased from 2003 to 2010 **(Figures 4b-d)**. In turn, from 2004 to 2010, in each group older than 19 years, prevalences of clinical overweight were markedly lower in the Marine Corps and Navy than the other Services. Of note, in each age group of Marines, annual prevalences of clinical overweight diagnoses were less than one percent through 2004 and less than two percent through 2009 **(Figures 4a-d; Table 1)**.

Categories of other diagnoses most often recorded during medical encounters at which overweight/obesity was also diagnosed were examinations/screenings (44%); medical conditions frequently comorbid with overweight (e.g., high cholesterol, high blood pressure, diabetes, sleep apnea) (16%); disorders of joints/back (7%); and tobacco use (5%).

Editorial comment:

The epidemic of obesity in the general U.S. population is well documented and highly publicized. In 2009, no U.S. state met the Healthy People 2010 adult obesity prevalence target of 15 percent, and the self-reported prevalence of obesity among adults aged 18-29 was 20.3 percent.[7] Not surprisingly, the increase of obesity in the general population is reflected in higher BMIs and more "medically unfit for service" rejections among civilian applicants for military service.

Military service is inherently physically demanding — many military activities require significant physical strength

Figure 3a-b. Annual percentage of female/male service members who received a clinical diagnosis of overweight/obesity, by age group, active component, U.S. Armed Forces, 1998-2010

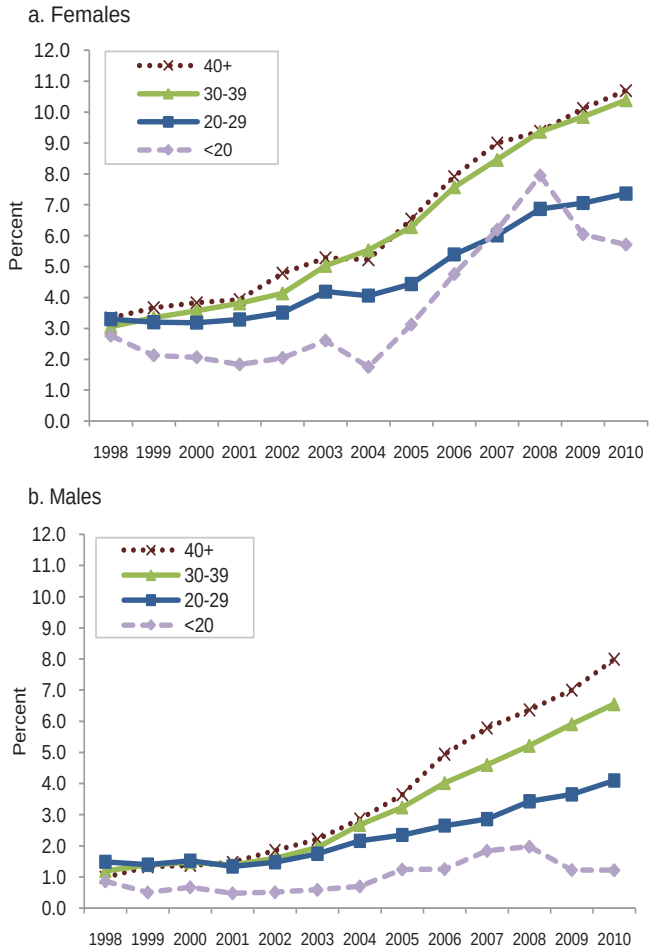
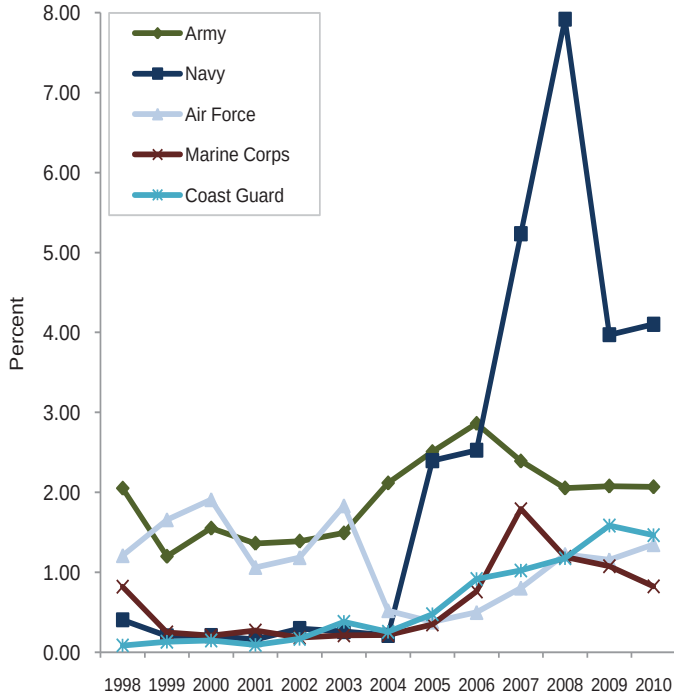
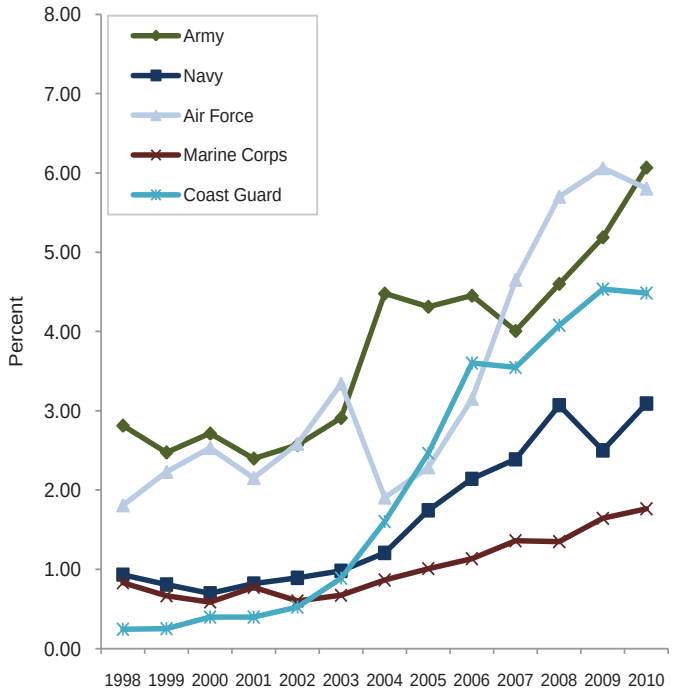


Figure 4a-d. Annual percentage of service members who received a clinical diagnosis of overweight/obesity, active component, U.S. Armed Forces, 1998-2010

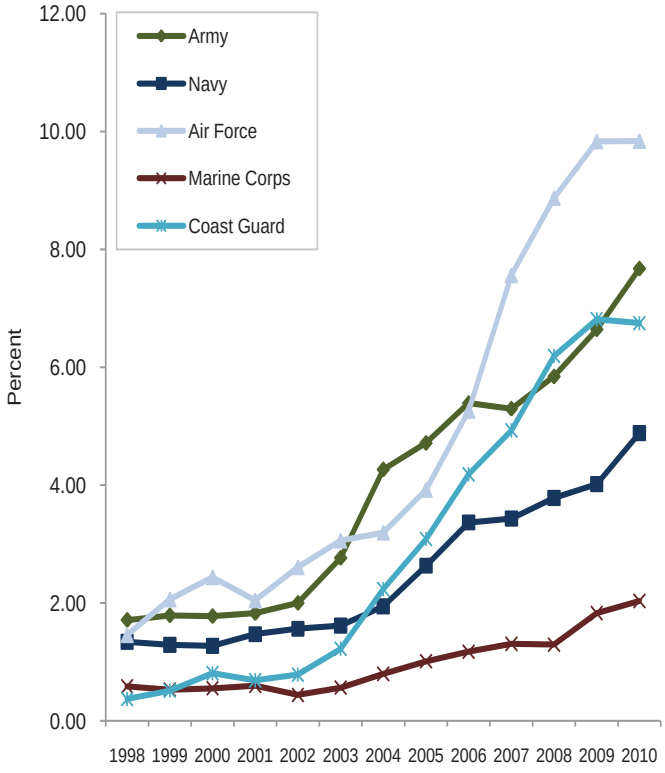
a. <20 years



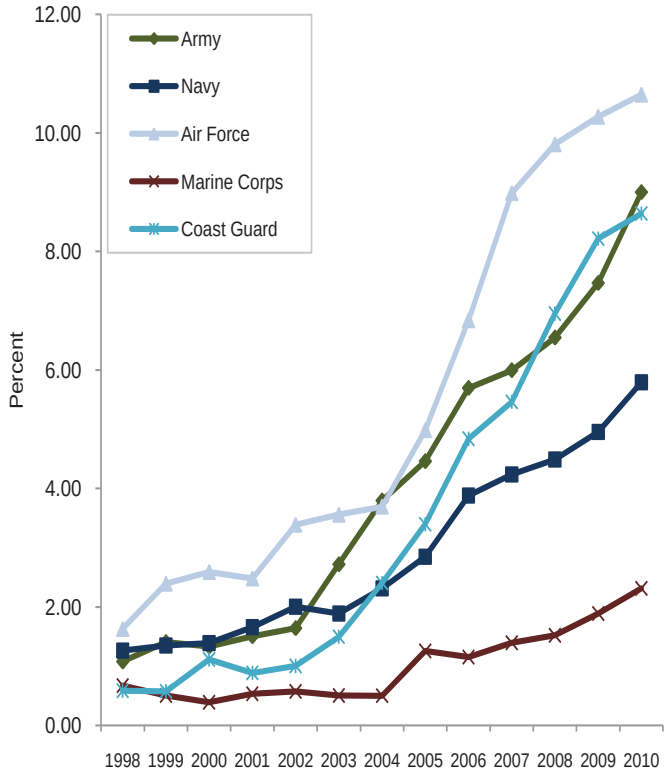
b. 20-29 years



c. 30-39 years



d. 40+ years



and endurance. Regular physical exercise and periodic fitness testing are important parts of the training regimens of most military units; also, military members must maintain compliance with service-specific height-weight standards to continue service. For these reasons, active military members have been considered relatively immune to the obesity epidemic. The results of this report suggest otherwise.

In the past decade among active military members in general, the percent of military members who experienced new and recurrent medical encounters for overweight/obesity has steadily increased; and since 2003, rates of increase have generally accelerated. After sharply increasing each year from 2001 to 2008, numbers of "new cases" per year leveled off through 2010. As a result, in the past three years, the majority of the increase in prevalent clinical overweight/obese cases overall was attributable to service members who continued in service and received recurrent overweight/obese diagnoses. Future analyses will examine the demographic and military characteristics of recurrently overweight/obese service members and estimate lengths of service (and recent trends) from first diagnosis of clinical overweight to termination of active service.

Among military members in general, prevalences of overweight/obesity diagnoses are higher among females than males and increase with age. During the period of interest for this report, prevalences of clinical overweight increased among males and females in every age group, particularly after 2003.

Among the Services, the Air Force and Marine Corps had the highest and lowest overall prevalences of medical encounters for overweight/obesity, respectively. For many reasons, prevalences of clinical overweight are not directly comparable among the Services. For example, prevalences of clinical overweight are generally higher among females than males and increase with age. Thus, differences in prevalences of clinical overweight across the Services reflect at least in part differences in their gender and age distributions, e.g., the Air Force has the highest and the Marine Corps the lowest proportions of females and older members.

The results of this report should be interpreted with consideration of its limitations. For example, this report was based on diagnoses of overweight/obesity reported on standard medical records rather than actual measurements of heights and weights. Prevalence and trends of overweight/obesity may reflect changes in clinical practice (e.g., referrals for nutritional counseling), medical administrative procedures (e.g., diagnostic coding), and/or health care seeking behaviors rather than actual changes in overweight/obesity prevalence. Also, the finding of higher numbers of medical encounters for overweight/obesity may reflect increasing uses of medical care for medical/nutritional counseling by, rather than increasing numbers of, overweight/obese service members. If so, the finding may reflect increasing awareness of the adverse health effects of overweight/obesity by affected service members, more effective community health education efforts, and/or more aggressive clinical prevention programs related to obesity, exercise, and nutrition.

Overweight/obesity is a significant military medical concern because it is associated with decreased military operational effectiveness (e.g., physical fitness) and both acute and chronic adverse health effects (e.g., musculoskeletal disorders, cardiovascular diseases, cancers). In a previous *MSMR* report, 23 percent and 16 percent of service members diagnosed with overweight/obesity in 2008 had at least one medical encounter for a joint or back disorder, respectively, within the prior year.[8] Joint and back disorders are among the leading causes of morbidity, lost duty time, and health care costs among military members in general; in this analysis, these conditions were among the most frequent comorbid conditions with overweight/obesity among military members.

The results of this analysis suggest that the U.S. military is significantly affected in many ways by the obesity epidemic among young adult Americans in general. For example, when not deployed or training, many service members live, shop, and recreate in civilian communities. "Fast food" restaurants and physically passive recreational outlets (e.g., video games, television, movies) are ubiquitous in both military and civilian communities. "Nutritional fitness" should be a priority of military medical and line leaders at every level.

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Multiple Sclerosis, Active Component, U.S. Armed Forces, 2000-2009

Multiple sclerosis (MS) is an autoimmune disease of the central nervous system. It is characterized by inflammation, demyelination, and axon degeneration resulting in impaired nerve conduction.[1] The signs and symptoms vary and may include weakness, painful muscle spasms, bladder dysfunction, vision disturbances, impaired speech or swallowing, tremor, poor balance, difficulty with coordination, or cognitive impairment.[2] The clinical course of MS varies from patient to patient; however, the usual course is characterized by recurrent clinical exacerbations. Exacerbations can produce new deficits, worsen persistent deficits, or resolve with complete recovery. In some cases, the disease progresses with worsening disabilities that can be life-threatening.[3]

No single factor has been identified as the cause of MS; however, several epidemiological patterns have emerged. For example, the risk of MS seems to be associated with latitude; several studies have reported higher MS prevalences with increasing distances from the equator.[4-7] Serum vitamin D levels have been cited frequently as a proxy for latitude;[8,9] birth month or season and *in utero* exposure to vitamin D have been hypothesized as correlates of risk.[10] Also, infectious agents such as Epstein-Barr virus (EBV) have been linked to increased risk of subsequent MS diagnosis.[11,12]

MS is militarily relevant because the disease often manifests for the first time in the age range of most military members. MS-related disabilities can degrade the operational capabilities of affected service members. In addition, there are significant costs associated with the clinical management of affected service members and MS-disabled retirees. This analysis estimates the frequencies, incidence rates, trends and correlates of risk of MS among active component U.S. military members from 2000-2009.

Methods:

The surveillance period was January 2000 to December 2009. The surveillance population included all individuals who served in an active component of any branch of the U.S. military at any time during the surveillance period. Incident cases were identified by searching for all primary diagnoses of multiple sclerosis (ICD-9-CM: 340) or "other demyelinating diseases of central nervous system" (ICD-9-CM: 341) reported during medical encounters in U.S. military medical facilities or with purchased care providers. A case was defined as an individual with a single inpatient diagnosis of MS, two outpatient encounters with diagnoses of MS, or an inpatient or outpatient encounter with "other demyelinating diseases of central nervous system" followed by an outpatient encounter with MS. Case-defining follow-up encounters were required to be at least one day after initial presentation. Date of onset was considered the date of the earliest medical encounter that was contributory to the definition of a MS case; each individual was considered an incident case only once during the surveillance period. Birth month and home-of-record state served as proxies for *in utero* vitamin D exposure and latitude of birth, respectively.

Table 1. Incident cases and incidence rates of multiple sclerosis, active component, U.S. Armed Forces, 2000-2009

	No.	%	Rate per 100,000 p-yrs	IRR[a]
Total	1,827	100	12.9	.
Sex				
Male	1,167	64	9.6	1.0
Female	660	36	32.0	3.3
Age at diagnosis				
<20	30	2	2.1	0.3
20-24	323	18	6.7	1.0
25-29	401	22	13.8	2.1
30-34	339	19	16.7	2.5
35-39	390	21	21.9	3.3
40+	344	19	26.9	4.0
Race				
White, non-Hispanic	1,124	62	12.5	1.0
Black, non-Hispanic	462	25	18.3	1.5
Hispanic	133	7	9.4	0.8
Other	108	6	8.4	0.7
Service				
Army	571	31	11.5	1.9
Navy	444	24	12.5	2.1
Air Force	639	35	18.3	3.1
Marine Corps	108	6	6.0	1.0
Coast Guard	65	4	16.8	2.8

[a]IRR= Incidence Rate Ratio

Results:

Between 2000 and 2009, there were 1,827 incident diagnoses of MS among active component military members. The overall incidence rate (IR) of MS was 12.9 per 100,000 person-years (p-yrs) **(Table 1)**. Ninety percent of cases (n=1,650) were individuals with two MS-related outpatient encounters prior to any MS-related hospitalization. During the 10-year period, annual incidence rates of MS remained remarkably stable (range: 12.3 per 100,000 p-yrs in 2004 to 14.1 per 100,000 p-yrs in 2008 **(data not shown)**.

The crude overall incidence rate was 3.3-times higher among females (32.0 per 100,000 p-yrs) than males (9.6 per 100,000 p-yrs) and increased monotonically with age; the rate was more than 12-times higher among service members older than 40 (26.9 per 100,000 p-yrs) compared to those younger than 20 (2.1 per 100,000 p-yrs) years **(Table 1)**.

The overall incidence rate (unadjusted) was higher among black, non-Hispanic (18.3 per 100,000 p-yrs) than white, non-Hispanic (12.5 per 100,000 p-yrs), Hispanic (9.4 per 100,000 p-yrs) or "other" (8.4 per 100,000 p-yrs) racial-ethnic group members **(Table 1)**. Overall, incidence rates were 15 percent and 27 percent higher among black, non-Hispanic than white, non-Hispanic males and females, respectively; the rates and relationships among black, non-Hispanic and white, non-Hispanic males and females were consistent throughout the period **(Figure 1)**. Among the Services, incidence rates (unadjusted) of MS were relatively high in the Air Force and Coast Guard, intermediate in the Army and Navy, and low in the Marine Corps **(Table 1, Figure 2)**.

During the surveillance period there was no clear relationship between birth month or season and MS diagnoses **(data not shown)**. Also, there was no apparent North to South gradient of MS incidence rates (based on the states military members entered into service) **(Figure 3)**.

Slightly more than one-third (n=661; 36%) of all case-defining medical encounters occurred within 30 days of an initial MS-related encounter; a similar proportion (n=646; 35%) of all case-defining medical encounters occurred more than 180 days after an initial MS-related encounter **(Figure 4)**. Approximately one-third of all cases (n=604) served in Operation Iraqi Freedom or Operation Enduring Freedom prior to their MS diagnosis **(data not shown)**.

Editorial comment:

This report documents a crude overall incidence rate of MS diagnoses among active component U.S. military members of 12.9 per 100,000 p-yrs. The crude incidence rate reported here is similar to that estimated in the general population of Scotland (12.0 per 100,000 p-yrs) and higher than those estimated in general populations of Minnesota (7.4 per 100,000 p-yrs) and several countries of western Europe (range of incidence rate estimates: 0.8-8.5 per 100,000 p-yrs).[13]

Differences in estimates of MS incidence rates between U.S. military and various general populations should be interpreted very carefully. For example, there are differences across the studies in the demographic characteristics of the populations of interest (e.g., age, gender, race-ethnicity), case-defining diagnostic criteria, the availability of relevant clinical records, and the reliability of recorded diagnoses. Specifically, the U.S. military consists of young and middle-aged adults (the age range of most first presentations of MS) while general populations include all age groups (some with very low risk of first MS clinical presentations); the U.S. military is predominately male (with a lower MS risk than females) while general populations are gender neutral; the U.S. military is more racially diverse than the general populations of Minnesota, Scotland, and most western European countries.

Figure 1. Incidence rates of multiple sclerosis by gender and race, active component, U.S. Armed Forces, 2000-2009

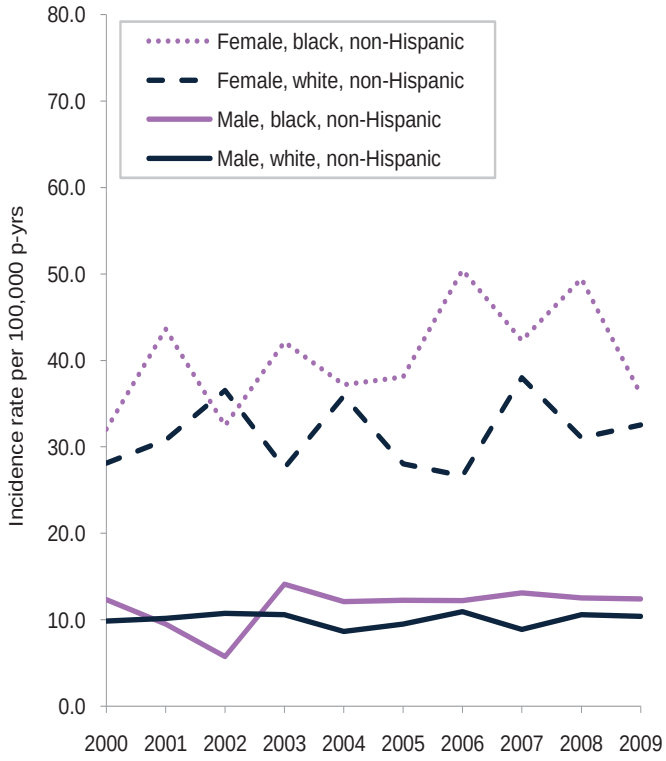
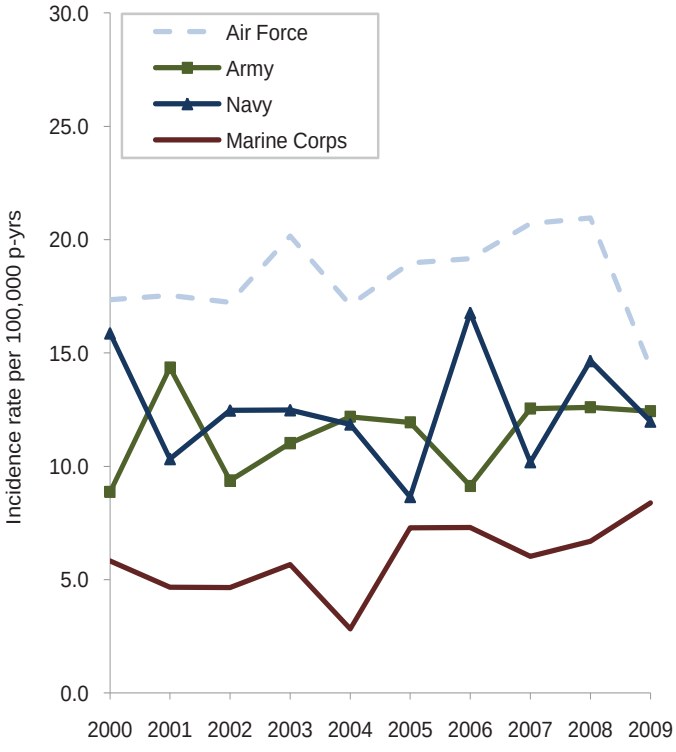
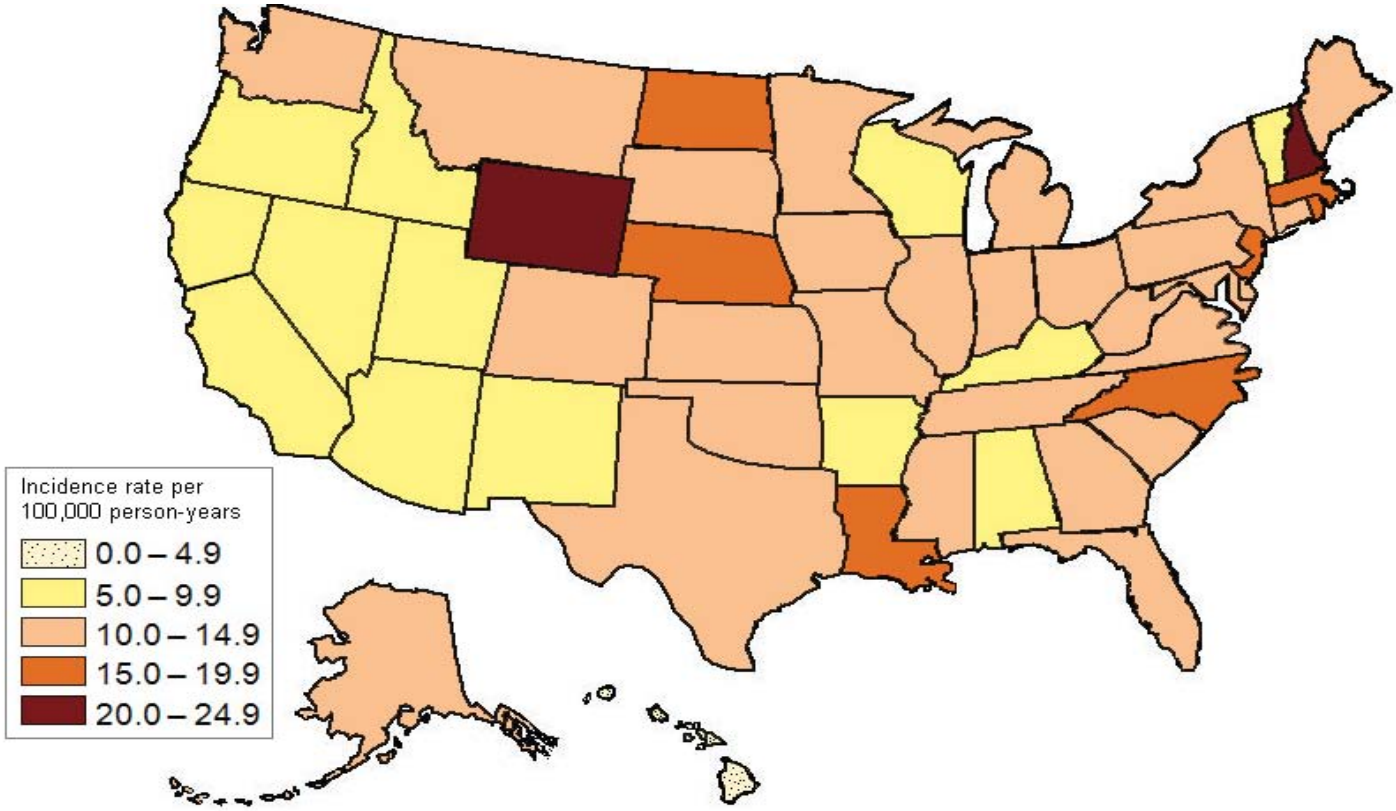


Figure 2. Incidence rates of multiple sclerosis by service[a], active component, U.S. Armed Forces, 2000-2009



[a]Coast Guard rates not shown due to low counts and unstable rates

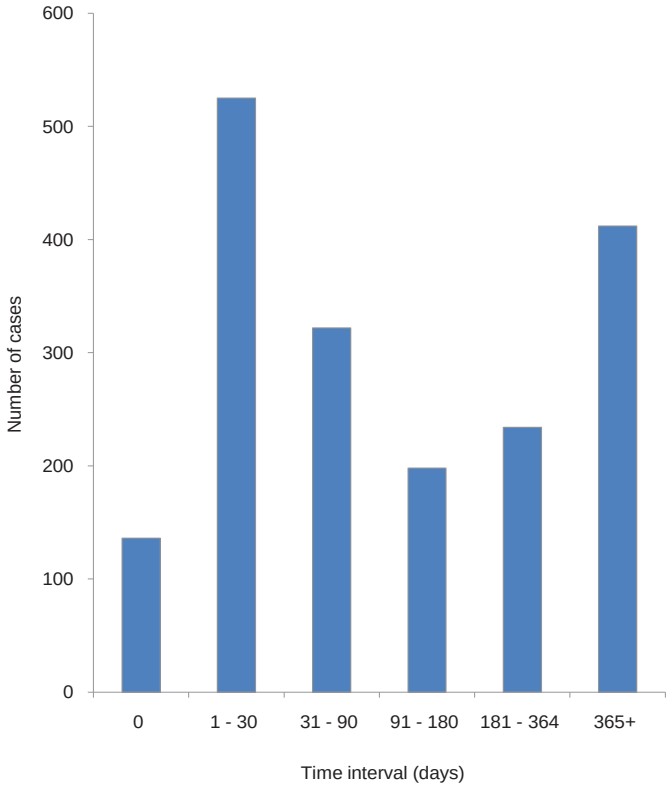
Figure 3. Incidence rates per 100,000 person-years of multiple sclerosis by state, active component, U.S. Armed Forces, 2000-2009



The MS incidence rate among U.S. military members was remarkably stable throughout the ten-year surveillance period. The finding suggests primary causes of MS and factors that precipitate its initial clinical expressions were not significantly influenced by physical or mental stresses or environmental exposures associated with military service during this period of sustained war fighting.

In this report, the incidence rate of MS was 1.5 times higher among black, non-Hispanic than white, non-Hispanic service members. To our knowledge, the finding has not been reported previously. U.S. military members are a racially diverse group of young and middle aged adults; their health status is systematically monitored (e.g., mandatory periodic medical examinations), and they have access to "free" health care. In contrast, most other studies of MS incidence have focused on predominately white, non-Hispanic general populations; as such, it is possible that this analysis revealed a race-ethnicity associated risk of MS that has not been observable by previous investigators. The finding of this report is interesting but not conclusive. Other studies are indicated to determine, for example, if the finding is generalizable to other racial-ethnically diverse populations; if there are differences in the clinical presentations (e.g., case-defining signs and symptoms) or clinical courses (e.g., number, periodicity, nature, and severity of exacerbations) of surveillance-based cases among black, non-Hispanic

Figure 4. Time interval between initial diagnosis and case-defining diagnosis among cases, active component, U.S. Armed Forces, 2000-2009



and white, non-Hispanic service members; if the apparent increase in risk is confounded by other differences between black, non-Hispanic and white, non-Hispanic military members (e.g., age, gender, service, medical history).

In this analysis, the incidence rate among females was 3.3 times higher than among males. The finding is consistent with other studies and reviews regarding gender-specific incidence of MS; also, it reflects the increased risk of autoimmune diseases in general among females.[14,15] Similarly, the relatively high incidence rates of MS among the oldest (>34 years) military members are consistent with current views regarding the typical pathogenesis of MS in adults.

Among the Services, differences in incidence rates of MS reflect differences in their age and gender compositions. For example, the Air Force has a higher proportion of females and is relatively older than the other services. Older age and female gender are correlates of risk of incident MS diagnosis; hence, it is not surprising that crude (unadjusted) incidence rates of MS are higher in the Air Force than the other services. Differences in diagnostic practices across the Services (e.g., natures and frequencies of medical examinations) may also affect service-specific rates.

Individuals who were diagnosed with MS during military service resided in all 50 states and many U.S. territories and foreign countries prior to their service. In this analysis, there were no apparent relationships between MS incidence rates and either states recorded as homes-of-record or birth months. The data used in this analysis may not have been accurate proxies for birth state or *in utero* vitamin D exposure. Also, actual relationships may not have been detectable because of the relatively small number of MS cases and the relatively narrow range of latitudes represented by the continental U.S. Of note, the association between latitude and MS risk is tenuous and has been under recent scrutiny. It is possible that the association is weakening or nonexistent.[14,16]

There is significant variability and a wide range of time intervals from initial MS-related clinical encounters to case-defining encounters among active military members. Unlimited "free" access to care in this population enables individuals with provisional diagnoses of MS to be closely monitored for clinical exacerbations. The wide variability of times from initial to subsequent MS-related clinical presentations reflects the natural history of MS. The course is often indolent, and exacerbations occur irregularly; intervals between exacerbations may be several months to years.

Finally, the findings in this report should be interpreted with consideration of its limitations. For example, cases were determined exclusively based on ICD-9-CM diagnostic codes reported on electronic medical records. MS is a clinical diagnosis with no confirmatory laboratory or radiologic tests; as such, it can be difficult to diagnose. If many provisional or "rule-out" diagnoses were reported with MS-specific diagnosis codes, the actual incidence rate of MS in military members would be overestimated in this report. Similarly, incidence could be underestimated if active component members sought medical care from sources other than the military health system or purchased care providers; if clinical manifestations of MS were not identified as MS-related or not reported with MS-specific diagnosis codes; or if affected individuals terminated their military service after a single MS diagnosis. The surveillance case definition used here was designed to identify as many "true cases" of MS as possible while limiting the number of "false possible" cases; the reliability of the case ascertainment method is unknown.

Reported by: LCDR Eric Deussing, MC (FS), USN

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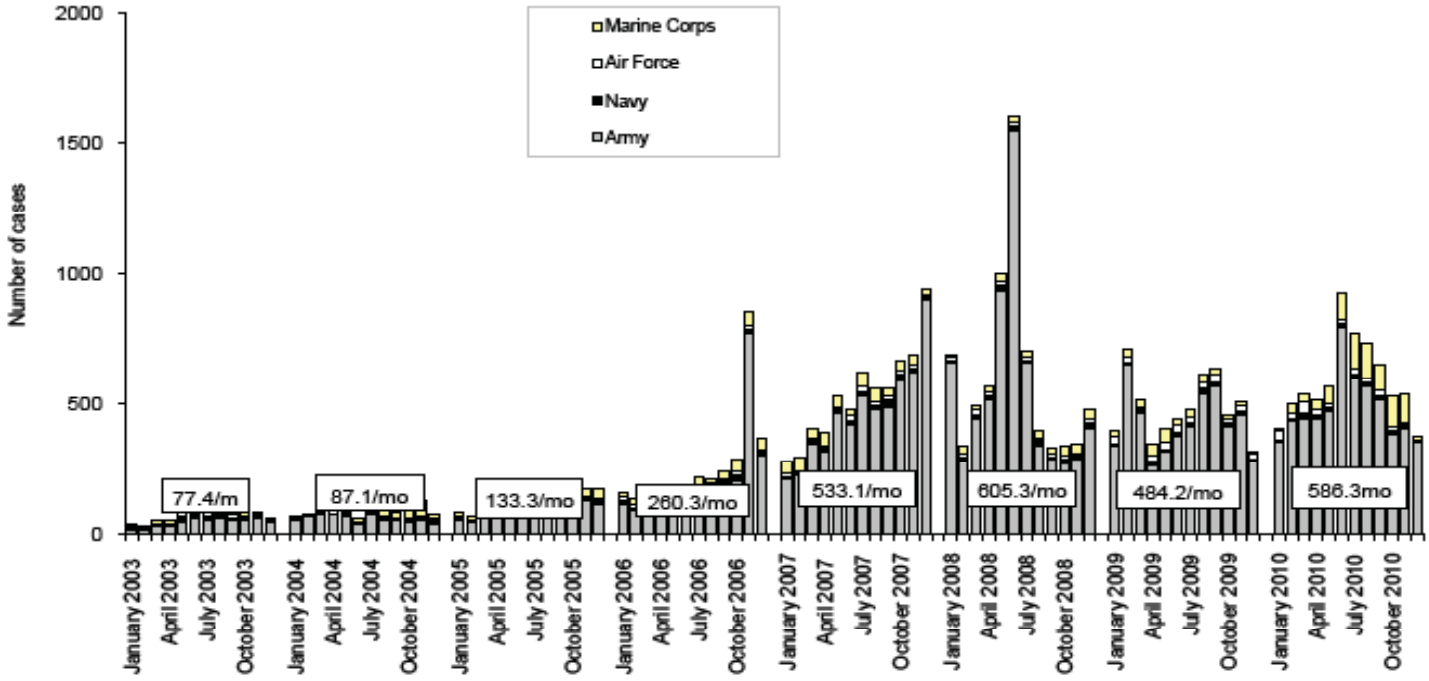
Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - December 2010 (data as of 29 January 2011)

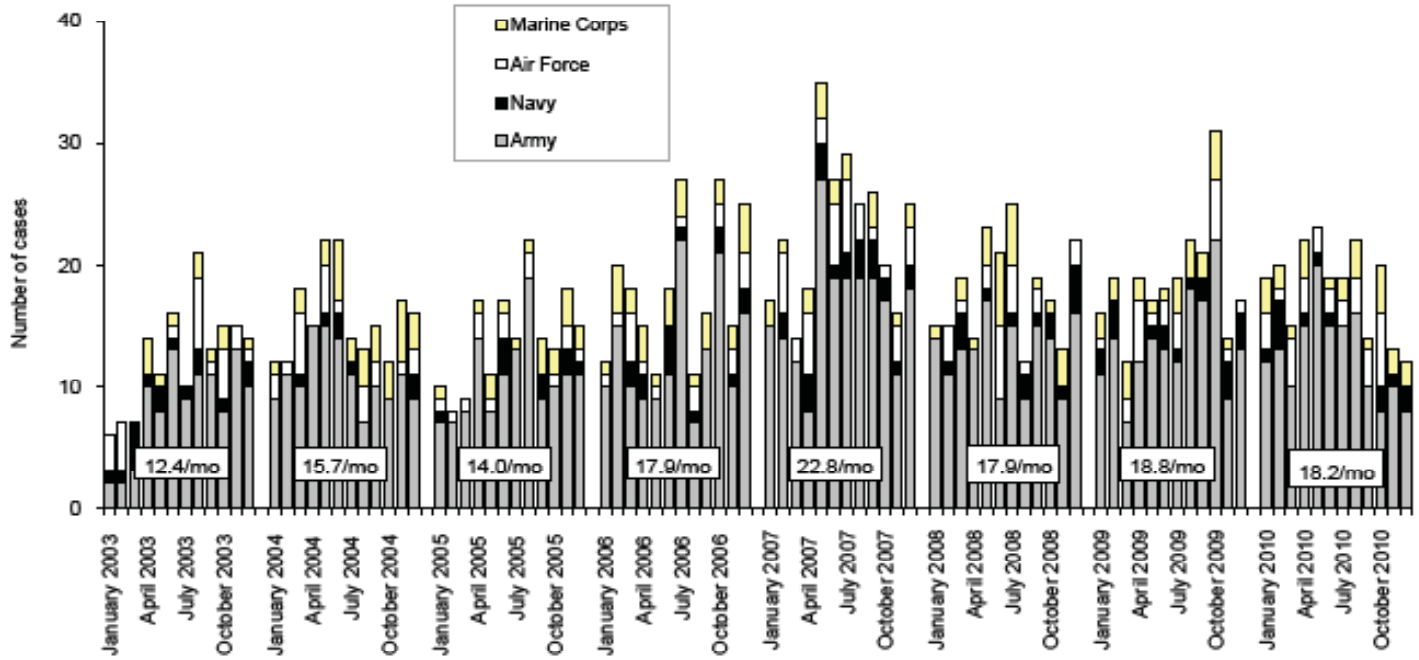
Traumatic brain injury (ICD-9: 310.2, 800-801, 803-804, 850-854, 907.0, 950.1-950.3, 959.01, V15.5_1-9, V15.5_A-F, V15.59_1-9, V15.59_A-F)[a]



Reference: Armed Forces Health Surveillance Center. Deriving case counts from medical encounter data: considerations when interpreting health surveillance reports. *MSMR*. Dec 2009; 16(12):2-8.

[a]Indicator diagnosis (one per individual) during a hospitalization or ambulatory visit while deployed to/within 30 days of returning from OEF/OIF. (Includes in-theater medical encounters from the Theater Medical Data Store [TMDS] and excludes 2,590 deployers who had at least one TBI-related medical encounter any time prior to OEF/OIF).

Deep vein thrombophlebitis/pulmonary embolus (ICD-9: 415.1, 451.1, 451.81, 451.83, 451.89, 453.2, 453.40 - 453.42 and 453.8)[b]

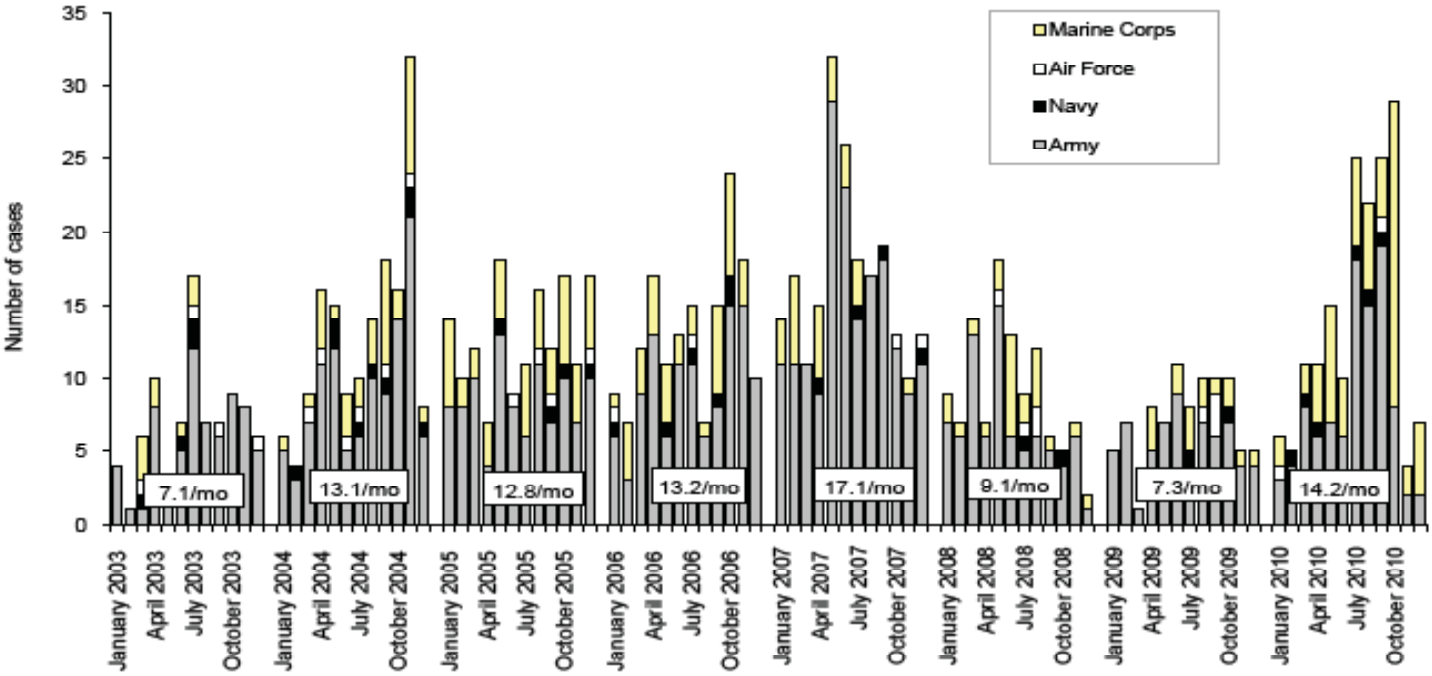


Reference: Isenbarger DW, Atwood JE, Scott PT, et al. Venous thromboembolism among United States soldiers deployed to Southwest Asia. *Thromb Res*. 2006;117(4):379-83.

[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 OEF/OIF.

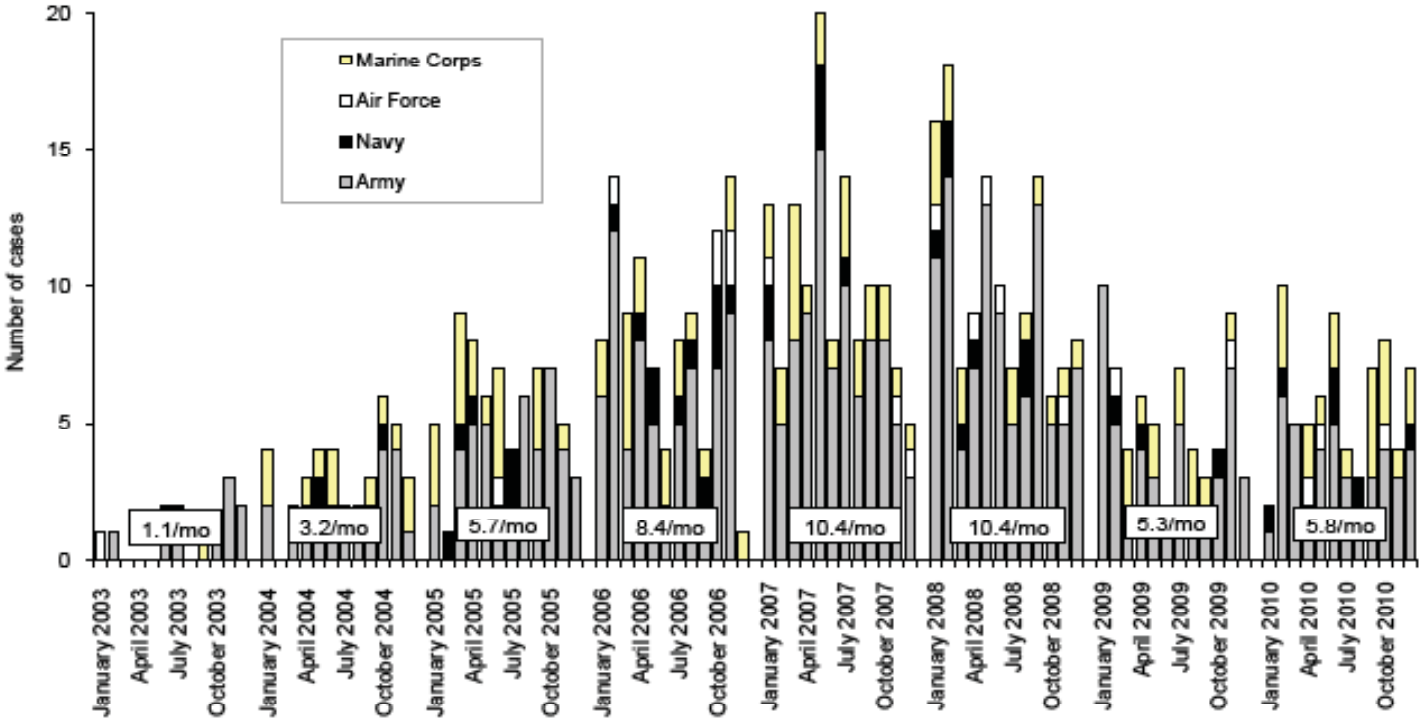
Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - December 2010 (data as of 29 January 2011)

Amputations (ICD-9: 887, 896, 897, V49.6 except V49.61-V49.62, V49.7 except V49.71-V49.72, PR 84.0-PR 84.1, except PR 84.01-PR 84.02 and PR 84.11)[a]



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*. Jan 2005;11(1):2-6.
[a]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 365 days of returning from OEF/OIF.

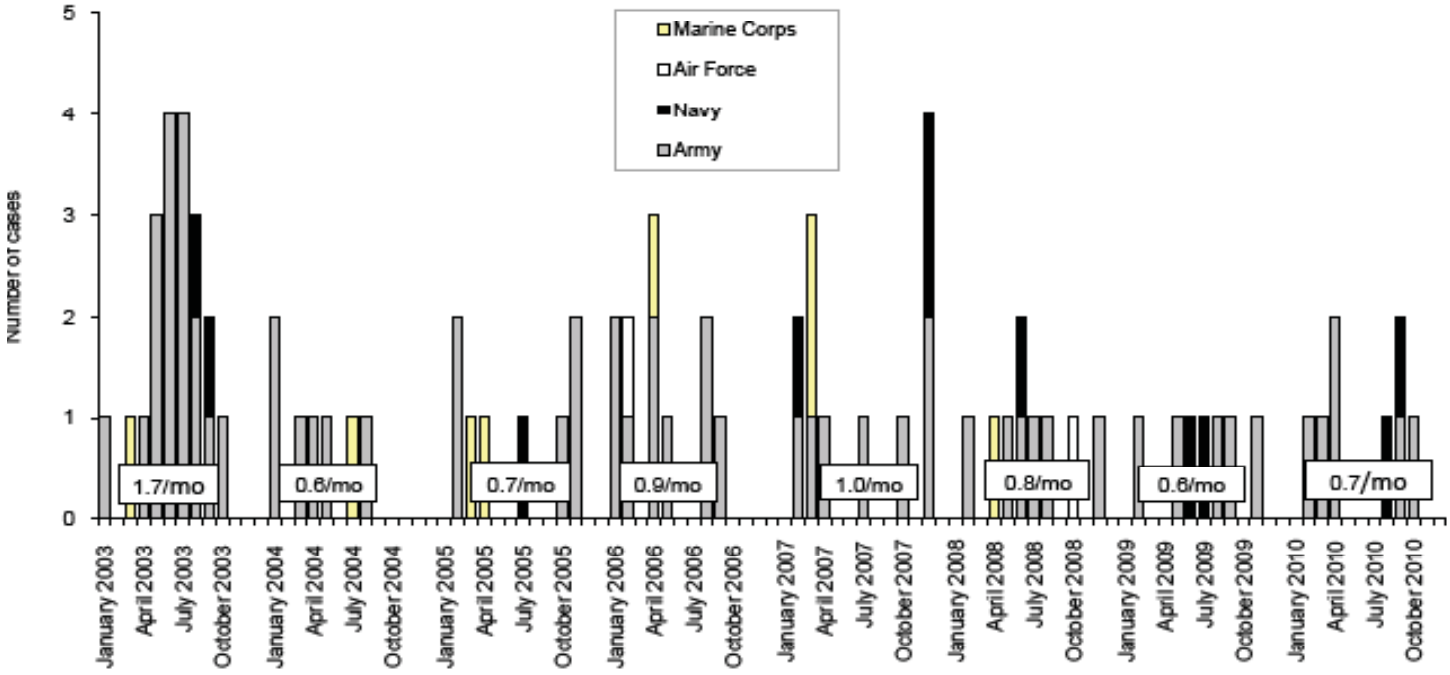
Heterotopic ossification (ICD-9: 728.12, 728.13, 728.19)[b]



Reference: Army Medical Surveillance Activity. Heterotopic ossification, active components, U.S. Armed Forces, 2002-2007. *MSMR*. Aug 2007; 14(5):7-9.
[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 OEF/OIF.

Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - December 2010 (data as of 29 January 2011)

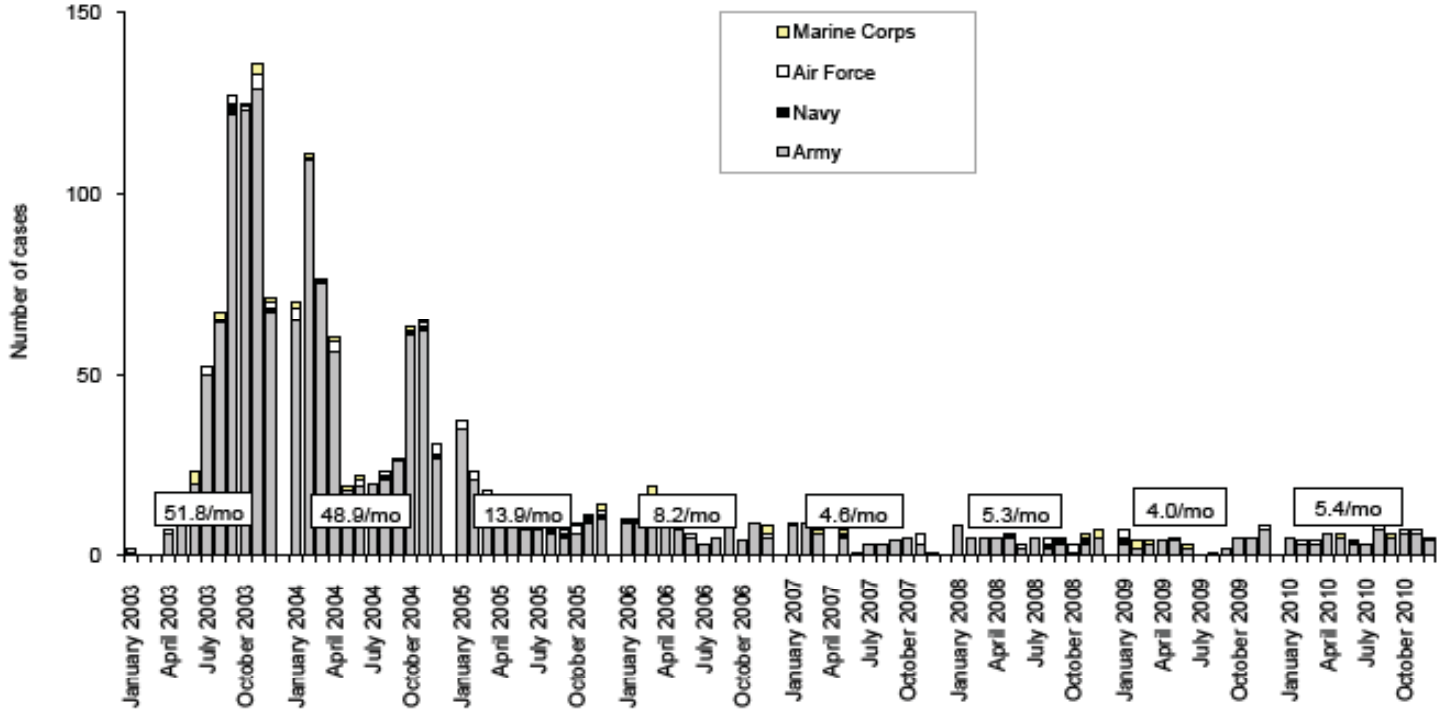
Severe acute pneumonia (ICD-9: 518.81, 518.82, 480-487, 786.09)[a]



Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: severe acute pneumonia. Hospitalizations for acute respiratory failure (ARF)/acute respiratory distress syndrome (ARDS) among participants in Operation Enduring Freedom/Operation Iraqi Freedom, active components, U.S. Armed Forces, January 2003-November 2004. *MSMR*. Nov/Dec 2004;10(6):6-7.

[a]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 30 days of returning from OEF/OIF.

Leishmaniasis (ICD-9: 085.0 to 085.9)[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*. Nov/Dec 2004;10(6):2-4.

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

Notices to Readers:

Sentinel reportable medical events, active component, U.S. Armed Forces, cumulative numbers through December 2009 and December 2010

Annual summaries of reportable medical events in CY 2010 will be published in a future MSMR issue.

Update: Deployment health assessments, U.S. Armed Forces

The monthly deployment health assessments update has been moved to the AFHSC website and will no longer appear in the MSMR. It has been posted at: http://www.afhsc.mil/deploymentHealth.

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