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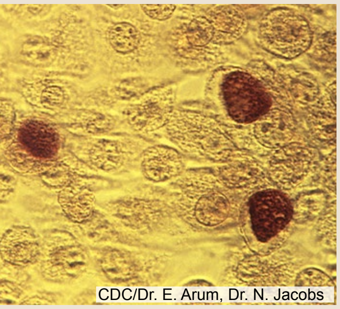

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Update: Malaria, U.S. Armed Forces, 2016

Malaria infection remains an important health threat to U.S. service members who are located in endemic areas because of long-term duty assignments, participation in shorter-term contingency operations, or personal travel. In 2016, a total of 57 service members were diagnosed with or reported to have malaria, which is the highest number of cases since 2011 (n=124). The relatively low numbers of cases during 2012–2016 mainly reflect decreases in cases acquired in Afghanistan, a reduction due largely to the progressive withdrawal of U.S. forces from that country. The percentage of cases of malaria caused by *Plasmodium vivax* (26.3%; n=15) in 2016 was the highest since 2012. The percentages of cases caused by *P. falciparum* (45.6%; n=26), by *P. malariae* and *P. ovale* (3.5%, n=2), and by unspecified agents (24.6%; n=14) remained similar to those of the preceding 4 years. Malaria was diagnosed at or reported from 25 different medical facilities in the U.S., Afghanistan, Germany, Korea, Djibouti, and Oman. Providers of medical care to military members should be knowledgeable of, and vigilant for, clinical manifestations of malaria outside of endemic areas.

Despite global reductions in malaria incidence and mortality rates in recent years, malaria remains one of the most severe public health problems worldwide. Malaria is endemic throughout most of the tropics; 95 countries and territories have ongoing transmission.[1] The World Health Organization estimated that there were 214 million cases of symptomatic malaria worldwide in 2015.[1] Between 2010 and 2015, the incidence of malaria decreased by 21% globally and malaria mortality rates among populations at risk fell 29% worldwide.[1] As a result of international efforts to control malaria during the past decade, many countries have reported substantial reductions in the numbers of malaria cases and deaths.[2] The majority of these cases and deaths are due to mosquito-transmitted *Plasmodium falciparum* and occur in sub-Saharan Africa among children under 5 years of age, but *P. vivax*, *P. ovale*, and *P. malariae* can also cause severe disease.[1,2] About 4% of estimated cases globally are due to *P. vivax*, but outside the African continent the proportion of *P. vivax* infections is approximately 41%.[1]

Since 1999, the *MSMR* has published periodic updates on the incidence of malaria among U.S. service members.[3-5] The *MSMR*'s focus on malaria reflects both historical lessons learned about this mosquito-borne disease and the continuing threat that it poses to military operations and service members' health. Malaria infected many thousands of service members during World War II (approximately 695,000 cases), the Korean War (approximately 390,000 cases), and the conflict in Vietnam (approximately 50,000 cases).[6,7] More recent military engagements in Africa, Asia, Southwest Asia, the Caribbean, and the Middle East have necessitated heightened vigilance, preventive measures, and treatment of cases.[8-16] In the planning for overseas military operations, the geography-based presence or absence of the malaria threat is usually known and can be anticipated. However, when preventive countermeasures are needed, their effective implementation is multifaceted and depends on the provision of protective equipment and supplies, individuals' understanding of the threat and attention to personal protective measures, treatment of malaria cases, and medical surveillance. The U.S. Armed Forces have long had policies and prescribed countermeasures effective against vector-borne diseases such as malaria, including chemoprophylactic drugs, permethrin-impregnated uniforms and bed nets, and topical insect repellents containing *N,N*-diethyl-*meta*-toluamide (DEET). When cases and outbreaks of malaria have occurred, they generally have been due to poor adherence to chemoprophylaxis and other personal preventive measures.[9–12]

The past four *MSMR* malaria updates documented that the annual case counts among service members after 2011 were the lowest in more than 15 years.[5,17-19] In particular, these updates showed that the numbers of cases associated with service in Afghanistan had fallen sharply in the past 4 years, presumably due to the dramatic reduction in the numbers of service members serving there. This update for 2016 uses methods similar to those employed in previous analyses to describe the epidemiologic patterns of malaria incidence in active and reserve component service members of the U.S. Armed Forces.

METHODS

The surveillance period was 1 January 2007 through 31 December 2016. The surveillance population included active and reserve component members of the U.S. Armed Forces. The Defense Medical Surveillance System (DMSS) was searched to identify reportable medical events and hospitalizations (in military and nonmilitary facilities) that included diagnoses of malaria. A case of malaria was defined as an individual with 1) a reportable medical event record of confirmed malaria; 2) a hospitalization record with a primary diagnosis of malaria; 3) a hospitalization record with a non-primary diagnosis of malaria due to a specific *Plasmodium* species; 4) a hospitalization record with a non-primary diagnosis of malaria plus a diagnosis of anemia, thrombocytopenia and related conditions, or malaria complicating pregnancy 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)[20] in each diagnostic position antecedent to malaria. The relevant ICD-9 and ICD-10 codes are shown in **Table 1**. Malaria diagnoses that were recorded only in the records of outpatient encounters (i.e., not hospitalized or reported as a notifiable event) were not considered case-defining for this analysis.

This analysis 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 algorithm: 1) cases hospitalized in a malarious country were considered acquired in that country; 2) 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 to a malarious country were considered acquired in that country; and 4) cases diagnosed among service members who had been deployed to Afghanistan or Korea within 2 years prior to diagnosis were considered acquired in those respective countries. The remaining cases with unknown locations were matched within a 14-day window to malaria case data from the Disease Reporting System Internet (DRSi). Cases with a malarious country of origin listed in the case report were considered acquired in that country. All remaining cases were considered acquired in unknown locations.

TABLE 1. ICD-9 and ICD-10 codes used in defining cases of malaria from the records for inpatient encounters (hospitalizations)

	ICD-9 codes	ICD-10 codes
Malaria (*Plasmodium* species)		
P. falciparum	84.0	B50
P. vivax	84.1	B51
P. malariae	84.2	B52
P. ovale	84.3	B53.0
Unspecified	84.4, 84.5, 84.6, 84.8, 84.9	B53.1, B53.8, B54
Anemia	280–285	D50–D53, D55–D64
Thrombocytopenia	287	D69
Malaria complicating pregnancy	647.4	O98.6
Signs, symptoms, or other abnormalities consistent with malaria	276.2, 518.82, 584.9, 723.1, 724.2, 780.0, 780.01, 780.02, 780.03, 780.09, 780.1, 780.3, 780.31, 780.32, 780.33, 780.39, 780.6, 780.60, 780.61, 780.64, 780.65, 780.7, 780.71, 780.72, 780.79, 780.97, 782.4, 784.0, 786.05, 786.09, 786.2, 786.52, 786.59, 787.0, 787.01, 787.02, 787.03, 787.04, 789.2, 790.4	E87.2, J80, M54.2, M54.5, N17.9, R05, R06.0, R06.89, R07.1, R07.81, R07.82, R07.89, R11, R11.0, R11.1, R11.2, R16.1, R17, R40, R41.0, R41.82, R44, R50, R51, G44.1, R53, R56, R68.0, R68.83, R74.0

RESULTS

In 2016, a total of 57 service members were diagnosed with or reported to have malaria **(Table 2)**, which is the highest number of cases since 2011(n=124) **(Figure 1)**. The percentage of cases of malaria caused by *P. vivax* (26.3%; n=15) in 2016 was the highest since 2012, while the percentages of cases caused by *P. falciparum* (45.6%; n=26) and other or unspecified agents (24.6%; n=14) remained similar to those of the preceding 4 years **(Figure 1)**. In addition, there were single cases of malaria due to *P. ovale* and *P. malariae* (1.8% each) during the year.

Similar to 2015, most U.S. military members diagnosed with malaria in 2016 were male (89.5%), active component members (84.2%), in the Army (80.7%), and in their 20s (52.6%) **(Table 2)**.

Of the 57 malaria cases in 2016, 36.8% of the infections were considered to have been acquired in Africa (n=21); 19.3% (n=11) in Korea; and 15.8% (n=9) in Afghanistan **(Figure 2)**. There was one case of *P. falciparum* malaria identified from South/Central America (Dominican Republic) in 2016. The single cases of malaria due to *P. ovale* and *P. malariae* were reported to have been acquired in Afghanistan. One of the remaining 15 malaria cases was reported to have been acquired in Oman ("other"). No specific geographic location could be discerned from the available documentation for the rest of the cases (n=14; "unspecified"). Of the 21 malaria infections considered acquired in Africa, five were linked to Cameroon, three to Djibouti, one to Gabon, two to Ghana, one to Morocco, two to Nigeria, one to Sudan, and six could not be linked to a specific country **(data not shown)**.

During 2016, malaria cases were diagnosed or reported from 25 different medical facilities in the U.S., Afghanistan, Germany, Korea, Djibouti, and Oman **(Table 3)**. Slightly less than a quarter of cases were reported from or diagnosed outside the U.S., which is a drop from the almost one-half (46.7%) of cases in this category in 2015. The largest number of malaria cases associated with a single medical facility during the year was 10 at Carl R. Darnall Army Medical Center at Fort Hood, TX.

The number of Africa-acquired cases (n=21) in 2016 was slightly higher than in

TABLE 2. Malaria cases by *Plasmodium* species and selected demographic characteristics, U.S. Armed Forces, 2016

	P. vivax	*P. falciparum*	Unspecified or other[a]	Total	% of total
Component					
Active	14	21	13	48	84.2
Reserve/Guard	1	5	3	9	15.8
Service					
Army	14	17	15	46	80.7
Navy	1	2	0	3	5.3
Air Force	0	6	1	7	12.3
Marine Corps	0	1	0	1	1.8
Sex					
Male	15	25	11	51	89.5
Female	0	1	5	6	10.5
Age group					
20–24	5	5	4	14	24.6
25–29	4	8	4	16	28.1
30–34	4	9	4	17	29.8
35–39	0	2	1	3	5.3
40–44	1	1	1	3	5.3
45–49	1	1	1	3	5.3
50+	0	0	1	1	1.8
Race/ethnicity					
White, non-Hispanic	11	10	8	29	50.9
Black, non-Hispanic	2	12	6	20	35.1
Other	2	4	2	8	14.0
Total	15	26	16	57	100.0

[a]Includes one case of *P. ovale* and one case of *P. malariae*

2014 (n=19) and 2015 (n=12) but lower than what was reported in 2009 through 2010 (range 25–33 cases) **(Figure 2)**. The number of Afghanistan-acquired cases (n=9) was higher than in 2015 (n=2) but similar to 2014 (n=7). The number of cases acquired in Korea (n=11) was also higher than in 2015 (n=8) but similar to what was reported in 2014 (n=10). Since 2012, the proportion of cases acquired in Korea and Africa generally increased while the proportion of cases acquired in Afghanistan decreased until 2015 and then increased in 2016 **(Figure 2)**.

During the entire period of 2007–2016, most cases were diagnosed or reported during the 6 months from the middle of spring to the middle of autumn in the northern hemisphere **(Figure 3)**. In 2016, 71.9% (41 of 57) of malaria cases among U.S. service members were diagnosed during May–October. This proportion is similar to the 71.0 % (493 of 694) of cases diagnosed during the same 6-month intervals over the entire 10-year surveillance period. During the past 10 years, the proportions of malaria cases diagnosed or reported during May–October varied by region of acquisition: Korea (93.7%); Afghanistan (78.2%); Africa (56.2%); and South/Central America (50.0%) **(data not shown)**.

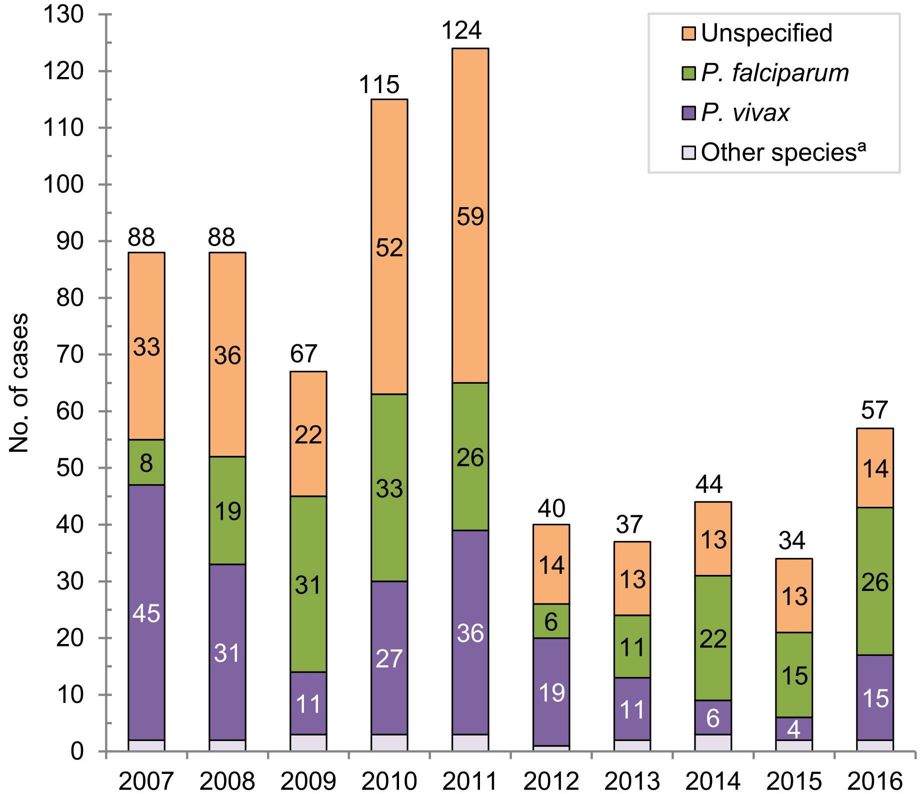
EDITORIAL COMMENT

MSMR annual reports on malaria incidence among all U.S. services began in 2007. Those reports show that the lowest annual numbers of cases during 2001–2016 were seen in 2012–2015 and reached a nadir of 34 in 2015. Most of the marked decline in the past 5 years is attributable to the decrease in numbers of malaria cases associated with service in Afghanistan. The dominant factor in that trend has undoubtedly been the progressive withdrawal of U.S. forces from that country. This report also documents the fluctuating incidence of acquisition of malaria in Africa and Korea among U.S. military members during the past decade. Although the predominant species of malaria in Korea and Afghanistan has been *P. vivax*, the more dangerous *P. falciparum* species is of primary concern in Africa. The planning and execution of military operations on that continent must incorporate actions to counter the threat of infection by that potentially deadly parasite wherever it is endemic. The 2014–2015 employment of U.S. service members to aid in the response to the Ebola virus outbreak in West Africa is an example of an operation where the risk of *P. falciparum* malaria was significant. Individual service members must be diligent in protecting themselves from biting mosquitoes by taking prescribed chemoprophylactic drugs and adhering to personal protective measures.

The finding that *P. falciparum* malaria was diagnosed in nearly half of the cases in 2016 highlights the need for continued emphasis on prevention of this disease, given its potential severity and risk of death. Although the case count for *P. falciparum* may be largely explained by infections acquired in Africa, the absence of data about the geographic locations of acquisition for 14 cases precludes a firm conclusion about that possibility. The striking decline in cases associated with service in Afghanistan, where *P. vivax* predominates, allowed *P. falciparum* to account for the highest proportion of cases in 2016. The 15 cases of *P. vivax* in 2016 represented the highest annual count of cases due to that species since 2012.

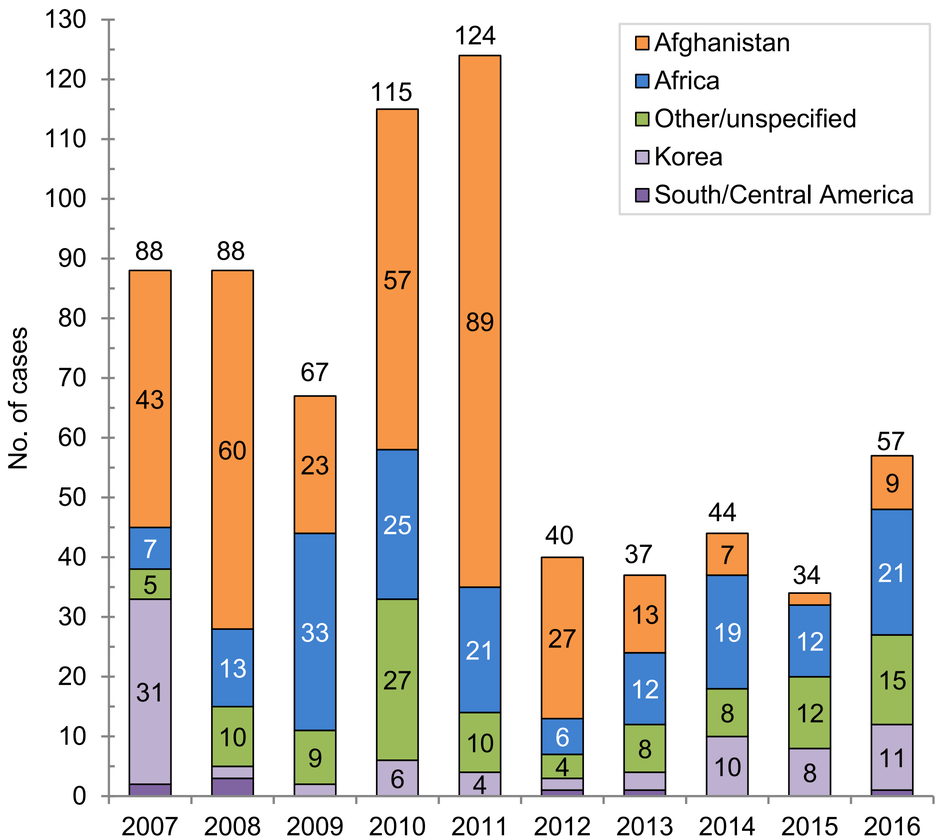
The observations about the seasonality of diagnoses of malaria are compatible with the presumption that the risk of acquiring and developing symptoms of malaria in a temperate climatic zone of the northern hemisphere would be greatest during May–October. Given the typical incubation periods of malaria infection (approximately 9–14 days for *P. falciparum*, 12–18

FIGURE 1. Malaria cases among U.S. service members, by *Plasmodium* species and calendar year of diagnosis/report, 2007–2016



[a]Includes *P. ovale* and *P. malariae*

FIGURE 2. Annual numbers of cases of malaria associated with specific locations of acquisition, U.S. Armed Forces, 2007–2016



days for *P. vivax* and *P. ovale*, and 18–40 days for *P. malariae*)[20] and the seasonal disappearance of biting mosquitoes during the winter, most malaria acquired in Korea and Afghanistan would be expected to cause symptoms during the warmer months of the year. However, it should be noted that studies of *P. vivax* malaria in Korea have found that the incubation period can be remarkably long, ranging from 1 to 18 months.[21] On the other hand, transmission of malaria in tropical regions such as sub-Saharan Africa is less subject to the limitations of the seasons in temperate climates but depends more on other factors affecting mosquito breeding such as the timing of the rainy season and altitude (below 2,000 meters).[22]

There are significant limitations to this report that should be considered when interpreting the findings. For example, the ascertainment of malaria cases is likely incomplete; some cases treated in deployed or non-U.S. military medical facilities may not have been reported or otherwise ascertained at the time of this analysis. A review of the series of *MSMR* updates on malaria reveals that the annual counts of cases for the most recent year have often been revised upward when the data analyses are repeated for subsequent updates. For example, this update reports 34 cases for 2015, but the original count in the update for that year reported 30 cases. Similarly, the original count of 38 cases for 2012 was revised upward to 40 cases the following year. It is possible that future analyses will find more than the 57 cases associated with 2016 reported in this update. Additionally, 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 acquisitions were estimated from reported relevant information. Some cases had reported exposures in multiple malarious areas, and others had no relevant exposure information. Personal travel to, or military activities in, malaria-endemic countries were not accounted for unless specified in notifiable event reports.

As in prior years, in 2016 most malaria

TABLE 3. Number of malaria cases by geographical locations of diagnosis or report and presumed location of acquisition, U.S. Armed Forces, 2016

	Presumed location of infection acquisition						
Location where diagnosed or reported from	Korea	Afghanistan	Africa	South/ Central America	Other or unknown location	Total for location of diagnosis or report	% of total 2016 cases
Fort Hood, TX	8	1	1	0	0	10	17.5
Fort Stewart, GA	0	0	4	0	1	5	8.8
Fort Bragg, NC	0	1	0	0	3	4	7.0
Fort Lewis, WA	1	0	3	0	0	4	7.0
Expeditionary Medical Support and Air Force Theater Hospital, Afghanistan	0	4	0	0	0	4	7.0
Fort Campbell, KY	0	1	2	0	0	3	5.3
Expeditionary Medical Facility, Djibouti	0	0	3	0	0	3	5.3
Location not reported	0	0	0	0	2	2	3.5
Fort Benning, GA	0	0	0	0	2	2	3.5
Walter Reed National Military Medical Center, MD	0	0	2	0	0	2	3.5
Landstuhl Regional Medical Center, Germany	0	0	1	0	1	2	3.5
Brian Allgood Army Community Hospital, Seoul, Korea	2	0	0	0	0	2	3.5
Naval Station San Diego, CA	0	0	1	0	0	1	1.8
10th Medical Group, Air Force Academy, CO	0	0	0	0	1	1	1.8
436th Medical Group, Dover AFB, DE	0	0	1	0	0	1	1.8
Tripler Army Medical Center, HI	0	0	1	0	0	1	1.8
Fort Knox, KY	0	0	0	1	0	1	1.8
Fort Polk, LA	0	1	0	0	0	1	1.8
Camp Lejeune, NC	0	0	0	0	1	1	1.8
75th Medical Group, Hill AFB, UT	0	0	1	0	0	1	1.8
Army Health Clinic, Fort Lee, VA	0	0	1	0	0	1	1.8
Army Health Clinic, Fort Stewart, GA	0	1	0	0	0	1	1.8
Naval Branch Health Clinic, LA	0	0	0	0	1	1	1.8
U.S. Office of Military Cooperation, Muscat, Oman	0	0	0	0	1	1	1.8
Fort Drum, NY	0	0	0	0	1	1	1.8
Army Health Clinic, Stuttgart, Germany	0	0	0	0	1	1	1.8
Total	11	9	21	1	15	57	

cases among U.S. military members were treated at medical facilities remote from malaria endemic areas. 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 among service members who are or were recently in malaria-endemic areas. Care providers should also be capable of diagnosing malaria (or have access to a clinical laboratory that is proficient in malaria diagnosis) and initiating treatment (particularly when *P. falciparum* malaria is clinically suspected).

Continued emphasis on standard malaria prevention protocols is warranted for all military members at risk of malaria. Personal protective measures against malaria include the proper wear of permethrin-treated uniforms and the use of permethrin-treated bed nets; the topical use of military-issued, DEET-containing insect repellent; and compliance with prescribed chemoprophylactic drugs before, during, and after times of exposure in malarious areas. Current Department of Defense guidance about medications for prophylaxis of malaria summarizes the roles of chloroquine, atovaquone-proguanil, doxycycline, mefloquine, and primaquine.[23]

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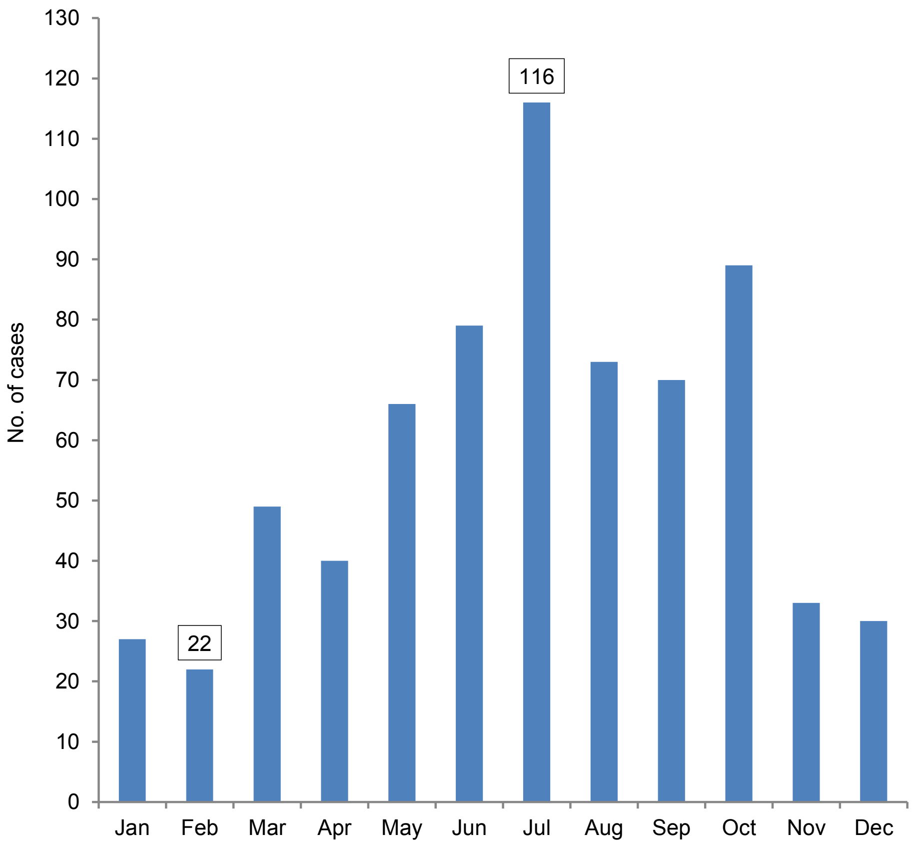
FIGURE 3. Cumulative numbers of diagnoses and reported cases of malaria, by month of clinical presentation or diagnosis, U.S. Armed Forces, January 2007–December 2016



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Diabetes Mellitus, Active Component, U.S. Armed Forces, 2008–2015

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From 2008 through 2015, a total of 9,092 incident cases of diabetes mellitus (DM) were reported among active component service members (incidence rate 82.8 cases per 100,000 person-years [p-yrs]). The overall incidence rate of type 1 DM was 3.0 cases per 100,000 p-yrs. The rate of type 2 DM was 74.5 cases per 100,000 p-yrs and rates doubled within each successive age group. Male service members had higher rates of both types of DM, compared to female service members. Black, non-Hispanic service members; service members of other or unknown race/ethnicity; and Hispanic service members had much higher rates of type 2 DM, compared to white, non-Hispanic service members. Rates of type 2 DM were highest among service members of the Army and the Navy, and lowest among Marine Corps members. Crude annual rates of type 2 DM peaked in 2010 and thereafter steadily decreased. During 2010–2015, decreases in rates of type 2 DM were observed for both sexes, those aged 25 years or older, all race/ethnicity groups, and all services except the Marine Corps. Potential explanations for these differences are discussed.

Diabetes mellitus (DM) is a group of chronic metabolic conditions characterized by high blood glucose levels resulting from a decreased ability to produce and/or use insulin. Over the long term, high blood glucose levels and other DM-related metabolic abnormalities are associated with damage to various organs and tissues.[1] Type 1 DM (previously called "insulin-dependent diabetes") is usually first diagnosed in children and young adults and is characterized by a severe impairment of insulin production. Type 2 DM (previously called "non-insulin-dependent diabetes") is the most common form (accounts for up to 95% of all diagnosed adult cases) and is usually diagnosed later in life.[1] Type 2 DM develops when there is an abnormal increased resistance to the action of insulin and the body is unable to produce enough insulin to overcome the resistance. Obesity and a sedentary lifestyle are key risk factors for type 2 DM.[2,3]

The annual numbers of new cases of diagnosed DM among adults aged 18 years or older in the general U.S. population decreased significantly from approximately 1.7 million in 2009 to about 1.4 million in 2014.[4] This decline in the number of new cases of diagnosed DM came after decades of increases.[4] Analysis of administrative data from the Military Health System (MHS) has indicated that, during 1997–2007, the incidence of DM among active duty service members was slightly lower and more stable than in the general U.S. population.[5] MHS data on DM prevalence for 2006–2010 showed a similar difference between active duty service members and the general U.S. population[6]; this difference is likely due to multiple factors including military weight and fitness standards, access to free health care, and mandatory medical examinations.

DM of any type is a disqualifying condition for entry into U.S. military service[7]; still, hundreds of service members are diagnosed with DM annually. This report estimates frequencies, incidence rates, trends, and correlates of risk of clinical diagnoses of DM among all active component service members of the U.S. military during the 8 years of 2008–2015.

METHODS

The surveillance period was 1 January 2008 through 31 December 2015. The surveillance population included all individuals who served in the active component of the Army, Navy, Air Force, and Marine Corps at any time during the surveillance period.

Cases of DM were ascertained from administrative healthcare records routinely maintained in the Defense Medical Surveillance System (DMSS). For this analysis, an incident case was defined as an individual with records of two or more medical encounters, hospitalization or outpatient, occurring within 90 days of each other, with any of the defining diagnoses of type 1 or type 2 DM in the primary diagnostic position (ICD-9: 250.00–250.99; ICD-10: E10–E11). Individuals were classified as cases of type 1 or type 2 based on the diagnoses reported in the two case-defining encounters. Type 1 cases were defined as having ICD-9 code fifth digit as 1 or 3, or having an ICD-10 code of E10. Type 2 individuals were classified as having an ICD-9 code fifth digit of 0 or 2, or an ICD-10 code of E11. If a type 1 DM diagnosis was recorded in one encounter and a type 2 diagnosis was recorded in a second encounter, then the individual was classified as an unspecified case.

Each individual was considered an incident case only once during the surveillance period and person-time was censored at the time of incident case diagnosis. For women with a diagnosis of gestational DM (ICD-10: O244) and women hospitalized for labor and delivery within 6 months of an incident diagnosis of DM, those diagnoses were not counted as incident cases because of the transient nature of gestational DM. However, such women could meet the case definition of DM at a later time if there was no documentation of labor or delivery within 6 months.

For these analyses, annual crude incidence rates were calculated by dividing the number of incident DM cases by the total person-time of active component service members during each year, overall, and for each demographic and military subgroup of interest. Cases of DM that occurred before the start of the surveillance period were excluded.

RESULTS

During 2008–2015, a total of 9,092 incident cases of DM were reported among active component service members. The crude overall incidence rate of diagnoses of any type of DM was 82.8 cases per 100,000 person-years (p-yrs) **(Table)**. The majority (90.0%) of incident DM cases were type 2; 3.6% were type 1; and 6.4% were not consistently reported as type 1 or type 2 ("unspecified") **(Table)**.

During the 8-year surveillance period, there were 327 incident cases of type 1 DM (mean number of cases per year: 41). The crude overall incidence rate for this type of DM was 3.0 cases per 100,000 p-yrs **(Table)**. The overall incidence rate of type 1 DM was slightly higher among Marine Corps members than among members of the other services and the overall rate among service men was twice as high as that among service women. Black, non-Hispanic and white, non-Hispanic service members had higher rates than service members of Hispanic ethnicity and those of other/unknown race/ethnicity **(Table)**.

A total of 8,181 incident cases of type 2 DM (mean number of cases per year: 1,023) were reported during the surveillance period. The crude overall incidence rate for this type of DM was 74.5 cases per 100,000 p-yrs **(Table)** and rates doubled within each successive age group. Male service members had a higher crude overall incidence rate of type 2 DM, compared to female service members. Service members who were black, non-Hispanic; of other or unknown race/ethnicity; or Hispanic had much higher rates of type 2 DM, compared to service members who were white, non-Hispanic. Crude overall incidence rates of type 2 DM were highest among service members in the Army (96.1 cases per 100,000 p-yrs) and the Navy (87.9 cases per 100,000 p-yrs), and lowest among Marine Corps members (20.3 cases per 100,000 p-yrs) **(Table)**.

Throughout the surveillance period, crude annual incidence rates of type 1 DM were relatively low and stable. The annual rates of type 2 DM peaked at 90.6 cases per 100,000 p-yrs in 2010 and thereafter steadily decreased to a low of 58.3 cases per 100,000 p-yrs in 2015 **(Figure 1)**. During 2010–2015, decreases in crude annual rates of type 2 DM were observed for both males and females **(data not shown)**, age groups 25 years or older **(Figure 2)**, all race/ethnicity groups **(data not shown)**, and for all services except the Marine Corps. The crude annual rates among Marine Corps members remained relatively low and stable throughout the period **(Figure 3)**.

TABLE. Incident cases of diabetes mellitus (DM), active component, U.S. Armed Forces, 2008–2015

	Type 1		Type 2		Unspecified		Any DM	
	No.	IR[a]	No.	IR[a]	No.	IR[a]	No.	IR[a]
Total	327	3.0	8,181	74.5	584	5.3	9,092	82.8
Service								
Army	122	2.9	4,097	96.1	246	5.8	4,465	104.8
Navy	76	3.0	2,254	87.9	117	4.6	2,447	95.4
Marine Corps	55	3.5	317	20.3	80	5.1	452	28.9
Air Force	74	2.9	1,513	58.4	141	5.4	1,728	66.7
Age group								
<20	23	3.7	43	6.9	51	8.2	117	18.8
20–24	124	3.6	435	12.5	197	5.7	756	21.7
25–29	84	3.1	710	26.4	143	5.3	937	34.9
30–34	43	2.5	970	56.4	71	4.1	1,084	63.1
35–39	28	2.2	1,914	150.1	67	5.2	2,009	157.6
40+	25	2.1	4,109	342.6	55	4.5	4,189	349.5
Sex								
Male	303	3.2	7,297	77.8	532	5.7	8,132	86.8
Female	24	1.5	884	54.9	52	3.2	960	59.7
Race/ethnicity								
White, non-Hispanic	214	3.2	3,235	48.2	360	5.4	3,809	56.7
Black, non-Hispanic	59	3.3	2,728	154.6	138	7.8	2,925	165.8
Hispanic	32	2.4	986	72.8	45	3.3	1,063	78.5
Other/unknown	22	1.9	1,232	107.5	41	3.6	1,295	113.0

IR, incidence rate

[a]Per 100,000 person-years

FIGURE 1. Incidence rates of diabetes mellitus (DM), by type, active component, U.S. Armed Forces, 2008–2015

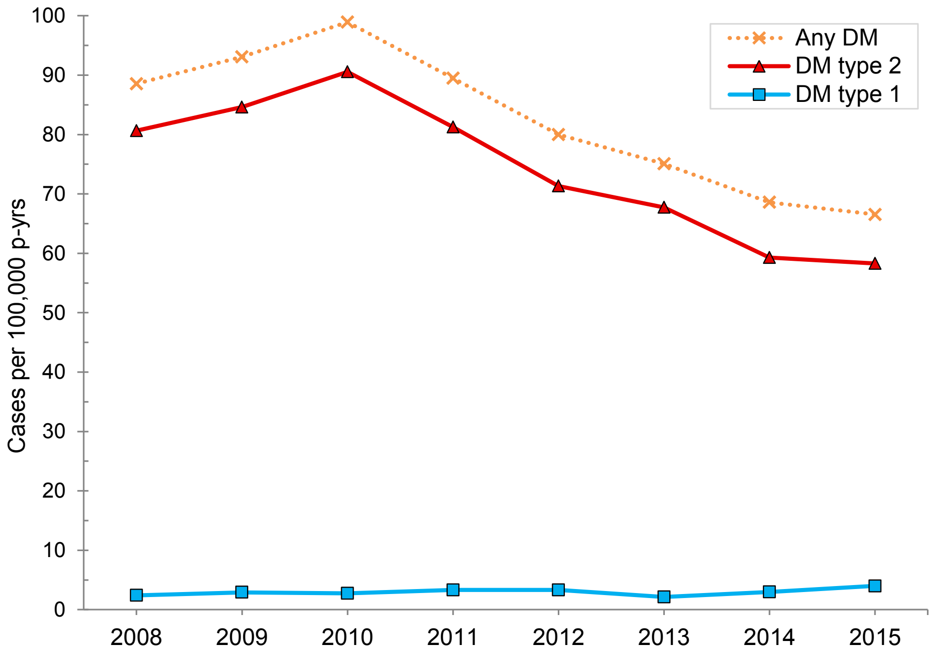
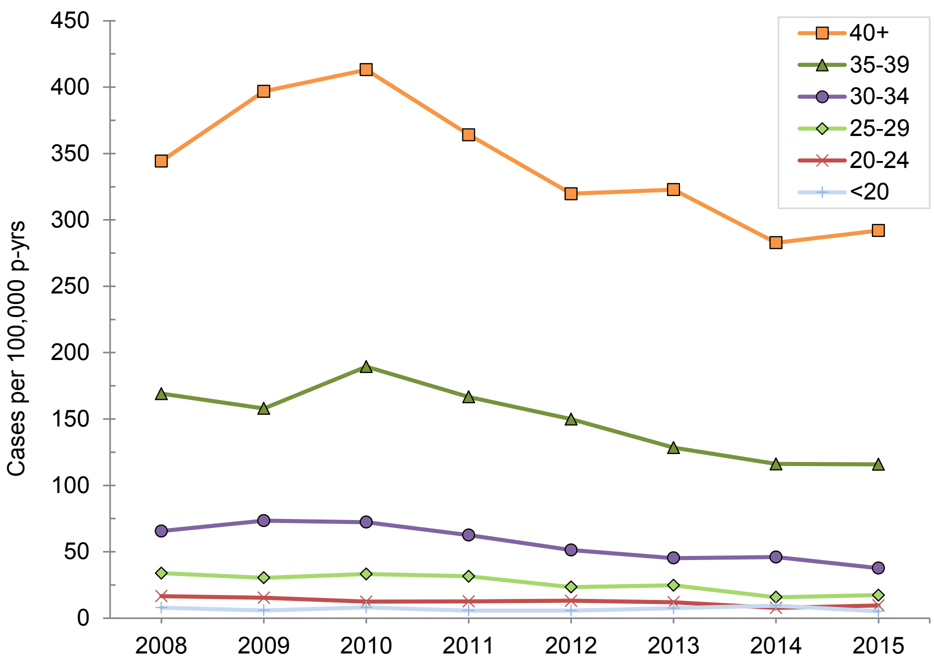


FIGURE 2. Incidence rates of type 2 diabetes mellitus, by age group, active component, U.S. Armed Forces, 2008–2015



EDITORIAL COMMENT

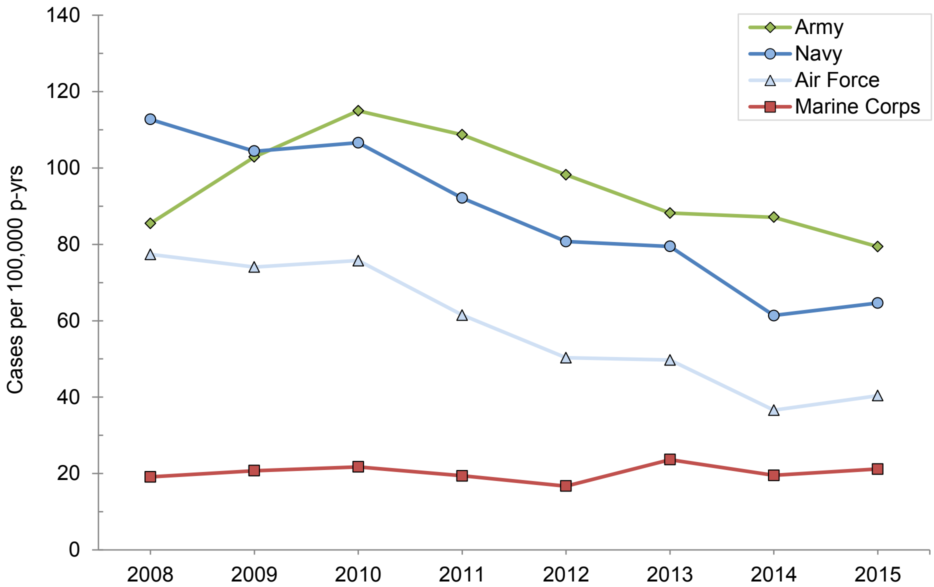
This analysis found that, from 2010 through 2015, the crude annual incidence rates of diagnoses of type 2 DM decreased among active component service members; decreases in rates were seen in all demographic groups except among service members aged 25 years or younger. Although rates of DM among adults aged 18–44 years in the U.S. general population were higher than among comparably aged active component service members during this period, the approximate timing of the peaks in rates was somewhat similar; a peak in annual incidence of diagnosed DM was observed in 2009 in the former[8] and 2010 in the latter.

As expected, the majority of incident diagnoses of DM among service members were reported as type 2 cases. The demographic differences in type 2 DM incidence observed in this analysis are consistent with those documented in civilian populations. Males have a higher risk of developing type 2 DM, compared to females; incidence increases with age in both sexes.[1,3] This form of DM occurs with varying frequency in different racial/ethnic subgroups; African Americans, Hispanics and Latinos, American Indians, Pacific Islanders, and some Asian Americans are at higher risk than whites.[3]

Each year for the past 8 years, approximately 1,135 service members have received incident clinical diagnoses of DM. Using National Health and Nutrition Examination Survey data for 2011 through 2014, the Centers for Disease Control and Prevention estimated that, among the 12.6% of adults aged 20 years or older with DM, approximately 3.0% were undiagnosed.[9] Because DM disqualifies individuals from entering active military service, and because active service members must meet height and weight standards that discourage obesity, and have mandatory medical examinations and free access to health care, prevalences of both diagnosed and undiagnosed DM would be expected to be much lower among active U.S. service members than similarly aged U.S. civilians. Military medical retention standards require that service members diagnosed with DM while in service and who cannot maintain a hemoglobin A1c (HbA1c) level below 7% without medication be referred to a medical evaluation board, which assesses their medical fitness and makes recommendations about follow-up care.[10]

If certain subgroups of service members are relatively more informed regarding risk factors and disease symptoms and/or more frequently screened (e.g., during periodic medical examinations), then higher proportions of detectable cases

FIGURE 3. Incidence rates of type 2 diabetes mellitus, by service, active component, U.S. Armed Forces, 2008–2015



may be identified among them. The higher crude overall rates of DM diagnoses in the Army and the Navy likely reflect, at least in part, different demographic makeup (e.g., Marine Corps members are, on average, younger than other services' personnel[11]), varying frequencies and intensities of physical activity (military and/or leisure), and/or more complete and timely case identification in these services than in the other services. Any further investigation of these differences should examine adjusted (e.g., by age, sex, race/ethnicity) incidence rates among members within the services. It is important to note that the prevalence of obesity in the identified DM cases was not examined in this analysis but might be relevant to potential studies of adjusted rates of this condition across the services.

Several limitations should be considered when interpreting the results of this analysis. First, incident cases of DM were ascertained from diagnosis codes recorded on administrative records of medical encounters. The reliability of diagnoses of DM on such records may be variable (e.g., some encounters that raise clinical suspicion of or "rule out" DM may be incorrectly documented with diagnostic codes specific for DM). To increase the likelihood that service members with DM diagnosis codes were true cases, the surveillance case definition required at least two medical encounters with primary diagnoses of DM within a 90-day period. In addition, this report summarized diagnoses of DM that were reported from medical encounters in fixed U.S. military and civilian (i.e., purchased care) medical facilities if reimbursed through the MHS. Because records of civilian health care not reimbursed by the MHS were not available for this analysis, the numbers and rates of incident diagnoses of DM reported here are likely an underestimate of the actual numbers and rates of incident diagnoses of this condition.

DM is one of the costliest diseases in the U.S. Spending on DM diagnosis and treatment was estimated at $101.4 billion in 2013, including 57.6% spent on pharmaceuticals and 23.5% spent on ambulatory care.[12] During 1996–2013, healthcare spending on DM increased twice as fast as all other conditions combined, with the highest annual growth rates seen among those aged 20–44 years.[12] With reduced productivity factored in, DM-related cost estimates for 2012 totaled $245 billion, including $176 billion in direct medical costs and $69 billion in lost productivity.[13] Sustained surveillance of DM along with continued research on the impact of comorbidities, risk factors, and lifestyle choices on DM incidence are needed to help the MHS develop and implement prevention and intervention strategies to decrease the incidence of this condition and its per capita cost.

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Rates of *Chlamydia trachomatis* Infections Across the Deployment Cycle, Active Component, U.S. Armed Forces, 2008–2015

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High rates of sexually transmitted infections (STIs), including *Chlamydia trachomatis* (CT), have been documented among U.S. military service members. However, it is unknown whether phases of the deployment cycle affect risk for CT. This article characterizes the rates of CT infections during the pre-deployment, deployment, and post-deployment phases for active component members of the U.S. Army, Navy, Air Force, and Marine Corps during 2008–2015. Cases of CT were defined using laboratory, reportable medical event, and prescription data in a sensitivity analysis approach. Adjusted incidence rate ratios for CT were calculated using a multivariable Poisson model. In these analyses, the crude and adjusted incidence rates of CT were found to be highest during the pre-deployment phase for both sexes. However, men's rates of CT differed only slightly across pre-, post-, and non-deployed phases, while women had substantial rate differences between phases. These analyses call for better screening and documentation of STIs during deployment, as well as continued surveillance of STIs in the Military Health System, to assess the true burden of disease.

High rates of sexually transmitted infections (STIs), including those due to *Chlamydia trachomatis* (CT), have been well documented among U.S. military service members.[1-3] The Centers for Disease Control and Prevention has reported that, among civilians in the U.S., the highest rates of CT are among those aged 24 years or younger and among residents of southern states.[4] Because more than 60% of active component military service members are younger than 25 years of age, and because the southern U.S. is not only the home of many service members, but also the location of many military installations, it is not unexpected that rates of CT infection are relatively high among service members.[5] Within the military, characteristics associated with higher risk for CT infection include being in the Army, age 17–19 years, female, black non-Hispanic, junior enlisted rank, and single/never-married.[1]

Screening for CT among individuals at risk for infection is important because most infections are asymptomatic in both men and women.[6] Left untreated, these infections can cause serious complications such as pelvic inflammatory disease or infertility in women.[6] However, STI screening protocols differ between the service branches, and access to routine screening conducted for CT in either men or women during deployment is limited.[7]

Military public health practitioners have suspected that STI rates vary over deployment cycles.[5,8] One hypothesis for the rises and falls in STI rates before, during, and after overseas deployments is that there are changes in sexual risk behaviors driven by the different life stressors associated with these phases.[9] For example, a pre-deployment phase marked by anticipatory worry and tension may introduce or exacerbate service members' relationship stressors.[10,11] These stressors could potentially lead to alcohol or other substance misuse and/or disruption in stable relationships, factors that may increase behaviors at higher risk for exposure to STIs. In a survey of shipboard active duty Navy and Marine Corps personnel administered 2 weeks before deployment, 16% of participants (395 of 2,453) reported a sexual relationship outside their main relationship; 44% (1,043 of 2,359) reported occasional or typical alcohol use before sex; and 2% (58 of 2,453) self-reported an STI within the previous 12 months.[8] Of those who self-reported an STI, about one-third (33.9%) reported acquiring an STI from another service member during the pre-deployment phase.[8] Similarly, a 2011 investigation of HIV seroconversions in the Department of Defense showed an increased risk for HIV seroconversion during deployment due to increased high-risk behaviors in the pre-deployment phase.[12]

Although regulations are in place to reduce the potential for sexual relationships during deployment, such as restrictions on "co-ed" housing and limitations on visitation times in opposite sex billeting, deployment may increase risk for STIs through lack of access to condoms, or by exposure to a high-risk environment that may increase risky behaviors.[13-16] Upon return from deployment, service members' readjustment to daily life and family reintegration may also affect sexual behavior.[10,17] Relationship distress may also be exacerbated by alcohol misuse and post-traumatic stress or depression.[10,18]

To date, there have been no extensive analyses of CT trends during pre-deployment, deployment, post-deployment, and non-deployment phases. Although suspected, it has not been clearly demonstrated that these phases of the deployment cycle affect service members' risk for STIs. Data on this issue are needed to inform contact tracing, screening, treatment, and prevention programs in the Military Health System (MHS).[5,19]

Among the challenges of tracking CT rates for all phases of the deployment cycle are the realities that the deployment phase is marked by incomplete capture of medical record data and the absence of routine screening for CT. However, in-theater prescription records may provide one way of formulating a rough estimate of the number of CT infections. The objective of the current analysis was to identify the trends in incidence for CT across deployment cycles, using available surveillance data, among male and female active component service members. In addition, this report presents a sensitivity analysis method for identifying possible cases of CT using prescription data.

METHODS

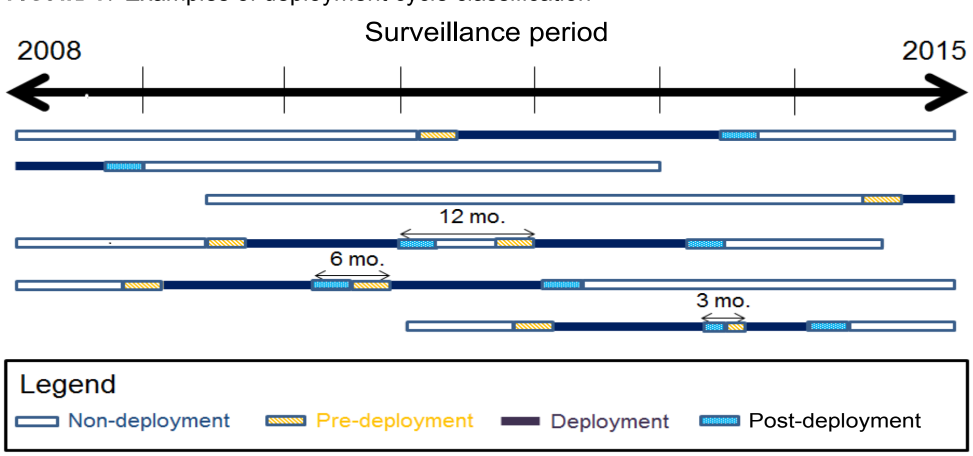
The surveillance period was 1 January 2008 through 31 December 2015. The surveillance population included all active component members of the U.S. Army, Navy, Air Force, and Marine Corps who served at any point during the surveillance period. Cases were identified from laboratory data obtained from the Navy and Marine Corps Public Health Center. These laboratory data are generated within the Composite Health Care System at fixed (i.e., not deployed or at sea) military treatment facilities.[20,21] Cases were also identified using reportable medical event data and records of prescribed medications in the Theater Medical Data Store (i.e., prescriptions from in-theater and shipboard care) housed in the Defense Medical Surveillance System (DMSS) at the Armed Forces Health Surveillance Branch.

A case of CT was defined as any one of the following: 1) a positive laboratory test result, 2) a confirmed reportable medical event, or 3) evidence that a prescription for CT treatment was filled during deployment, based on the prescription's conformance to Centers for Disease Control and Prevention (CDC) recommended treatment regimens.[6] The CDC recommends 1 gm of azithromycin orally in a single dose or 100 mg of doxycycline orally twice a day for 7 days for treatment of CT.[6] A 30-day gap between qualifying medical records was applied to identify incident cases. Prescription data were used as a supplementary method to identify cases in deployment settings due to the reduced likelihood that cases of CT would be captured in electronic medical records in these settings. Because the antibiotics used to treat CT may also have been used to treat a variety of other bacterial infections in theater, the case definition excluded prescription data-identified CT cases with documented ICD 9/10 diagnoses of any of the following conditions within 14 days of the medication dispensing date: acne, actinomycosis, anthrax, bronchitis, brucellosis, *Campylobacter* enteritis, cholera, Lyme disease, malaria, psittacosis, periodontitis, pertussis, plague, pneumonia, proctitis, relapsing fever, upper respiratory tract infection, rickettsial infection, rosacea, trachoma, tularemia, or typhoid. Possible cases were also excluded if the records' prescription instructions field contained the words "malaria" or "diarrhea."

A sensitivity analysis in the non-deployed setting was conducted to examine the percentage of cases flagged as CT using prescription data (i.e., 1 gm of azithromycin in a single dose or 100 mg of doxycycline twice a day for 7 days) that were within 14 days of a laboratory diagnosed or confirmed reportable event for CT. The non-deployed setting was used to test the validity of the case definition because it was presumed less likely that cases would be underdiagnosed as compared with the deployed setting. Among those possible cases that were found not to be within 14 days of a laboratory diagnosed or confirmed reportable event for CT, the analysis recorded the five most common ICD-9 and ICD-10 codes that were documented within 14 days of the prescription medication dispensing date.

Crude incidence of CT was calculated across the four deployment cycles separately for men and women. Deployment cycles during the surveillance period were categorized into four discrete time segments: 1) non-deployed, 2) pre-deployed, 3) deployed, and 4) post-deployed. Deployment status was ascertained through data from the Contingency Tracking System provided by the Defense Manpower Data Center, which is routinely archived in the deployment records in DMSS. If an individual had only one deployment during the surveillance period, then the 3 months prior to the deployment were considered "pre-deployed," and the 3 months following the deployment were considered "post-deployed" **(Figure 1)**. If an individual had multiple deployments during the surveillance period that were greater than 6 months apart, then the 3 months following the first deployment were categorized as "post-deployed"; the 3 months prior to the second deployment were categorized as "pre-deployed"; and the remaining time in-between deployments was categorized as "non-deployed." For deployments that were

FIGURE 1. Examples of deployment cycle classification



less than 6 months apart, "post-deployed" and "pre-deployed" time were split equally between the two phases. For example, if an individual had 3 months between two deployments, that phase was categorized as having 1.5 months of "post-deployed" time followed by 1.5 months of "pre-deployed" time.

Adjusted incidence rate ratios for CT were calculated using a Poisson model with an offset for follow-up time, and the primary exposure of interest was deployment cycle. The model included generalized estimating equations with an exchangeable correlation structure to allow for clustering of multiple data records within individual subjects. The model adjusted for sex, service branch, grade, race/ethnicity, education level, military occupation, and marital status. The Poisson multivariable model was used for the combined laboratory and reportable event data.

RESULTS

In the sensitivity analysis, roughly one-third (7,078 of 21,676) of the cases of CT that were identified using prescription data in non-deployed settings occurred within 14 days of a laboratory-confirmed diagnosis or confirmed reportable event for CT. Of the cases that were flagged as CT using prescription data but were not within 14 days of a laboratory or reportable event-confirmed case of CT, the most common primary ICD-9 diagnosis codes within 14 days of the prescription date were: 799.89 (other ill-defined conditions; 12.9%), V70.5 (health examinations of defined subpopulations; 5.2%), V57.1 (care involving other physical therapy; 2.2%), 788.1 (dysuria; 2.0%), and V01.6 (contact with or exposure to venereal diseases; 2.0%). The most common primary ICD-10 diagnosis codes were: R68.89 (other general symptoms and signs; 12.9%), Z20.2 (contact with and [suspected] exposure to infections with a predominantly sexual mode of transmission; 2.9%), Z23 (encounter for immunization; 2.9%), Z02.89 (encounter for other administrative examinations; 2.5%), and Z88.1 (allergy status to other antibiotic agents status; 2.2%).

The demographic characteristics of the study population at the beginning of the follow-up period are shown in **Table 1.** Briefly, the study population consisted of Army (40%), Air Force (21%), Marine Corps (16%), and Navy (23%) active component members who were predominantly male (84%), white non-Hispanic (62%), single (64%), and with a high school or less education (78%). Service members aged 20–24 years constituted the single largest age category (37%).

When using only laboratory data, there were a total of 84,783 incident cases of CT among men and 54,867 cases among women during the surveillance period. The highest rates of CT for both men and women were during the pre-deployment

TABLE 1. Demographic and military characteristics of service members at start of follow-up, active component, U.S. Armed Forces, 2008–2015

	N	%
Age (years)		
<20	758,487	27.6
20–24	1,005,709	36.6
25–29	433,398	15.8
30–34	225,241	8.2
35–39	176,679	6.4
40–44	99,340	3.6
45+	50,143	1.8
Sex		
Male	2,316,979	84.3
Female	432,046	15.7
Grade		
Junior enlisted (E1–E4)	1,855,239	67.5
Senior enlisted (E5–E9)	575,891	20.9
Junior officer (O1–O4)	257,902	9.4
Senior officer (O5–O10)	42,017	1.5
Warrant officer (W1–W5)	17,976	0.7
Service		
Army	1,093,550	39.8
Air Force	575,612	20.9
Marine Corps	441,677	16.1
Navy	638,186	23.2
Race/ethnicity		
White, non-Hispanic	1,693,669	61.6
Black, non-Hispanic	436,471	15.9
Hispanic	336,181	12.2
Other	282,704	10.3
Occupation		
Infantry/artillery/combat engineer	323,981	11.8
Motor transport	99,985	3.6
Pilot/air crew	55,473	2.0
Repair/engineer	549,507	20.0
Communications/intelligence	433,632	15.8
Health care	179,216	6.5
Other/unknown	1,107,231	40.3
Education		
High school or less	2,144,700	78.0
College/other	604,325	22.0
Marital status		
Single	1,757,002	63.9
Married	919,646	33.5
Other	72,377	2.6

phase, and the differences in rates across phases were much larger for women, compared with men **(Table 2, Figure 2)**. The lowest rates of CT for both sexes occurred during deployment.

When considering both laboratory and reportable event data, there were 102,650 CT cases among men and 65,473 cases among women **(Table 2)**. The relative distribution by deployment cycle of incidence rates for CT for both sexes was similar to that of the laboratory-only data **(Figure 3)**. When the deployment pharmacy data were included with the laboratory and reportable event data, the highest rates of CT among both men and women remained during the pre-deployment phase and the second highest rates for both sexes occurred during the post-deployment phase **(Figure 4)**. In the multivariable model, incident CT was associated with being in the pre-deployment phase, compared with all the other deployment phases **(Table 3)**. Other variables associated with incident CT included being female, age 20–24 years, being in the Army, having a lower enlisted rank (E1–E4), being black non-Hispanic (vs. white non-Hispanic), having a high school education or less (vs. a college education or more), and having a marital status of single or "other" (vs. married).

EDITORIAL COMMENT

In these analyses, the crude incidence of CT was found to be highest during the pre-deployment phase for both sexes. However, men tended to have similar rates of CT across pre-, post-, and non-deployed phases in contrast to the more distinct rate differences between phases among women. Overall, results from the multivariable model suggested that CT incidence was highest during pre-deployment.

The finding that rates of CT were higher

FIGURE 2. Incidence rates of laboratory-confirmed *Chlamydia trachomatis* diagnoses, by deployment cycle and sex, active component, U.S. Armed Forces, 2008–2015

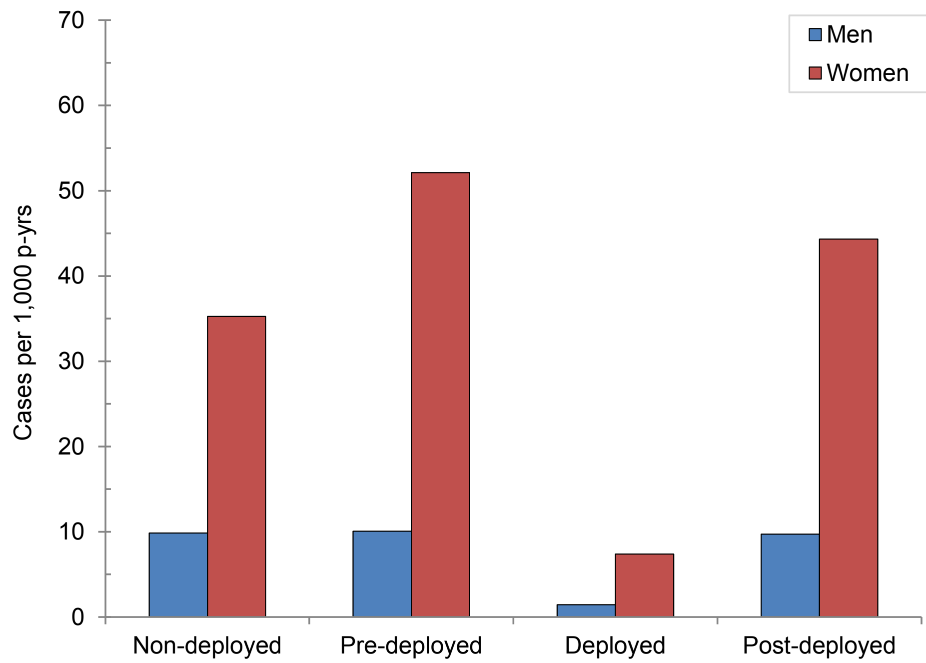


TABLE 2. Incidence of *Chlamydia trachomatis* diagnosis, by sex and deployment cycle, active component, U.S. Armed Forces, 2008–2015

	Non-deployment		Pre-deployment		Deployment		Post-deployment		Total	
	Cases	Rate*	Cases	Rate*	Cases	Rate*	Cases	Rate*	Cases	Rate*
Laboratory data only										
Men	76,395	9.84	3,391	10.06	1,322	1.44	3,675	9.73	84,783	9.02
Women	49,645	35.25	2,275	52.13	833	7.37	2,114	44.33	54,867	34.02
Total	126,040	13.74	5,666	14.88	2,155	2.09	5,789	13.61	139,650	12.68
Laboratory and reportable events data										
Men	92,126	11.86	4,226	12.53	1,831	1.99	4,467	11.83	102,650	10.92
Women	59,114	41.97	2,751	63.03	1,098	9.72	2,510	52.63	65,473	40.6
Total	151,240	16.48	6,977	18.32	2,929	2.84	6,977	16.4	168,123	15.27
Laboratory, reportable events, and deployment prescription data										
Men	93,662	12.06	4,443	13.17	5,245	5.71	4,670	12.36	108,020	11.49
Women	59,670	42.37	2,845	65.19	2,230	19.74	2,584	54.19	67,329	41.75
Total	153,332	16.71	7,288	19.13	7,475	7.25	7,254	17.05	175,349	15.92

*Rate per 1,000 person-years

FIGURE 3. Incidence rates of laboratory- and reportable event–confirmed *Chlamydia trachomatis* cases, by deployment cycle and sex, active component, U.S. Armed Forces, 2008–2015

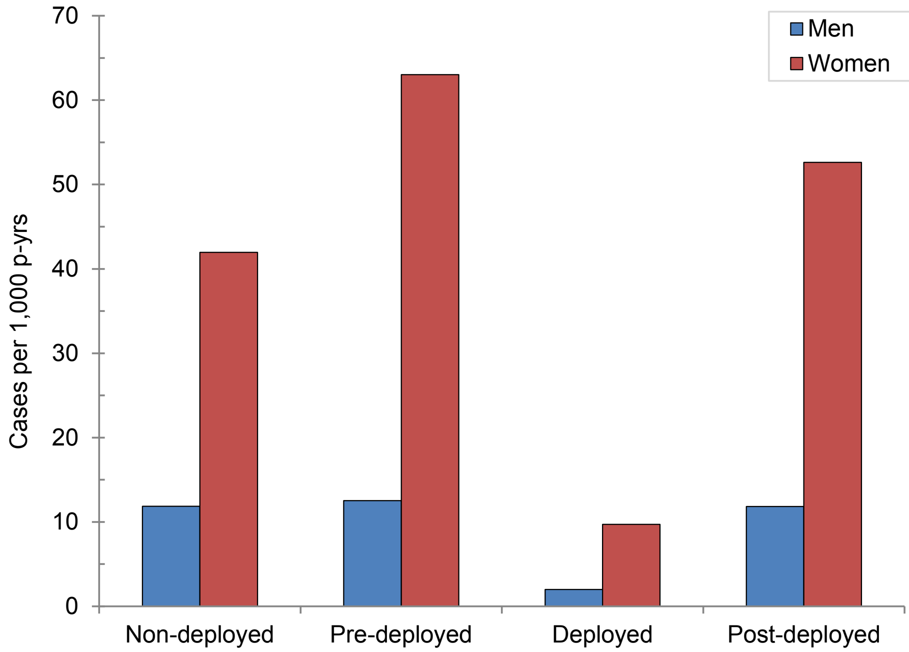
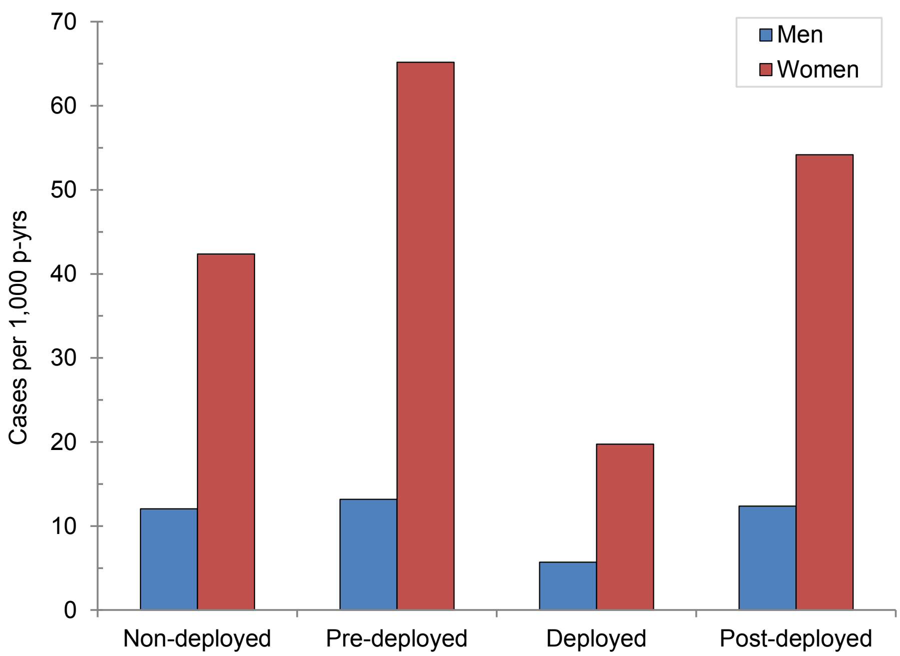


FIGURE 4. Incidence rates of laboratory-confirmed, reportable event–confirmed, and deployment prescription data–confirmed *Chlamydia trachomatis* cases, by deployment cycle and sex, active component, U.S. Armed Forces, 2008–2015



during pre-deployment may be attributed to enhanced pre-deployment screening procedures, such as HIV screening and pre-deployment health assessments that occur within 3–4 months prior to deployment.[22] Women's deployment health screening, which includes CT screening, was official deployment policy for Iraq and Afghanistan from 2009 to 2011.[23] The increased rates of health screening in the months immediately before and after deployment and particularly among women may have resulted in a higher number of cases identified during these phases.

Another potential explanation for these findings is that true STI incidence rates are higher during pre-deployment phases, perhaps due to relationship distress, mental health and adjustment disorders, or other deployment-related stressors.[5,9] For example, self-reported high levels of family and personal life stress among active duty female service members have been associated with increased number of sexual partners, and self-reported stress among both male and female service members has been associated with sexual risk behaviors including lack of condom use and higher number of sexual partners.[24] Incidence rates were consistently low during deployment for both sexes. The low incidence rates observed during deployment may be attributed to the lack of screening procedures in theater, poor or no documentation of STIs in the medical record, or because true incidence rates were lower during deployment.

There are several limitations to these analyses. As previously mentioned, there is likely greater under-diagnosis of CT in men, given that women are more routinely screened. Cases are likely to be underreported during deployment for both sexes, despite efforts to supplement these data using prescription records. In addition, alternative medication regimens for CT besides the CDC-recommended regimen were not included. Medical encounters among military members accessing non-military health centers would also not be captured using DMSS data. Although service members are not routinely screened for CT before or after deployments, there is increased health-related screening in general during the more immediate pre- and post-deployment health assessment processes. This increased healthcare utilization and medical record scrutiny during the pre- and post-deployment phases may have resulted in increased numbers of CT cases being screened for and diagnosed. Finally, the deployment prescription data-identified CT cases may not be reflective of true CT cases, although care was taken to exclude other bacterial infections from the case definition. In particular,

TABLE 3. Adjusted rate ratios for *Chlamydia trachomatis* infection among active component service members, 2008–2015, using laboratory and reportable event data

	Adjusted IRR	95% CI		P-value
Deployment period				
Pre-deployment	Ref.	--	--	--
Deployment	0.15	0.15	0.16	<.0001
Non-deployment	0.93	0.91	0.95	<.0001
Post-deployment	0.97	0.93	1.00	.0404
Age (years)				
<20	Ref.	--	--	--
20–24	1.04	1.02	1.06	<.0001
25–29	0.65	0.64	0.67	<.0001
30–34	0.36	0.35	0.37	<.0001
35–39	0.19	0.19	0.20	<.0001
40–44	0.13	0.12	0.14	<.0001
45+	0.08	0.07	0.08	<.0001
Sex				
Male	Ref.	--	--	--
Female	3.03	2.99	3.07	<.0001
Grade				
Junior enlisted (E1–E4)	Ref.	--	--	--
Senior enlisted (E5–E9)	0.75	0.74	0.76	<.0001
Junior officer (O1–O4)	0.41	0.39	0.42	<.0001
Senior officer (O5–O10)	0.23	0.19	0.28	<.0001
Warrant officer (W1–W5)	0.58	0.52	0.65	<.0001
Service				
Air Force	0.74	0.72	0.75	<.0001
Army	Ref.	--	--	--
Marine Corps	0.62	0.61	0.63	<.0001
Navy	0.73	0.72	0.74	<.0001
Race/ethnicity				
White, non-Hispanic	Ref.	--	--	--
Black, non-Hispanic	2.47	2.43	2.50	<.0001
Hispanic	1.37	1.34	1.39	<.0001
Other	1.30	1.27	1.33	<.0001
Occupation				
Infantry/artillery/combat engineer	0.85	0.83	0.86	<.0001
Motor transport	1.07	1.04	1.10	<.0001
Pilot/air crew	1.00	0.95	1.06	.9991
Repair/engineer	0.93	0.92	0.95	<.0001
Communications/intelligence	0.90	0.88	0.91	<.0001
Health care	0.71	0.70	0.73	<.0001
Other/unknown	Ref.	--	--	--
Education				
High school or less	Ref.	--	--	--
College/other	0.72	0.71	0.74	<.0001
Marital status				
Single	1.47	1.45	1.49	<.0001
Married	Ref.	--	--	--
Other	2.15	2.10	2.21	<.0001

IRR, incidence rate ratio

many cases of traveler's diarrhea and a few cases of malaria were likely not documented in service members' medical records during deployment but may have been treated with azithromycin or doxycycline. However, the sensitivity analysis did not identify any additional frequently occurring ICD codes for bacterial infections included in the CT case definition, suggesting that most of the documented false positives were excluded to the extent possible.

The results of these analyses underscore the need for better screening and documentation of STIs during deployment to assess the true burden of disease. Better screening during deployment is also warranted given the high rates of infection during the 3 months surrounding departure and return from deployment. The findings reported here should be compared with data from other sources such as self-reported risk behaviors that occurred during and in the time surrounding deployment, to provide a more complete assessment of CT risk. Continued surveillance of STIs in the MHS is needed across all phases of the deployment cycle.

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Brief Report

Selected Demographic and Service Characteristics of the U.S. Armed Forces, Active and Reserve Components, 2001, 2009, and 2016

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

On 7 October 2001, the U.S. Armed Forces launched Operation Enduring Freedom (OEF) in Afghanistan in response to the terrorist attacks of 11 September 2001. Thus began 15 years of U.S. military operations in Southwest Asia. In March 2003, U.S. forces invaded Iraq at the beginning of Operation Iraqi Freedom (OIF). In 2010, OIF was renamed Operation New Dawn (OND) to coincide with the significant reduction of U.S. Armed Forces in Iraq, and OND ended when U.S. combat forces withdrew in 2011. The official end of combat operations in Afghanistan took place at the end of 2014. In both Iraq and Afghanistan, U.S. service members are still present to train and advise local armed forces, and to support counter-terrorism activities.

Since 2001, the U.S. Armed Forces have seen a significant rise and fall in the numbers of men and women serving in uniform. The need for trained service members to meet the demands of ongoing combat operations, repeated deployments, and personnel attrition have implications for military recruitment requirements and standards as well as for provision of health services, particularly for deployment-related health conditions. The goal of this report is to provide a brief summary of the demographic composition of the U.S. Armed Forces at three points in time during the past 15 years, and to provide historical context for health surveillance efforts related to this period.

METHODS

The surveillance period consisted of three specific time points chosen to provide demographic descriptions of U.S. Armed Forces at the time of the beginning of OEF (1 October 2001), 15 years later (1 October 2016), and at the midpoint (1 April 2009) of the entire period. The surveillance population included all active and reserve component members of the U.S. Army, Navy, Air Force, and Marine Corps. For the purposes of this report, the term reserve component includes members of both the reserves and the National Guard. Demographic data from the Defense Manpower Data Center and inpatient (hospitalization) data from the Defense Health Services System were gathered from the Defense Medical Surveillance System (DMSS) at the Armed Forces Health Surveillance Branch. Records for all service members in the active or reserve component at each of the three time points were used to gather information on branch of service, sex, age, race/ethnicity, rank or grade, deployments to OEF, OIF, or OND, hospitalizations during the 15-year period, and service status at the other two points in time. For simplicity in this report, those serving on the specific dates described above will be referred to by the four-digit name of the corresponding year. Thus, the three points in time will be referred to as 2001, 2009, and 2016.

RESULTS

From 1 October 2001 through 1 October 2016, a total of 4,073,124 unique individuals served at least 1 day in the active component and 2,561,073 served at least 1 day in the reserve component **(data not shown)**. For the three time points examined, the total number of men serving in the active component was greatest in 2009 but was 10% lower in 2016 **(Table 1, Figure 1)**. The total number of men serving in the reserve component was 7.5% lower in 2016, compared to 2001 **(Table 2, Figure 1)**. Among women, the numbers serving in the active component were similar in 2001 and 2016, but the number serving in 2009 was slightly (2.4%) lower. In contrast, the numbers of women serving in the reserve component were successively higher at each point in time, with a net increase of 9.9% from 2001 to 2016.

The mean and median ages of male and female service members in the active component at the three points in time suggested a slightly older force in 2016, compared to 2001. In contrast, the mean and median ages for both sexes in the reserve component were clearly lower in 2016 compared to 2001. A comparison of the active and reserve components showed that the mean and median ages of both sexes were distinctly higher in members of the reserve component at all of the three time points **(Table 1, Table 2)**.

The distribution of service members by race/ethnicity varied at the three time points. Most notably, the percentages of Hispanic men and women serving in both the active and reserve components were higher at each successive point in time. The distribution of service members by rank/grade remained similar for men across the time points for both the active and reserve components. For women, rank/grade distribution remained similar across time points for the reserve component; however, there was a slight increase in the percentage of female officers in the active component at each successive point in time.

In general, the percentages of men and women in both the active and reserve components who ever deployed to OEF/OIF/OND at any time during 1 October 2001–1 October 2016 were highest among those in service in 2009 and lowest for those in service in 2016 **(Figure 2)**. One exception to this generalization is that women in the reserve component in 2001 and 2016 were similarly likely to have ever deployed.

TABLE 1. Numbers and percentages of service men and women, active component, U.S. Armed Forces, 1 October 2001–1 October 2016

	1 October 2001				1 April 2009				1 October 2016			
	No. of men	%	No. of women	%	No. of men	%	No. of women	%	No. of men	%	No. of women	%
Total	1,164,044	100.0	204,207	100.0	1,200,070	100.0	199,211	100.0	1,080,495	100.0	204,063	100.0
Age (years) on date specified above												
Mean (SD)	28 (8)		27 (8)		28 (8)		28 (7)		28 (8)		28 (7)	
Median (IQR)	26 (22–34)		25 (21–32)		26 (22–34)		26 (22–32)		27 (22–33)		26 (22–32)	
Race/ethnicity												
White, non-Hispanic	741,287	63.7	100,407	49.2	779,344	64.9	95,487	47.9	648,324	60.0	88,563	43.4
Black, non-Hispanic	205,211	17.6	63,281	31.0	172,844	14.4	53,869	27.0	157,824	14.6	52,956	26.0
Hispanic	108,670	9.3	19,402	9.5	133,510	11.1	25,568	12.8	158,743	14.7	34,491	16.9
Asian/Pacific Islander	41,544	3.6	7,106	3.5	43,284	3.6	8,289	4.2	42,846	4.0	9,091	4.5
Native American/Alaska Native	13,753	1.2	2,905	1.4	13,192	1.1	2,677	1.3	10,664	1.0	2,250	1.1
Other	53,579	4.6	11,106	5.4	57,896	4.8	13,321	6.7	62,094	5.7	16,712	8.2
Grade on date specified above												
Junior enlisted (E1–E4)	508,718	43.7	107,192	52.5	526,450	43.9	90,847	45.6	469,734	43.5	93,765	45.9
Senior enlisted (E5–E9)	472,345	40.6	65,278	32.0	483,150	40.3	73,816	37.1	422,671	39.1	70,808	34.7
Junior officer (O1–O3)	97,573	8.4	20,433	10.0	98,521	8.2	22,073	11.1	101,895	9.4	25,632	12.6
Field grade officer (O4–O6)	70,791	6.1	10,286	5.0	73,791	6.1	10,893	5.5	68,711	6.4	12,187	6.0
Flag officer (O7–O10)	848	0.1	31	0.0	869	0.1	64	0.0	835	0.1	64	0.0
Warrant officer (W1–W3)	11,511	1.0	921	0.5	13,683	1.1	1,287	0.6	13,532	1.3	1,372	0.7
Senior warrant officer (W4–W5)	2,258	0.2	66	0.0	3,606	0.3	231	0.1	3,117	0.3	235	0.1
Times deployed to U.S. Central Command for more than 30 days during 2001–2016												
Never	574,410	49.3	126,287	61.8	361,328	30.1	87,365	43.9	656,022	60.7	143,816	70.5
1	312,057	26.8	48,441	23.7	360,048	30.0	62,119	31.2	188,527	17.4	33,860	16.6
2	145,133	12.5	18,419	9.0	262,406	21.9	31,790	16.0	115,970	10.7	16,032	7.9
3	76,107	6.5	7,249	3.5	132,255	11.0	12,300	6.2	68,468	6.3	6,806	3.3
4	35,519	3.1	2,615	1.3	54,634	4.6	3,946	2.0	32,364	3.0	2,421	1.2
5	12,948	1.1	810	0.4	18,393	1.5	1,103	0.6	11,921	1.1	739	0.4
>5	7,870	0.7	386	0.2	11,006	0.9	588	0.3	7,223	0.7	389	0.2
Times hospitalized in a military treatment facility or outsourced TRICARE facility during 2001–2016												
Never	944,556	81.1	99,378	48.7	931,453	77.6	76,021	38.2	957,389	88.6	130,095	63.8
1	147,218	12.6	53,421	26.2	176,039	14.7	54,285	27.3	91,467	8.5	36,904	18.1
2	42,855	3.7	27,615	13.5	53,800	4.5	35,965	18.1	20,988	1.9	20,824	10.2
3	15,294	1.3	12,757	6.2	19,965	1.7	17,542	8.8	6,297	0.6	9,387	4.6
4	6,465	0.6	5,616	2.8	8,599	0.7	7,947	4.0	2,286	0.2	3,853	1.9
5	3,138	0.3	2,594	1.3	4,223	0.4	3,586	1.8	999	0.1	1,545	0.8
>5	4,518	0.4	2,826	1.4	5,991	0.5	3,865	1.9	1,069	0.1	1,455	0.7
Serving in the military on:												
1 October 2001	1,164,044	100.0	204,207	100.0	454,288	37.9	68,966	34.6	182,169	16.9	28,561	14.0
1 April 2009	454,288	39.0	68,966	33.8	1,200,070	100.0	199,211	100.0	414,002	38.3	67,466	33.1
1 October 2016	182,169	15.6	28,561	14.0	414,002	34.5	67,466	33.9	1,080,495	100.0	204,063	100.0
Service												
Army	399,699	34.3	73,320	35.9	471,551	39.3	73,238	36.8	400,121	37.0	68,711	33.7
Navy	320,419	27.5	53,256	26.1	277,590	23.1	49,500	24.8	259,539	24.0	59,808	29.3
Air Force	281,746	24.2	67,178	32.9	262,515	21.9	63,933	32.1	251,954	23.3	60,593	29.7
Marine Corps	162,180	13.9	10,453	5.1	188,414	15.7	12,540	6.3	168,881	15.6	14,951	7.3

SD, standard deviation; IQR, interquartile range

TABLE 2. Numbers and percentages of service men and women, reserve component, U.S. Armed Forces, 1 October 2001–1 October 2016

	1 October 2001				1 April 2009				1 October 2016			
	No. of men	%	No. of women	%	No. of men	%	No. of women	%	No. of men	%	No. of women	%
Total	707,118	100.0	142,917	100.0	698,259	100.0	152,578	100.0	653,787	100.0	157,119	100.0
Age (years) on date specified above												
Mean (SD)	35 (10)		33 (10)		32 (10)		31 (10)		32 (10)		31 (10)	
Median (IQR)	34 (26–41)		32 (24–40)		30 (23–40)		28 (23–38)		30 (24–38)		28 (23–36)	
Race/ethnicity												
White, non-Hispanic	454,775	64.3	72,796	50.9	500,010	71.6	85,864	56.3	439,636	67.2	81,599	51.9
Black, non-Hispanic	91,666	13.0	36,394	25.5	86,161	12.3	38,865	25.5	88,415	13.5	41,057	26.1
Hispanic	57,638	8.2	10,596	7.4	64,569	9.2	15,447	10.1	72,416	11.1	18,928	12.0
Asian/Pacific Islander	18,608	2.6	4,035	2.8	21,288	3.0	5,670	3.7	26,464	4.0	7,296	4.6
Native American/Alaska Native	6,121	0.9	1,625	1.1	6,292	0.9	1,806	1.2	5,308	0.8	1,632	1.0
Other	78,310	11.1	17,471	12.2	19,939	2.9	4,926	3.2	21,548	3.3	6,607	4.2
Grade on date specified above												
Junior enlisted (E1–E4)	278,680	39.4	66,793	46.7	291,259	41.7	70,180	46.0	269,888	41.3	70,902	45.1
Senior enlisted (E5–E9)	321,644	45.5	53,335	37.3	306,913	44.0	60,390	39.6	278,364	42.6	61,098	38.9
Junior officer (O1–O3)	38,691	5.5	10,579	7.4	38,702	5.5	10,500	6.9	47,381	7.2	13,446	8.6
Field grade officer (O4–O6)	57,228	8.1	11,370	8.0	51,402	7.4	10,320	6.8	46,643	7.1	10,171	6.5
Flag officer (O7–O10)	547	0.1	17	0.0	561	0.1	53	0.0	589	0.1	76	0.0
Warrant officer (W1–W3)	6,441	0.9	688	0.5	6,937	1.0	967	0.6	8,661	1.3	1,212	0.8
Senior warrant officer (W4–W5)	3,887	0.5	135	0.1	2,485	0.4	168	0.1	2,261	0.3	214	0.1
Times deployed to U.S. Central Command for more than 30 days during 2001–2016												
Never	460,650	65.1	113,109	79.1	300,420	43.0	97,670	64.0	437,304	66.9	123,160	78.4
1	163,755	23.2	22,284	15.6	256,356	36.7	40,939	26.8	135,796	20.8	25,173	16.0
2	58,599	8.3	5,684	4.0	103,370	14.8	10,852	7.1	56,733	8.7	6,741	4.3
3	16,245	2.3	1,347	0.9	26,910	3.9	2,355	1.5	16,513	2.5	1,516	1.0
4	4,847	0.7	317	0.2	7,128	1.0	519	0.3	4,621	0.7	368	0.2
5	1,735	0.2	107	0.1	2,372	0.3	153	0.1	1,605	0.2	95	0.1
>5	1,287	0.2	69	0.0	1,703	0.2	90	0.1	1,215	0.2	66	0.0
Times hospitalized in a military treatment facility or outsourced TRICARE facility during 2001–2016												
Never	657,591	93.0	125,220	87.6	632,875	90.6	121,502	79.6	621,119	95.0	135,033	85.9
1	33,619	4.8	11,017	7.7	45,894	6.6	19,912	13.1	25,412	3.9	15,082	9.6
2	9,169	1.3	3,856	2.7	11,509	1.6	6,922	4.5	4,799	0.7	4,779	3.0
3	3,295	0.5	1,524	1.1	3,899	0.6	2,410	1.6	1,398	0.2	1,425	0.9
4	1,591	0.2	630	0.4	1,859	0.3	945	0.6	565	0.1	483	0.3
5	733	0.1	276	0.2	850	0.1	385	0.3	210	0.0	162	0.1
>5	1,120	0.2	394	0.3	1,373	0.2	502	0.3	284	0.0	155	0.1
Serving in the military on:												
1 October 2001	707,118	100.0	142,917	100.0	248,292	35.6	48,079	31.5	107,066	16.4	21,078	13.4
1 April 2009	248,292	35.1	48,079	33.6	698,259	100.0	152,578	100.0	267,714	40.9	58,715	37.4
1 October 2016	107,066	15.1	21,078	14.7	267,714	38.3	58,715	38.5	653,787	100.0	157,119	100.0
Service												
Army	457,149	64.6	90,407	63.3	470,630	67.4	100,943	66.2	436,693	66.8	102,298	65.1
Navy	68,544	9.7	17,063	11.9	53,588	7.7	13,182	8.6	44,879	6.9	13,138	8.4
Air Force	144,106	20.4	33,593	23.5	138,330	19.8	36,581	24.0	135,120	20.7	40,084	25.5
Marine Corps	37,319	5.3	1,854	1.3	35,711	5.1	1,872	1.2	37,095	5.7	1,599	1.0

SD, standard deviation; IQR, interquartile range

FIGURE 1. Numbers of service men and women, by component, U.S. Armed Forces, 1 October 2001 through 1 October 2016

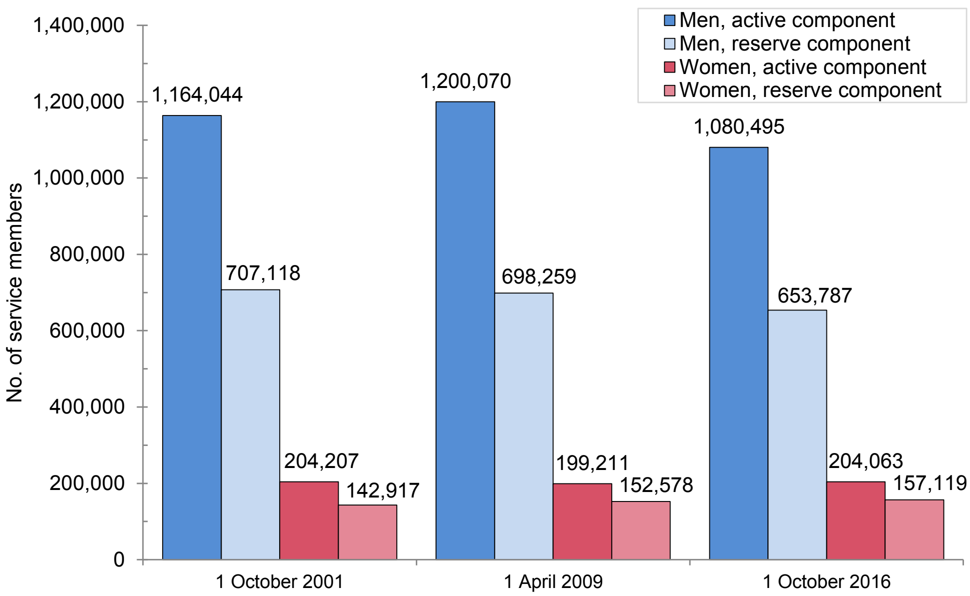


FIGURE 2. Percentages of service members ever deployed, U.S. Armed Forces, 1 October 2001 through 1 October 2016

The percentages of men in the active and reserve components who had ever been hospitalized in a military treatment facility or an outsourced TRICARE facility at any time during 1 October 2001–1 October 2016 were highest for those in service in 2009 and lowest for those serving in 2016 **(Figure 3)**. The same pattern was true for women in the active component; however, for women in the reserve component, the lowest percentage of hospitalizations was for those serving in 2001.

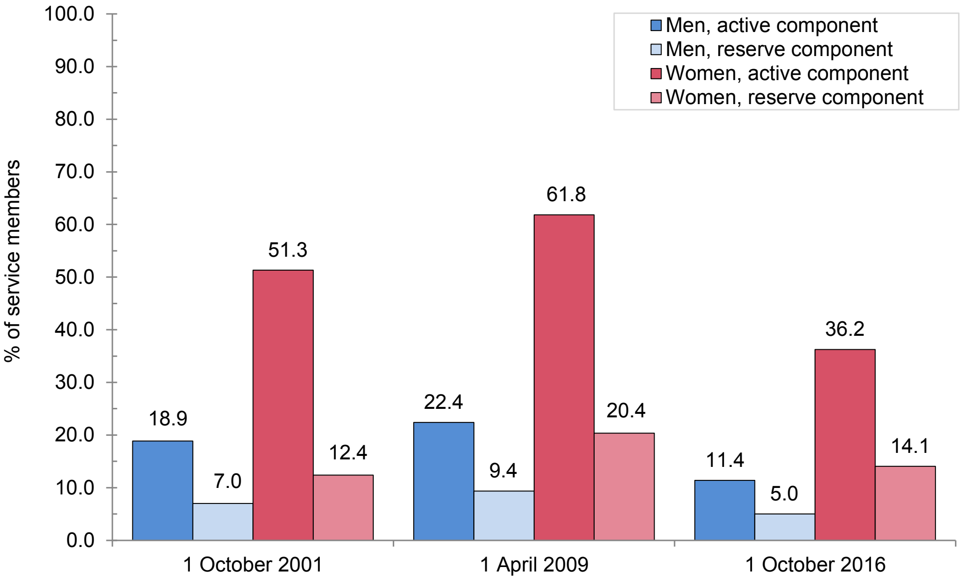
Of the 1,164,044 men in the active component in 2001, 39.0% and 15.6% were also serving in 2009 and 2016, respectively. Among the 204,207 women in the active component in 2001, 33.8% and 14.0% were serving in 2009 and 2016 **(Table 1)**. Similar proportions were noted for both men and women in the reserve component **(Table 2)**. Among men and women in the active component in 2009, the proportions who were serving in 2016 were 34.5% and 33.9%, respectively. For men and women in the reserve component in 2009, the proportions who were serving in 2016 were 38.3% and 38.5%, respectively.

The numbers of service members in each of the services changed at each point in time. For active component men, the Army and Marine Corps services were larger in 2009 than in 2001 but had declined to 2001 levels by 2016. In contrast, the numbers of active component male service members in the Navy and Air Force were lower at each successive point in time. For active component women, the number in the Marine Corps increased over time, but the number in the Navy was lowest in 2009 and highest in 2016. The numbers of active component women in the Army and Air Force declined throughout the period. In the reserve component, male Army strength was highest in 2009 while Navy and Air Force strength was lower at each successive point in time. Female reserve component strength increased at each successive time point for the Army and Air Force but decreased in each successive time point for Navy. The decline in overall reserve component strength of 4.6% across the three time periods is the net effect of a decrease of 7.5% for males but an increase of 9.9% for females.

EDITORIAL COMMENT

The number of men and women in uniform at the three time points examined in this article reflect the demands of U.S. Armed Forces operations at each time. The 2001 Armed Forces represented a force maintained in the era before the events of 11 September 2001. The demographics of 2009 and 2016 reflect first the ongoing conduct of two major combat operations (OEF and OIF) and then the time frame after the end of those operations. The greater number of service members in uniform on

FIGURE 3. Percentages of service members ever hospitalized, U.S. Armed Forces, 1 October 2001 through 1 October 2016



1 April 2009 is attributable to the demands of OIF and the then recently completed Iraq troop surge. Similarly, the percentages of service members who had ever deployed or been hospitalized at any point during 1 October 2001–1 October 2016 were highest among those serving during the 2009 midpoint of that period. The higher proportion of women who were hospitalized is undoubtedly due to maternal deliveries, which number about 15,000 per year among active component service women.[1]

The increasing percentage of Hispanic men and women serving in uniform reflects the changing composition of the U.S. civilian population and increased recruiting efforts.[2-5] The limited changes to the distribution of rank/grade and service branch through the time points are likely due to fixed military policies for these factors over time. However, the increased number of women serving in officer positions, particularly flag officers and senior warrant officers, may reflect increased retention rates among women over time and increased opportunities for advancement within the military.[6]

This study was limited in its ability to assess military demographic changes over time in that only three time points were assessed. More detailed demographic information regarding the U.S. Armed Forces can be found in the U.S. Department of Defense annual demographic reports.[7]

The findings of the current analysis may be used to provide an overall estimation of denominators of service members during the most recent three major military operations, and to provide historical context for the surveillance and assessment of health outcomes among U.S. Armed Forces related to the 15-year period of conflict in Southwest Asia.

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