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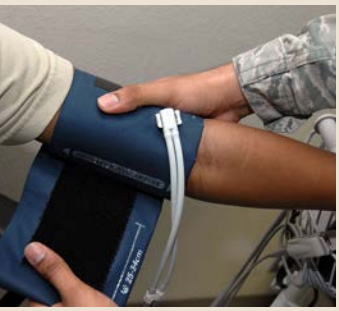

Mental Health Disorders and Mental Health Problems, Active Component, U.S. Armed Forces, 2007–2016

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Mental health disorders have historically accounted for significant morbidity, healthcare utilization, disability, and attrition from military service. From 2007 through 2016, a total of 853,060 active component service members were diagnosed with at least one mental health disorder and 115,378 were diagnosed with mental health problems related to family/support group problems, maltreatment, lifestyle problems, or substance abuse counseling. Annual rates of incident diagnoses of at least one mental health disorder decreased by approximately 6.2% during the period. Most of the incident mental health disorder diagnoses were attributable to adjustment disorders, depressive disorders, and anxiety disorders. Similar to the findings of a previous *MSMR* report, rates of incident mental health disorders were generally higher among females and Army members, and declined with increasing age. The number of individuals affected by any mental health diagnosis during deployment to a U.S. Central Command area of responsibility decreased from 10,951 in 2008 to 3,239 in 2016. Ongoing efforts to assist and treat service members should continue to promote help-seeking behavior to improve psychological and emotional well-being of service members and reduce the burden of mental health disorders.

In 2016, mental health disorders accounted for the largest total number of hospital bed days and the third highest total number of medical encounters for members of the active component of the U.S. Armed Forces.[1] A prior *MSMR* documented the increasing incidence of PTSD, anxiety disorders, depressive disorders, adjustment disorders, and other mental health disorders from 2003 through 2011.[2] Between 2000 and 2011, the highest incidence rates of mental health disorders diagnosed among active component service members were for adjustment disorders, "other" mental health disorders, depressive disorders, alcohol abuse or dependence, and anxiety disorders, respectively.[2] In general, crude incidence rates of mental health disorders were highest among service members in the Army, females, and in younger age groups.[2]

Psychosocial and behavioral health problems related to difficult life circumstances (e.g., marital, family, other interpersonal relationships) are also important to consider for comprehensive surveillance of service members' mental health; these are often documented using V-codes in ICD-9 and Z-codes in ICD-10. For example, one study found that service members who received mental health care (documented with V-coded diagnoses) were at greater risk of attrition from military service than those treated for only physical health conditions but at less risk of attrition than those who received mental health disorder–specific diagnoses.[3] In addition, Skopp et al. reported that service members with V-coded diagnoses indicating partner or family problems were at increased risk of suicide.[4]

This report summarizes the numbers, natures, and rates of incident mental health disorder diagnoses among active component U.S. service members over a 10-year surveillance period. It also summarizes the numbers, natures, and rates of incident "mental health problems" (documented with mental health–related V- or Z-codes in ICD-9 or ICD-10, respectively) among active component service members during the same period.

METHODS

The surveillance period was 1 January 2007 through 31 December 2016. The surveillance population included all individuals who served in the active component of the Army, Navy, Air Force, or Marine Corps at any time during the surveillance period. All data used to determine incident mental health disorder–specific diagnoses and mental health problems were derived from records routinely maintained in the Defense Medical Surveillance System (DMSS). These records document both ambulatory encounters and hospitalizations of active component members of the U.S. Armed Forces in fixed military and civilian (if reimbursed through the Military Health System) treatment facilities. Cases of each mental health disorder

TABLE 1. Mental health categories and ICD-9/ICD-10 diagnostic codes

Diagnostic category	ICD-9 codes	ICD-10 codes
Mental health disorders		
Adjustment disorders	309, 309.0, 309.1, 309.2, 309.21–309.24, 309.28, 309.29, 309.3, 309.4, 309.8, 309.82, 309.83, 309.89, 309.9	F43.2, F43.20–F43.25, F43.29, F43.8, F43.9, F93.0, F94.8, F94.9
Alcohol-related disorders	291.0, 291.81, 303.9, 303.90–303.93, 303.00, 303.01–303.03, 305.00, 305.01–305.03	F10.1, F10.10, F10.12, F10.120, F10.121, F10.129, F10.14, F10.15, F10.150, F10.151, F10.159, F10.18, F10.180, F10.181, F10.182, F10.188, F10.19, F10.2, F10.20–F10.22, F10.220, F10.221, F10.229, F10.23, F10.230–F10.232, F10.239, F10.24, F10.25, F10.250, F10.251, F10.259, F10.26, F10.27, F10.28, F10.280–F10.282, F10.288, F10.29
Substance-related disorders	304.*, 305.2*–305.9*	F11.2*, F12.2*, F13.2*, F14.2*, F15.2*, F16.2*, F18.2*, F19.2*, F11.1*, F13.1*, F14.1*, F15.1*, F16.1*, F18.1*, F19.1*
Anxiety disorders	300.22, 300.21, 300.23, 300.29, 300.20, 300.01, 300.02, 300.09, 300.00, 300.3	F40.0, F40.00, F40.01, F40.02, F40.1, F40.10, F40.11, F40.2, F40.21, F40.210, F40.218, F40.22, F40.220, F40.228, F40.23, F40.230–F40.233, F40.24, F40.240–F40.243, F40.248, F40.29, F40.290, F40.291, F40.298, F40.8, F40.9, F41, F41.0, F41.1, F41.3, F41.8, F41.9, F42.*
Post-traumatic stress disorder	309.81	F43.1, F43.10–F43.12
Depressive disorders	296.2, 296.21–296.26, 296.20, 296.3, 296.30–296.33, 296.35, 296.36, 296.9, 296.90, 296.99, 300.4, 311	F32.*, F33.*, F34, F34.1, F34.8, F34.9, F39, F348.1, F34.89
Bipolar disorder	296.0, 296.00, 296.01, 296.02, 296.03–296.06, 296.1, 296.10–296.16, 296.4, 296.40–296.46, 296.5, 296.50–296.56, 296.6, 296.60–296.66, 296.7, 296.8, 296.80, 296.81, 296.89, 301.13	F30, F30.1, F30.10–F30.13, F30.2–F30.4, F30.8, F30.9, F31, F31.0, F31.1, F31.10, F31.12, F31.13, F31.2, F31.3, F31.30–F31.32, F31.4–F31.6, F31.60, F31.61–F31.64, F31.7, F31.70–F31.78, F31.8, F31.81, F31.89, F31.9, F34.0
Personality disorders	301.10, 301.12, 301, 301.0, 301.1, 301.11, 301.2, 301.20, 301.21, 301.22, 301.3, 301.4, 301.5, 301.50, 301.59, 301.6, 301.7, 301.8, 301.81–301.84, 301.89, 301.9	F21, F60, F60.0, F60.2–F60.8, F60.81, F60.89, F60.9
Schizophrenia	295*	F20.*, F25.*
Psychotic disorders (other psychoses)	293.81, 293.82, 297.0, 297.1, 297.2, 297.3, 297.8, 297.9, 298.0, 298.1, 298.2, 298.3, 298.4, 298.8, 298.9	F06.0, F06.2, F22–F24, F28, F29
Other mental health disorder	Any other code between 290–319 (excluding 299.*, 305.1, 310.2, 315.*, 317.*–319.*)	Any other code between F01–F99 (excluding F07.81, F70–F79, F17.*, F80.*–F82.*, F84.*, F88–F89)
V-/Z-coded behavioral health problems		
Family/support group problems	V61.0*, V61.3, V61.41, V61.42, V61.49, V61.8, V61.9, V62.82	Z63.*
Maltreatment-related	V61.11, V61.12, V61.21, V61.22, V62.83	Z69.*
Lifestyle problems	V49.85, V62.4, V62.89, V69.*, V71.01, V71.02	Z72.*, Z73.*
Substance abuse counseling	V65.42	Z71.4*, Z71.5*, Z71.6

*Any digit/character

that occurred during periods of deployment to a U.S. Central Command (CENTCOM) area of responsibility (AOR) were evaluated separately. These diagnoses were derived from records of medical encounters of deployed service members that were documented in the Theater Medical Data Store (TMDS).

For surveillance purposes, "mental health disorders" were ascertained from records of medical encounters that included mental health disorder–specific diagnoses (ICD-9: 290–319; ICD-10: F01–F99 **[Table 1]**) in the 1st or 2nd diagnostic position. Diagnoses of pervasive developmental disorder (ICD-9: 299.*; ICD-10: F84.*), specific delays in development (ICD-9: 315.*; ICD-10: F80.*–F82.*, F88–F89), mental retardation (ICD-9: 317.*–319.*; ICD-10: F70–F79), tobacco use disorder/nicotine dependence (ICD-9: 305.1; ICD-10: F17.*), and post-concussion syndrome (ICD-9: 310.2; ICD-10: F07.81) were excluded from the analysis. Diagnoses of

"mental health problems" were ascertained from records of healthcare encounters that included V- or Z-coded diagnoses indicative of psychosocial or behavioral health issues in the 1st or 2nd diagnostic position **(Table 1)**. "Family/support group problems" included family disruption, health problems within the family, bereavement, and other family problems; "maltreatment" included counseling and other encounters for victims or perpetrators of abuse; "lifestyle problems" included social maladjustment, lack of exercise, high-risk sexual behavior, sleep deprivation, and other psychological or physical stress; and "substance abuse counseling" included counseling encounters for substance use and abuse.

Each incident diagnosis of a mental health disorder or a mental health problem was defined by a hospitalization with an indicator diagnosis in the 1st or 2nd diagnostic position; two outpatient visits within 180 days documented with indicator diagnoses (from the same mental health disorder or mental health problem–specific category) in the 1st or 2nd diagnostic positions; or a single outpatient visit in a psychiatric or mental healthcare specialty setting (defined by Medical Expense and Performance Reporting System [MEPRS] code beginning with "BF") with an indicator diagnosis in the 1st or 2nd diagnostic position. The case definition for schizophrenia required either a single hospitalization with a diagnosis of schizophrenia in the 1st or 2nd diagnostic position or four outpatient encounters with a diagnosis of schizophrenia in the 1st or 2nd diagnostic position. Schizophrenia cases who remained in the military for more than 2 years after becoming incident cases were excluded as these cases were assumed to have been misdiagnosed.

Service members who were diagnosed with one or more mental health disorders prior to the surveillance period (i.e., prevalent cases) were not considered at risk of incident diagnoses of the same conditions during the period. Service members who were diagnosed with more than one mental health disorder during the surveillance period were considered incident cases in each category in which they fulfilled the case-defining criteria. Service members could be incident cases only once in each mental health disorder–specific category. Only service members with no incident mental health disorder–specific diagnoses (ICD-9: 290–319; ICD-10: F01–F99) during the surveillance period were eligible for inclusion as cases of incident mental health problems (selected V- or Z-codes).

RESULTS

During the 10-year surveillance period, 853,060 active component service members were diagnosed with at least one mental health disorder; of these individuals, 435,898 (51.1%) were diagnosed with mental health disorders in more than one diagnostic category. Overall, there were 1,672,809 incident diagnoses of mental health disorders in all diagnostic categories **(Table 2a)**. Annual numbers and rates of incident diagnoses of at least one mental health disorder decreased by 6.2% during the period, from 981.2 cases per 10,000 person-years (p-yrs) in 2007 to 920.6 cases per 10,000 p-yrs in 2016.

Over the entire period, 92.4% of all incident mental health disorder diagnoses were attributable to adjustment disorders (n=467,305; 27.9%), depressive disorders (n=281,829; 16.8%), anxiety disorders (n=249,882; 14.9%), "other" mental health disorders (n=244,535; 14.6%); alcohol-related disorders (165,347; 9.9%), and PTSD (138,221; 8.3%). In comparison, relatively few incident diagnoses were attributable to substance-related disorders (n=55,133; 3.3%), personality disorders (36,510; 2.2%), bipolar disorder (19,666; 1.2%), psychotic disorders (11,514; 0.7%), and schizophrenia (2,867; 0.2%) **(Table 2a)**.

It was common for individuals who were diagnosed with alcohol- or substance-related disorders to also be diagnosed with other mental health disorders during the period. Among individuals who were diagnosed with alcohol-related disorders, 40.6% were also diagnosed with incident adjustment disorder and 31.9% with depressive disorder. Among those diagnosed with substance-related disorders, 54.8% were diagnosed with alcohol-related disorders and 46.6% were diagnosed with adjustment disorders **(data not shown)**.

Crude annual rates of incident diagnoses of alcohol-related disorders, substance-related disorders, and depressive disorders declined during the surveillance period. In contrast, crude annual incidence rates of diagnoses of anxiety disorders increased, and all other mental health diagnoses were relatively stable during the period **(Figure 1)**.

In all categories of mental health disorders, the proportions of incident diagnoses that affected military members in their first 6 months of service generally declined from 2007 through 2011 and remained stable from 2011 through 2016; however, the proportions of other psychotic disorders and schizophrenia diagnosed within the first 6 months of service increased slightly during 2015–2016. The mental health disorders that were relatively most frequently diagnosed in the first 6 months of service were personality disorders (11.3%), psychotic disorders (10.5%), and adjustment disorders (10.0%) **(data not shown)**.

In general, rates of incident mental health disorder diagnoses were higher among females than males, except for schizophrenia, for which rates were similar between the two sexes **(Figure 2)**. In addition, rates of both alcohol- and substance-related disorders were higher among men. Rates of most mental health disorder diagnoses declined with increasing age **(Figure 3)**. In particular, crude incidence rates of adjustment, bipolar, personality, and psychotic disorders were higher among the youngest (less than 20 years old), compared to any older age group of service members. Rates of alcohol- and substance-related disorders, depressive disorders, schizophrenia, and "other" mental health disorders were highest among service members aged 20–24 years, and the rate of anxiety disorders was highest among those aged 25–29 years **(Figure 3)**. In contrast, the rate of PTSD was highest among service members in their 40s.

Overall incidence rates of mental health disorders were higher in the Army than in any of the other services **(Figure 4)**. The Army also had the highest crude incidence rates for each category of mental health disorders except other psychoses. Crude incidence rates for adjustment disorders, depressive disorders, personality disorders, bipolar disorder, schizophrenia,

TABLE 2a. Incident diagnoses and rates of mental health disorders, active component, U.S. Armed Forces, 2007–2016

	Total (2007–2016)		2007		2008		2009		2010		2011	
Category[a]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]
Adjustment disorders	467,305	420.1	38,145	352.6	45,464	418.0	47,436	424.4	48,880	434.9	52,468	471.7
Alcohol-related disorders	165,347	139.3	18,549	166.3	20,163	178.6	20,389	174.2	17,946	151.0	16,427	138.0
Substance-related disorders	55,133	44.7	5,589	48.4	6,809	58.1	7,583	62.2	7,104	57.4	6,670	53.8
Anxiety disorders	249,882	212.0	16,045	141.9	19,716	172.6	21,590	182.8	22,252	186.4	26,930	226.7
Post-traumatic stress disorder	138,221	114.1	10,975	95.6	13,671	117.8	13,139	109.2	13,666	112.1	15,039	123.6
Depressive disorders	281,829	242.5	25,921	234.6	29,257	262.0	30,106	261.0	28,029	240.0	30,220	259.4
Bipolar disorder	19,666	15.9	2,492	21.5	2,694	22.9	2,665	21.8	2,143	17.2	2,008	16.1
Personality disorders	36,510	29.6	5,929	51.4	5,028	42.9	4,073	33.4	3,263	26.3	3,432	27.7
Schizophrenia	2,867	2.3	296	2.5	298	2.5	316	2.6	293	2.3	295	2.4
Psychotic disorders	11,514	9.3	1,376	11.9	1,464	12.4	1,423	11.6	1,037	8.3	1,280	10.3
Other mental health disorders	244,535	209.3	21,275	190.8	23,522	208.9	23,890	205.1	24,923	211.6	25,655	218.6
No. of individuals												
>1 type of mental health diagnosis	435,898	379.3	32,034	318.1	37,723	359.5	38,543	347.0	36,824	321.8	39,314	339.5
Any mental health diagnosis[c]	853,060	742.3	98,809	981.2	110,339	1051.4	114,088	1027.3	115,881	1012.8	122,320	1056.4

TABLE 2a (cont.) Incident diagnoses and rates of mental health disorders, active component, U.S. Armed Forces, 2007–2016

	Total (2007–2016)		2012		2013		2014		2015		2016	
Category[a]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]
Adjustment disorders	467,305	420.1	53,899	479.6	47,022	414.6	43,654	386.7	44,442	399.1	45,895	417.0
Alcohol-related disorders	165,347	139.3	17,171	141.2	14,617	118.9	13,507	110.3	13,403	111.0	13,175	110.0
Substance-related disorders	55,133	44.7	5,976	47.2	4,890	38.3	4,132	32.6	4,011	32.1	2,369	19.1
Anxiety disorders	249,882	212.0	30,177	250.7	29,290	242.2	28,780	240.2	28,721	243.9	26,381	226.7
Post-traumatic stress disorder	138,221	114.1	16,973	137.1	14,691	117.7	13,999	112.8	13,406	109.6	12,662	104.5
Depressive disorders	281,829	242.5	31,048	261.9	28,805	240.7	27,110	227.6	26,503	225.5	24,830	213.1
Bipolar disorder	19,666	15.9	1,841	14.5	1,669	13.0	1,432	11.2	1,423	11.3	1,299	10.5
Personality disorders	36,510	29.6	3,059	24.1	2,886	22.6	2,937	23.1	2,974	23.8	2,929	23.7
Schizophrenia	2,867	2.3	313	2.5	288	2.2	248	1.9	249	2.0	271	2.2
Psychotic disorders	11,514	9.3	1,267	10.0	1,160	9.0	967	7.6	828	6.6	712	5.7
Other mental health disorders	244,535	209.3	26,942	225.9	25,035	208.3	22,809	191.0	23,321	198.1	27,163	233.8
No. of individuals												
>1 type of mental health diagnosis	435,898	379.3	41,155	345.1	36,547	301.4	34,658	285.4	34,990	290.5	33,184	276.7
Any mental health diagnosis[c]	853,060	742.3	128,483	1077.4	117,724	970.7	109,293	899.9	108,603	901.7	110,419	920.6

[a]An individual may be a case within a category only once per lifetime.
[b]Rate per 10,000 person-years
[c]At least one recorded mental health disorder diagnosis

and other psychotic disorders were higher among those in motor transport occupations than in any other occupation category **(Figure 5)**. Crude incidences of alcohol- and substance-related disorders and PTSD were higher among those in combat-related and motor transport occupations. In contrast, crude incidence rates of anxiety and "other" mental health disorders were highest among those in healthcare occupations. Finally, rates of incident anxiety disorder, PTSD, depressive disorders, and "other" mental health disorders were highest among service members who had ever deployed to a CENTCOM AOR **(data not shown)**.

During the surveillance period, there were 123,763 incident diagnoses of mental health problems related to family/support group problems, maltreatment, lifestyle problems, or substance abuse counseling (documented with ICD-9 and ICD-10 V- and Z-codes, respectively) among 115,378 active component members who were not diagnosed with a mental health disorder (ICD-9: 290–319; ICD-10: F01–F99). During the period, slightly more than one-third

TABLE 2b. Incident diagnoses and rates of V-/Z-coded mental health visits, among those without a mental health disorder diagnoses, active component, U.S. Armed Forces, 2007–2016

	Total (2007–2016)		2007		2008		2009		2010		2011	
Category[a]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]
Family/support group problems	32,964	27.1	2,417	21.3	2,476	21.4	2,234	18.6	2,661	21.7	2,653	21.6
Maltreatment-related	4,218	3.4	580	5.0	339	2.9	217	1.8	306	2.5	292	2.4
Lifestyle problems	42,316	34.9	3,210	28.4	3,000	26.0	4,008	33.4	2,620	21.5	2,990	24.4
Substance abuse counseling	44,265	36.4	4,395	38.6	5,066	43.7	5,769	47.9	5,159	42.2	4,819	39.3
No. of individuals												
>1 type of V-/Z-coded diagnosis	7,982	6.9	324	3.2	368	3.5	251	2.3	296	2.6	348	3.0
Any V-/Z-coded diagnosis[c]	115,378	100.4	10,271	102.0	10,500	100.1	11,971	107.8	10,444	91.3	10,401	89.8

TABLE 2b (cont.) Incident diagnoses and rates of V-/Z-coded mental health visits, among those without a mental health disorder diagnoses, active component, U.S. Armed Forces, 2007–2016

	Total (2007–2016)		2012		2013		2014		2015		2016	
Category[a]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]
Family/support group problems	32,964	27.1	2,995	23.9	3,122	24.7	3,060	24.4	4,094	33.1	7,252	59.4
Maltreatment-related	4,218	3.4	229	1.8	281	2.2	344	2.7	484	3.9	1,146	9.3
Lifestyle problems	42,316	34.9	3,694	29.5	4,650	36.9	5,071	40.5	6,135	49.8	6,938	57.0
Substance abuse counseling	44,265	36.4	4,544	36.3	4,682	37.2	3,783	30.2	3,263	26.5	2,785	22.8
No. of individuals												
>1 type of V-/Z-coded diagnosis	7,982	6.9	350	2.9	441	3.6	459	3.8	602	5.0	920	7.7
Any V-/Z-coded diagnosis[c]	115,378	100.4	11,106	93.1	12,281	101.3	11,786	97.0	13,357	110.9	17,178	143.2

[a]An individual may be a case within a category only once per lifetime.
[b]Rate per 10,000 person-years
[c]At least one reported mental health problem (V-/Z-coded diagnosis)

(35.8%) of all incident diagnoses of these mental health problems were related to substance abuse counseling and an additional one-third (34.2%) were related to lifestyle problems **(Table 2b)**. A little more than one-quarter (26.6%) were related to family/support group problems and only 3.4% were related to maltreatment (i.e., counseling and encounters for victims or perpetrators of abuse).

Rates of any V-/Z-coded mental health problems were fairly stable from 2007 through 2014, and then increased sharply in 2015 and 2016 **(Figure 6)**. This increase was primarily driven by family/support group problems. Rates of lifestyle-related problems increased steadily from 2010 through 2016, whereas substance abuse counseling decreased steadily during 2009–2016. In general, rates of mental health problems related to family/support group and maltreatment were higher among service members in the Army, women, non-Hispanic blacks, those aged 20–24 years, and those in motor transport occupations **(data not shown)**. Incidence of substance abuse counseling was highest among service members in the Air Force, men, those aged 24 years or younger, and those in "other" occupations. Incidence of substance abuse counseling was relatively evenly distributed among the race/ethnicity categories. Finally, incidence of lifestyle-related problems was highest among service members in the Air Force and Army, women, non-Hispanic blacks, those less than 20 years of age, and those in "other" and motor transport occupations **(data not shown)**.

A significant proportion of mental health problems related to lifestyle occur in the first 6 months of service members' military service; overall, 10% of these lifestyle-related problems were diagnosed within the first 6 months of service **(data not shown)**. Only 5.5% of mental health problems related to substance abuse counseling, 1.8% related to family/support group, and 0.4% related to maltreatment were diagnosed in the first 6 months of service.

During 2008–2016, there were 53,966 individuals with any diagnosis for a mental health disorder during deployment to a CENTCOM AOR, representing 154,676 total encounters **(data not shown)**. The number of individuals affected by any mental health diagnosis during deployment to a CENTCOM AOR decreased during the surveillance period, from 10,951 in 2008 to 3,239 in 2016 **(Figure 7)**.

FIGURE 1. Annual incidence rates of mental health disorders, active component, U.S. Armed Forces, 2007–2016

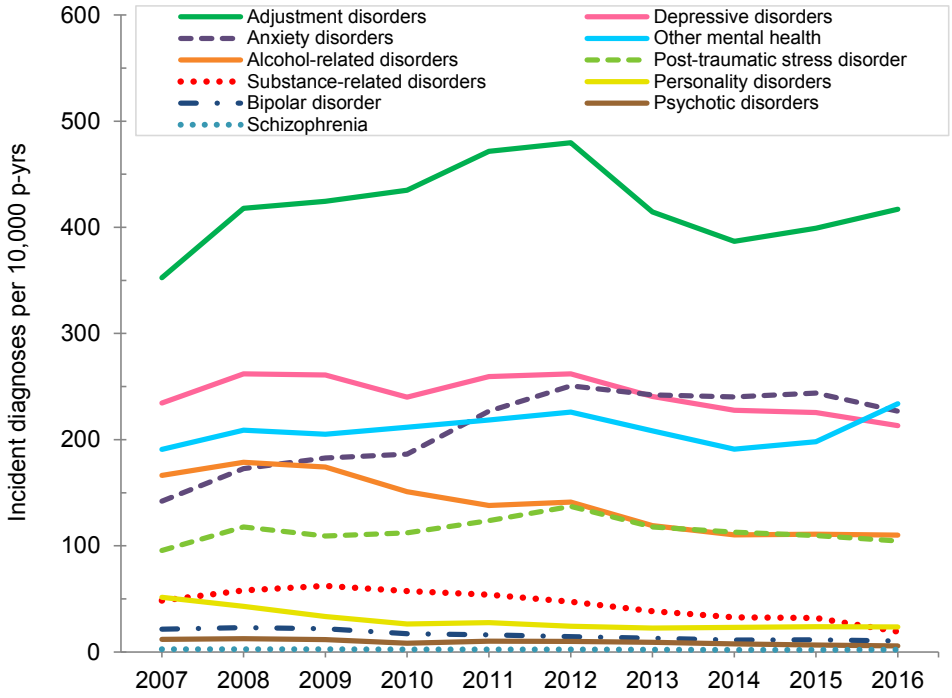
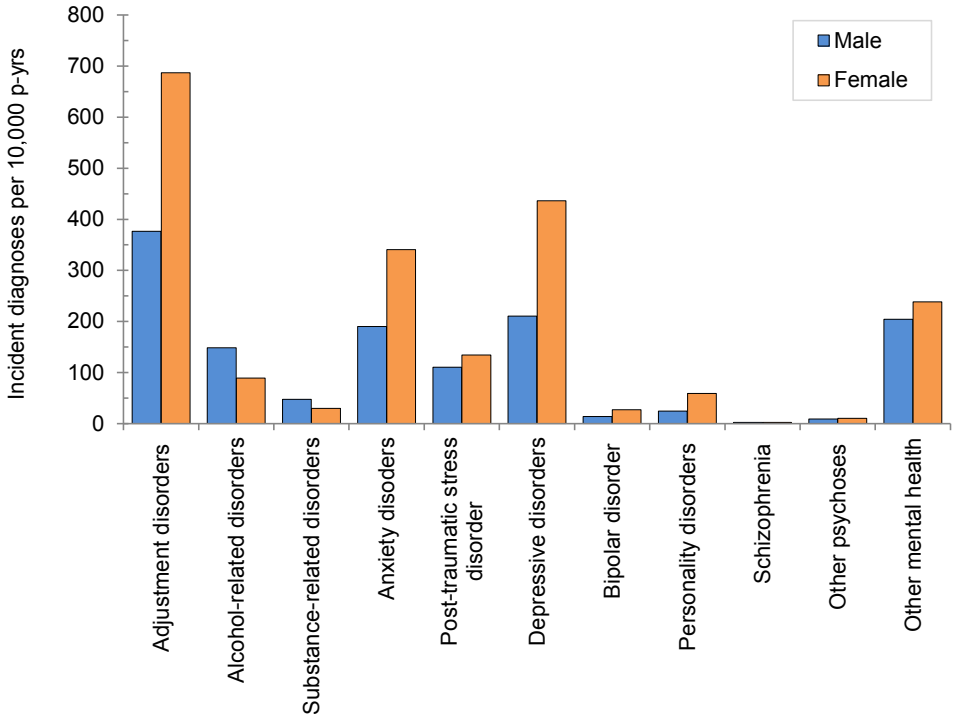


FIGURE 2. Incidence rates of mental health disorder diagnoses, by category and sex, active component, U.S. Armed Forces, 2007–2016



EDITORIAL COMMENT

This report describes incident diagnoses for mental health disorders among active component service members of the U.S. Armed Forces. Similar to the findings of the previous *MSMR* report, adjustment disorders were the most commonly diagnosed incident mental health disorder, and depressive disorders, anxiety disorders, alcohol-related disorders, and "other" mental health disorders were also relatively common.[2] In contrast to the previous *MSMR* report, which documented an overall increase in mental health disorders from 2003 through 2009, data presented here show an overall decline in crude incidence of any mental health disorder from 2007 to 2016, with notable decreases in the incidence of alcohol- and substance-related disorders, personality disorders, and depressive disorders. The incidence rates of most other mental health diagnoses remained relatively stable during the period.

The overall decline in rates of incident mental health disorder diagnoses could have been driven by two primary factors. First, the period from 2011 through 2016 coincided with a period of significant reduction of U.S. Armed Forces in Iraq, and with an official end to combat operations in Afghanistan at the end of 2014. In this report and in several previous studies, mental health disorders such as anxiety, depression, and PTSD have been found to be significantly higher among service members with histories of deployment to a CENTCOM AOR, and the decline in mental health disorders could be related to reduced levels of deployment and combat exposure during this period.[5-7] This assessment is reinforced by the finding of decreasing numbers of medical encounters for, and individuals receiving, mental health diagnoses during deployment, and the rates of several mental health disorders being higher among those in combat-related occupations. Second, the Department of Defense (DoD) has recently promoted anti-stigma efforts to encourage individuals to seek treatment and to demonstrate that seeking treatment will not harm one's military career. One example of this is the "Real Warriors" campaign launched in 2009, which utilized a website with articles on psychological disorders and their treatment, as well as a crisis intervention hotline (https://www.realwarriors.net).[8] Although these efforts to combat stigma may have resulted in an initial increase of diagnoses as more people with symptoms came forward, they may have also attenuated the incidence of new diagnoses if service members self-treated (e.g., stress reduction, counseling, resilience

FIGURE 3. Incidence rates of mental health disorder diagnoses, by category and age group, active component, U.S. Armed Forces, 2007–2016

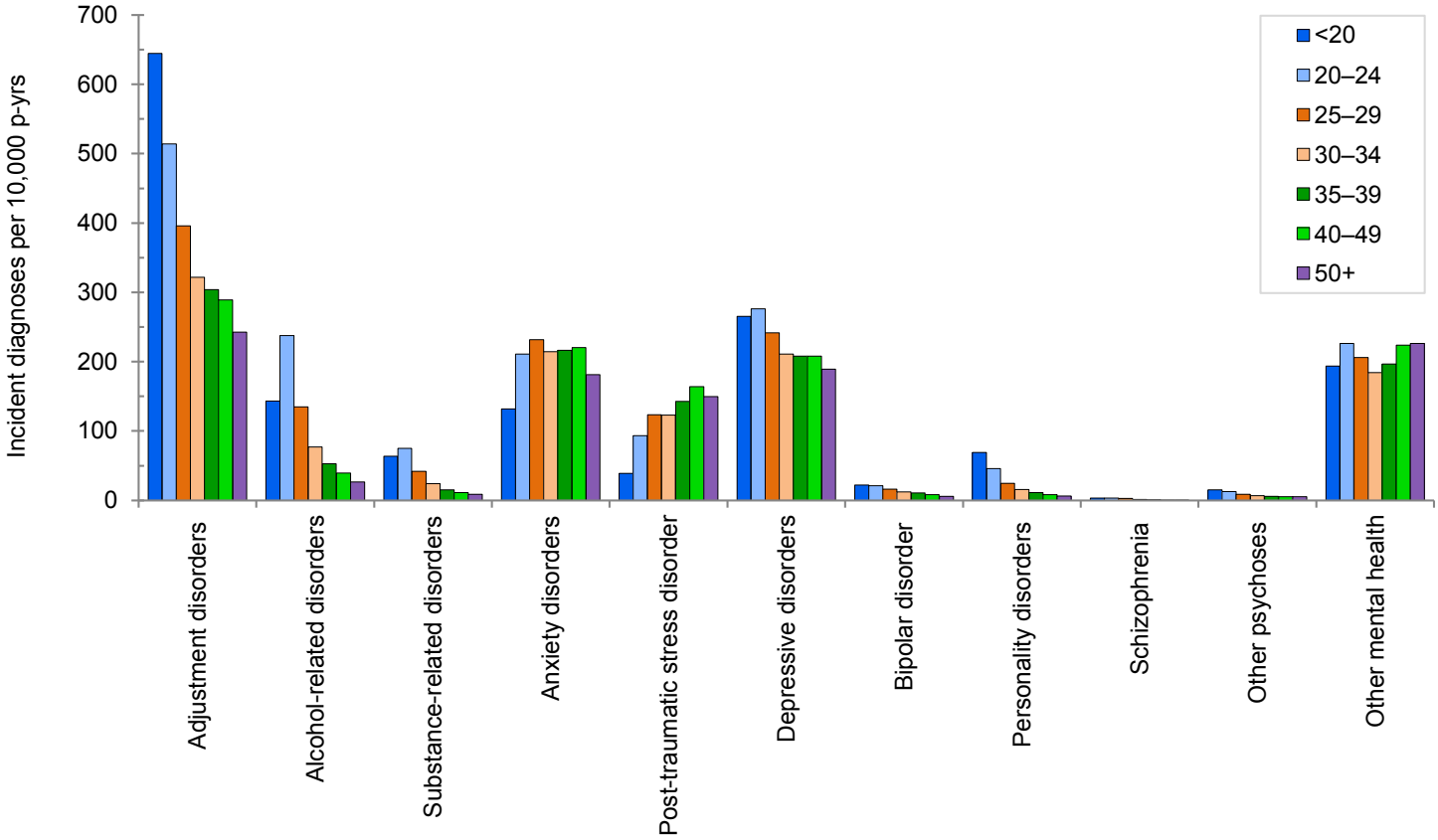


FIGURE 4. Incidence rates of mental health disorder diagnoses, by category and service, active component, U.S. Armed Forces, 2007–2016

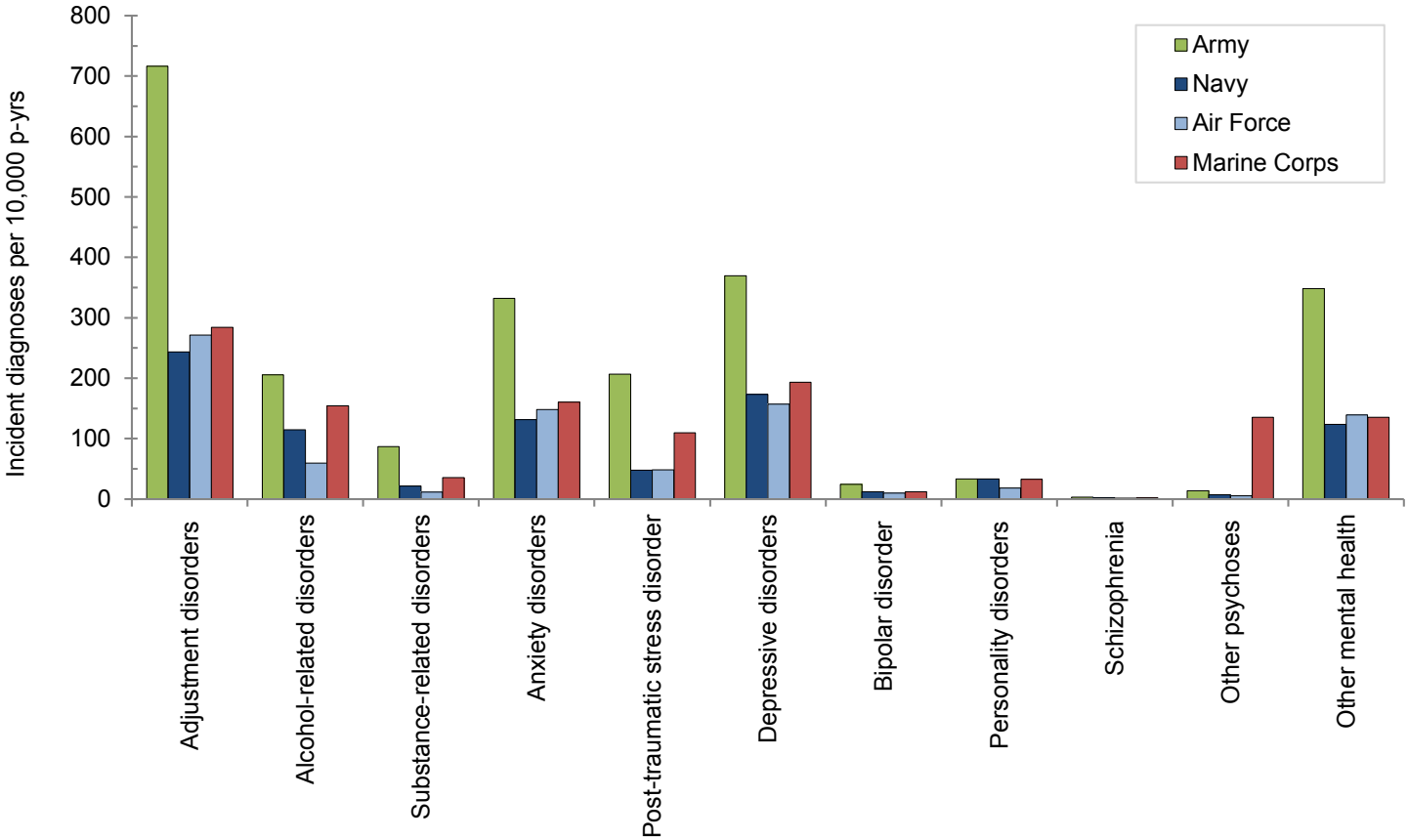
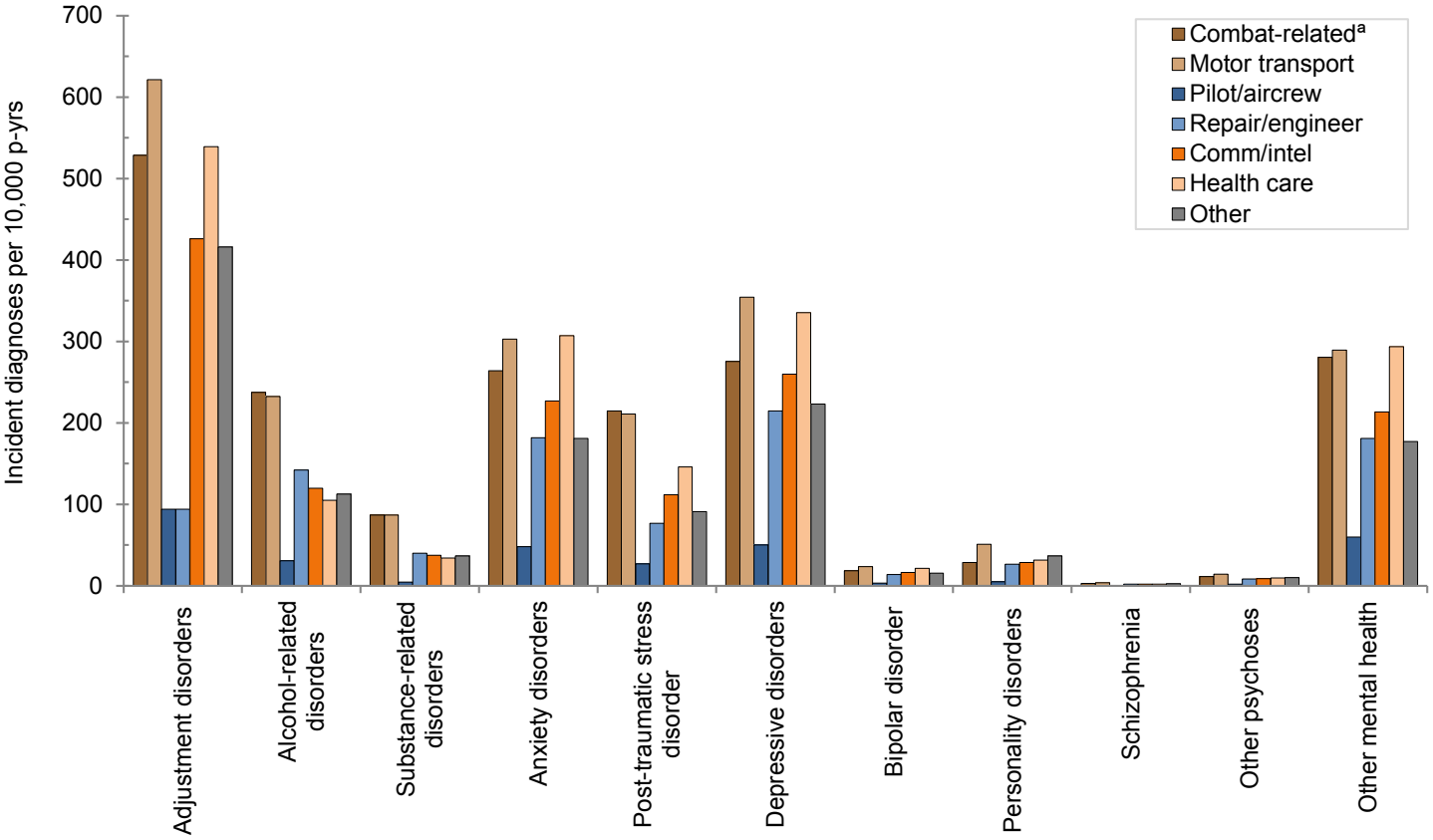


FIGURE 5. Incidence rates of mental health disorder diagnoses, by category and military occupation, active component, U.S. Armed Forces, 2007–2016



[a]Infantry/artillery/combat engineering

building) before more severe clinical diagnoses were made.

Also in accordance with a previous report, rates of incident mental health disorders were generally higher among females than males and among Army service members, but rates declined with increasing age.[2] Of note, however, the incidence of PTSD began to shift to older age groups around 2010. The reasons for this are not immediately apparent, although the shift could be related to the drawdown of U.S Armed Forces in Iraq and Afghanistan during the surveillance period because older service members are more likely to have had one or multiple deployments. A recent meta-analysis of risk factors for combat-related PTSD reported mixed findings with respect to the relationship between age and PTSD.[9] In addition, PTSD was more common among men than women in the previous *MSMR* report covering a 2000–2011 surveillance period, but

FIGURE 6. Annual incidence rates of V-/Z-coded mental health diagnoses, active component, U.S. Armed Forces, 2007–2016

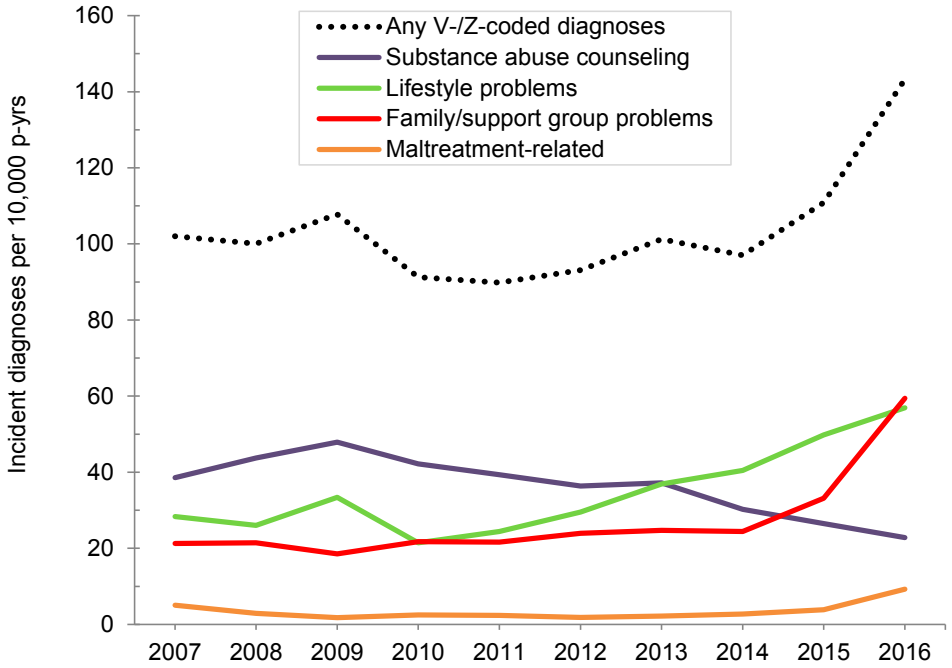
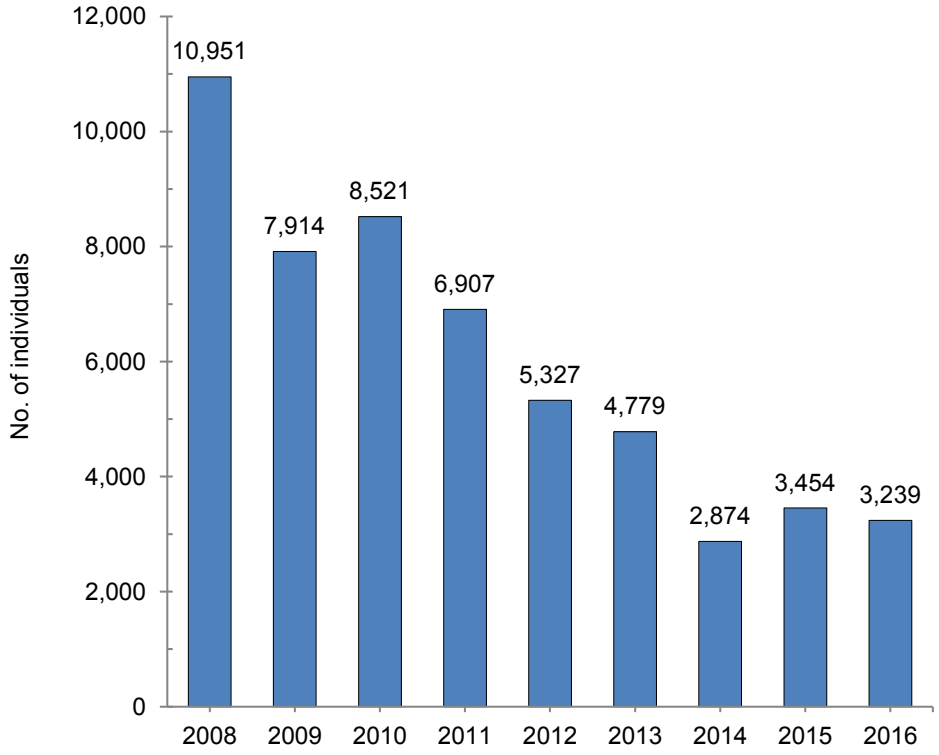


FIGURE 7. Annual numbers of individuals affected by any mental health disorder diagnosis during deployment to a U.S. Central Command area of responsibility, active component, U.S. Armed Forces, 2008–2016



the findings presented here demonstrate a higher incidence among women from 2009 to 2016. This could be related to a growing number of women having been exposed to combat or other traumatic exposures such as sexual harassment or sexual assault.[10]

The decline of alcohol- and substance-related disorders diagnosed during the surveillance period is also noteworthy. In 2012, the Institute of Medicine (IOM) released a report that analyzed the policies and programs within the DoD that pertain to prevention, screening, diagnosis, and treatment of substance use disorders among service members. The IOM report recommended to military leadership several proactive public health interventions such as limiting access to alcohol, encouraging service members to seek help without fear of stigma or negative consequences through confidential treatment programs, increasing the use of evidence-based programs and practices, and expanding access to care.[11] Although the results presented here cannot provide direct evidence for the effectiveness of these programs, they do support the hypothesis that at least some of these interventions have been effective in reducing rates of substance use disorders.

There are significant limitations to this report that should be considered when interpreting the results. For example, incident cases of mental health disorders and mental health problems were ascertained from ICD-9-/ICD-10-coded diagnoses that were reported on standardized administrative records of outpatient clinic visits and hospitalizations. Such records are not completely reliable indicators of the numbers and types of mental health disorders and mental health problems that actually affect military members. For example, the numbers reported here are underestimates to the extent that affected service members did not seek care or received care that is not routinely documented in records that were used for this analysis (e.g., private practitioner, deployed troop clinic, counseling or advocacy support center); that mental health disorders and mental health problems were not diagnosed or reported on standardized records of care; and/or that some indicator diagnoses were miscoded or incorrectly transcribed on the centrally transmitted records. On the other hand, some conditions may have been erroneously diagnosed or miscoded as mental health disorders or mental health problems (e.g., screening visits). In addition, the analyses reported here summarize the experiences of individuals while they were serving in an active component of the U.S. military; as such, the results do not include mental health disorders and mental health problems that affected members of reserve components or veterans of recent military service who received care outside of the Military Health System.

The accuracy of estimates of the numbers, natures, and rates of illnesses and injuries of surveillance interest depend to a great extent on specifications of the surveillance case definitions that are used to identify cases. If case definitions with different specifications were used to identify cases of nominally the same conditions, the resultant estimates of numbers, rates, and trends might vary from those reported here. Furthermore, the transition from ICD-9 to ICD-10 posed a challenge in creating comparable code groupings for the behavioral health V-/Z-coded disorders. In particular, the increase in V-/Z-coded diagnoses from 2015 through 2016 is likely related to the transition from ICD-9 to ICD-10. Future analyses using only Z-coded diagnoses will help to determine whether there is a true increase in mental health problems such as family/support group problems.

Overall, this report indicates that the incidence of mental health disorders has stabilized in the past decade, in contrast to the trend of increasing incidence observed in previous years. Ongoing efforts to assist and treat service members should continue to promote help-seeking behavior to improve the psychological and emotional well-being of U.S. service members.

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Key points

- Incidence of mental health disorders in the active component of the U.S. Armed Forces remained relatively stable from 2007 to 2016 and in some instances even decreased, in contrast to the trend of increasing incidence observed from 2003 through 2009.
- Most of the incident mental health disorder diagnoses during the surveillance period were attributable to adjustment disorders, depressive disorders, anxiety disorders, "other" mental health disorders, alcohol-related disorders, and post-traumatic stress disorder.
- Similar to the findings from previous surveillance reports, rates of incident mental health disorders were generally higher among females and Army members, and declined with increasing age.

Learning objectives

1. The reader will understand recent trends in the incidence of mental health disorders among the active component of the U.S. Armed Forces.
2. The reader will identify factors (e.g., age and sex) that correlate with mental health disorders in the population studied.
3. The reader will recognize that, in addition to medically coded mental health disorders, mental health problems identified using V-/Z-codes also account for significant morbidity among service members.

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Incidence Rates of Diagnoses of Cardiovascular Diseases and Associated Risk Factors, Active Component, U.S. Armed Forces, 2007–2016

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During 2007–2016, 18.1% of all active component service members were diagnosed with at least one of the five risk factors for cardiovascular disease (CVD) studied in this analysis. In addition, 0.6% of service members were diagnosed with at least one of the four CVDs studied. The most frequently diagnosed risk factors were (in descending order of frequency) obesity, hyperlipidemia, essential hypertension, abnormal blood glucose level, and diabetes mellitus. Incidence rates of both risk factors and CVD were progressively higher with advancing age. Annual incidence rates during the 10-year period declined for the risk factors hyperlipidemia, hypertension, and diabetes, but rose for obesity and abnormal blood glucose level. Annual rates of the CVDs ischemic heart disease and cerebrovascular disease declined, but rates of hypertensive heart/kidney disease and atherosclerosis remained relatively stable. Noteworthy findings were the increase in incidence rates of obesity, the decline in incidence rates of ischemic heart disease, and the decline in rates of hypertension in non-Hispanic black service members. The identification of CVD risk factors, including others not studied in this analysis, offers the opportunity for preventive interventions that can reduce the rates of clinical CVD during, but especially after, military service.

The American Heart Association (AHA) estimates that more than one-third of American adults have at least one type of cardiovascular disease (CVD) and 50% of the affected adults are 60 years of age or older.[1] Furthermore, the AHA cites projections that, by the year 2030, 44% of the U.S. population will have some form of CVD.[1] Since the early 1900s, CVD has accounted for more deaths in the U.S. than any other major cause of death.[1] Although U.S. mortality rates from CVD have declined during the past two decades, in 2014, CVD was the underlying cause of 30.8% of all deaths, whereas cancer—the second leading cause of death—was responsible for 22.5% of all deaths.[1]

Numerous major risk factors have been linked to CVD. They include high blood cholesterol levels, high blood pressure, smoking, insulin resistance (marked by elevated fasting blood glucose level), diabetes, overweight or obesity, lack of physical activity, unhealthy diet, older age, and family history (particularly a history of early coronary heart disease).[2] Optimal cardiovascular health is marked by the absence of those risk factors that are susceptible to intervention. Of those factors mentioned above, only age and family history are not modifiable by either individual lifestyle modification or medical detection and intervention.[1]

With respect to risk factors for CVD, members of the Armed Forces differ from the general U.S. population by virtue of being younger (96% are less than 45 years old), more physically active, and having been in good physical health at the time of entry into military service.[3] However, following entry, many service members develop or are discovered to have risk factors for CVD.[4] Most service members with risk factors may never develop overt CVD while in uniform. However, if the risk factors are recognized and they take steps to modify their lifestyles or obtain appropriate medical intervention, then they can reduce the likelihood of significant CVD not only while members of the Armed Forces, but also during the years following their military service.

Studies of the burden of disease and injury among active component service members have documented that the incidence of diagnoses of CVD is considerably lower than the incidence of many other types of disorders.[5] Given the relative youth of service members and the nature of their duties, these observations about the relatively infrequent occurrence of CVDs are not surprising. This report represents an extension of a previous *MSMR* study that examined the incidence and prevalence of select risk factors for CVD among active component service members in the U.S. Armed Forces.[4] This analysis not only reports on more recent incidence rates of CVD risk factors through 2016, but also provides estimates of the incidence rates of major categories of cardiovascular diseases themselves.

METHODS

The surveillance period was 1 January 2007 through 31 December 2016. The surveillance population included any individual who served in the active component (AC) of the U.S. Army, Navy, Air Force, or Marine Corps at any time during the surveillance period. All data used to determine incident cases were derived from records routinely maintained in the Defense Medical

Surveillance System (DMSS). These records document both ambulatory encounters and hospitalizations of AC members of the U.S. Armed Forces in fixed military and civilian (if reimbursed through the Military Health System) treatment facilities.

For surveillance purposes of counting CVD risk factors, an incident case of hypertension, hyperlipidemia, obesity, or abnormal blood glucose was defined as any inpatient or outpatient medical encounter with one of the ICD-9 or ICD-10 codes of interest in any diagnostic position **(Table 1)**. An incident case of diabetes mellitus was defined as having two or more inpatient or outpatient medical encounters occurring within 90 days of each other with a defining diagnosis code in the first diagnostic position. Women with a hospitalization with a diagnosis code for labor and delivery (ICD-9: 650.*–659.*, 660.*–669.*, V27.*; ICD-10: O60.*–O77.*, O80, O82, Z37.*) within 6 months before or after an incident diabetes diagnosis were excluded because they were assumed to have gestational diabetes. However, these women were eligible to be counted as incident cases if at least 6 months had passed since a labor and delivery code had been documented in their records. No attempt was made to estimate the incidence or prevalence of smoking, lack of physical activity, unhealthy diet, or family history of CVD because these risk factors are not reliably documented in health records that are reflected in DMSS data.

For surveillance purposes of counting cardiovascular diseases (CVDs), an incident case of hypertensive heart and/or kidney disease, ischemic heart disease, cerebrovascular disease, or atherosclerosis was defined as any inpatient report with one of the defining diagnosis codes in the 1st or 2nd diagnostic position, or two outpatient encounters with a defining diagnosis (for the same CVD) in the 1st or 2nd diagnostic position **(Table 1)**. The two outpatient encounters must have occurred within 60 days of each other.

For each of the CVDs and CVD risk factors, an individual could be counted as an incident case only once during the surveillance period; prevalent cases (i.e., cases who had received one of the diagnoses of interest before the start of the surveillance period) were excluded from the incidence analysis. All service members serving at any point during the period in the AC of any service were included in the analysis in the denominator. Counts and percentages of service members who had an incident diagnosis of one or more CVD or CVD risk factors during the surveillance period were assessed. For a separate analysis of service members diagnosed with CVDs during the surveillance period, their health records for their entire military careers were searched for diagnoses of CVD risk factors at any time, even before the surveillance period.

TABLE 1. ICD-9 and ICD-10 diagnostic codes used to define cardiovascular disease risk factors and cardiovascular diseases

Cardiovascular disease risk factors	ICD-9 codes	ICD-10 codes
Essential hypertension	401.*	I10, I16.*
Hyperlipidemia	272.0–272.4	E78.0*–E78.5
Obesity	278.00, 278.01, 278.03, V85.3*–V85.4*, V85.54	E66.0*–E66.2, E66.8–E66.9
Abnormal glucose level	790.2*	R73.*
Diabetes mellitus	250.*	E10.*, E11.*
Cardiovascular diseases		
Hypertensive heart and/or kidney disease	402.*, 403.*, 404.*	I11.*, I12.*, I13.*
Ischemic heart disease	410.*, 411.*, 412, 413.*, 414.*	I20.*–I25.*
Cerebrovascular diseases	430, 431, 432.*, 433.*, 434.*, 435.*, 436, 437.0–437.2	I60.*–I66.*, I67.2
Atherosclerosis	440.*	I70.*

RESULTS

A total of 3,105,061 individuals served in the AC of the Armed Forces during the 10-year surveillance period. During that period, 561,819 different service members (18.1% of all service members) were diagnosed with at least one of the CVD risk factors. Of these service members, 73.9% (n=415,044) received just one incident diagnosis of a CVD risk factor; 20.1% (n=112,837) received two diagnoses; 5.0% (n=27,914) received three diagnoses; 0.9% (n=5,262) received four diagnoses; and 0.1% (n=762) were diagnosed with every one of the five CVD risk factors over the course of the surveillance period **(data not shown)**.

A total of 18,187 service members (0.6% of all AC service members) were diagnosed with at least one CVD. Of these service members, 95.9% (n=17,443) received just one incident diagnosis of a CVD; 3.9% (n=716) received two diagnoses; 0.1% (n=25) received three diagnoses; and 0.02% (n=3) were diagnosed with all four types/forms of CVD over the course of the surveillance period **(data not shown)**.

In the separate examination of risk factors at any time during service members' careers, among the 18,187 service members who were diagnosed with one or more CVDs during the surveillance period, 76.4% (n=13,899) were diagnosed with one or more CVD risk factors on at least one occasion at any time during their military careers. For service members with two CVDs during the surveillance period, the percentage who were ever diagnosed with at least one CVD risk factor was 93.2% (n=667). Those who were diagnosed with three (n=25) or four (n=3) CVDs had all been diagnosed with at least one CVD risk factor during their period of active service.

Cardiovascular Disease Risk Factors

Among the five categories of CVD risk factors examined in this analysis, the

TABLE 2. Incident counts and incidence rates of cardiovascular disease risk factors by type and demographic/military characteristics, active component, U.S. Armed Forces, 2007–2016

	Obesity		Hyperlipidemia		Essential hypertension		Abnormal glucose level		Diabetes mellitus	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	244,358	19.1	234,553	18.7	196,892	15.3	62,246	4.6	11,269	0.8
Inpatient	4,356	0.3	3,560	0.3	8,271	0.6	1,862	0.1	810	0.1
Outpatient	240,002	18.8	230,993	18.4	188,621	14.7	60,384	4.5	10,459	0.8
Sex										
Male	201,966	18.4	212,715	20.0	175,736	16.1	51,768	4.5	10,084	0.9
Female	42,392	23.2	21,838	11.5	21,156	11.1	10,478	5.3	1,185	0.6
Race/ethnicity										
Non-Hispanic white	136,081	17.4	141,240	18.4	110,997	14.1	31,600	3.8	4,712	0.6
Non-Hispanic black	52,171	26.0	39,786	19.7	47,296	23.7	14,727	6.8	3,649	1.7
Hispanic	34,271	21.8	27,718	17.7	19,078	11.8	7,538	4.5	1,301	0.8
Asian/Pacific Islander	7,609	15.7	11,036	24.1	8,089	16.9	4,006	8.0	908	1.8
Other/unknown	14,226	16.3	14,773	17.3	11,432	13.0	4,375	4.8	699	0.8
Age										
<20	5,949	6.8	1,505	1.7	2,613	3.0	1,360	1.6	146	0.2
20–29	133,991	18.3	68,959	9.2	75,069	10.0	14,919	2.0	2,114	0.3
30–39	72,000	21.8	96,666	30.4	71,629	21.5	21,553	6.0	3,785	1.0
40–49	29,635	25.5	60,972	65.6	42,271	39.2	20,962	16.7	4,480	3.4
50+	2,783	23.5	6,451	80.6	5,310	54.4	3,452	28.9	744	5.8
Service										
Army	129,294	26.8	108,654	22.4	96,891	19.7	25,362	4.9	5,429	1.0
Navy	46,226	15.1	57,526	19.6	39,981	13.1	19,931	6.3	3,074	1.0
Air Force	58,586	19.7	51,993	17.8	44,148	14.6	13,672	4.3	2,236	0.7
Marine Corps	10,252	5.4	16,380	8.8	15,872	8.4	3,281	1.7	530	0.3
Status										
Recruit	1,947	7.1	589	2.2	1,665	6.1	1,931	7.1	84	0.3
Nonrecruit	242,411	19.4	233,964	19.0	195,227	15.5	60,315	4.6	11,185	0.8
Rank										
Junior enlisted (E1–E4)	112,260	19.5	46,030	7.8	58,344	10.0	12,243	2.1	1,998	0.3
Senior enlisted (E5–E9)	106,492	22.1	133,691	28.5	105,289	21.6	36,169	6.9	7,486	1.4
Junior officer (O1–O3)	11,478	9.4	19,387	16.4	12,782	10.5	3,535	2.8	454	0.4
Senior officer (O4–O10)	11,264	14.1	29,622	45.8	16,549	22.1	8,866	10.7	1,076	1.3
Warrant officer (W01–W05)	2,864	16.5	5,823	38.1	3,928	23.5	1,433	7.8	255	1.4
Occupation										
Combat-specific[b]	31,662	16.4	29,734	15.6	26,676	13.8	6,008	3.0	1,262	0.6
Armor/motor transport	8,416	21.8	6,304	16.2	6,432	16.5	1,955	4.8	396	1.0
Pilot/air crew	3,988	8.1	10,216	22.7	4,741	9.7	1,627	3.2	217	0.4
Repair/engineering	73,266	19.9	66,675	18.3	55,532	14.9	16,892	4.3	3,217	0.8
Communications/intelligence	61,238	22.1	57,894	21.1	47,915	17.1	16,358	5.5	2,962	1.0
Healthcare	24,732	23.0	24,610	23.3	21,718	20.1	7,944	6.9	1,255	1.1
Other	41,056	16.9	39,120	16.4	33,878	13.9	11,462	4.5	1,960	0.8

[a]Rate per 1,000 person-years
[b]Infantry/artillery/combat engineering

numbers of service members with diagnosed risk factors during the surveillance period were (in decreasing order of frequency) obesity (n=244,358 individuals), hyperlipidemia (n=234,553), essential hypertension (n=196,892), abnormal blood glucose level (n=62,246), and diabetes mellitus (n=11,269) **(Table 2)**.

For all CVD risk factors, overall incidence rates were higher among service members in healthcare occupations than members of the other occupational categories. In addition, incidence rates were higher among service members in the Army compared to the other services for all CVD risk factors except abnormal glucose level, which was highest among Navy members **(Table 2)**. Overall incidence rates for risk factors were higher among men for hypertension, hyperlipidemia, and diabetes, but women's rates were higher for obesity and abnormal glucose levels. For all five risk factors examined, rates were progressively higher with advancing age, with the highest rates found among the oldest age category (50 years or older) except for obesity, for which the peak rate was among those 40–49 years of age. Consistent with this age-related pattern of incidence rates of all risk factors, rates were also higher in more senior enlisted and officer personnel compared to junior service members **(Table 2)**.

Obesity

For the entire 10-year surveillance period, the crude (unadjusted) overall incidence rate of diagnoses of obesity was 19.1 cases per 1,000 p-yrs. Annual incidence rates of obesity almost doubled from 13.4 per 1,000 p-yrs in 2007 to a peak of 24.7 per 1,000 p-yrs in 2013, although incidence rates leveled off and then decreased in 2016 to 21.3 per 1,000 p-yrs **(Figure 1)**. Rates of incident obesity diagnoses were higher among female service members compared to males (23.2 per 1,000 p-yrs vs. 18.4 per 1,000 p-yrs), and among non-Hispanic black service members (26.0 per 1,000 p-yrs) compared to other race/ethnicity groups **(Table 2)**. Obesity was the most commonly diagnosed CVD risk factor among service members less than 30 years old.

Hyperlipidemia

A total of 234,553 service members received incident diagnoses of hyperlipidemia during the 10-year surveillance period; the overall rate was 18.7 per 1,000 p-yrs. About 90 percent of these diagnoses (n=212,715) occurred among male service members, whose overall rate (20.0 per 1,000 p-yrs) was much higher than that of females (11.5 per 1,000 p-yrs) **(Table 2)**. Annual incidence rates of hyperlipidemia decreased 57% during the period, from 24.6 per 1,000 p-yrs in 2007 to 10.6 per 1,000 p-yrs in 2016 **(Figure 1)**.

The strongest demographic correlate of increasing incidence of hyperlipidemia was increasing age **(Table 2)**. Hyperlipidemia was the most commonly diagnosed CVD risk factor among service members 30 years of age or older. Of note, the overall incidence rate among those in their forties (65.6 per 1,000 p-yrs) was more than seven times the rate of those in their 20s (9.2 per 1,000 p-yrs), and the rate among those aged 50 years or older (80.6 per 1,000 p-yrs) was almost nine times that of service members in their 20s **(Table 2)**. Overall incidence rates of hyperlipidemia were similar among all race/ethnicity groups with the exception of Asian/Pacific Islander service members who had a moderately higher rate (24.1 per 1,000 p-yrs).

Essential hypertension

During the surveillance period, there were 196,892 incident diagnoses of essential hypertension in AC service members. The crude overall incidence rate for the surveillance period was 15.3 per 1,000 p-yrs **(Table 2)**. Unadjusted annual incidence rates of hypertension decreased 28.4% during the period, from 17.3 per 1,000 p-yrs in 2007 to 12.4 per 1,000 p-yrs in 2016 **(Figure 1)**.

As with hyperlipidemia, incidence rates of essential hypertension increased with advancing age and the highest rates were found in those aged 50 years or older. During the surveillance period, annual incidence rates decreased by at least 25% in all age groups, but among those aged 50 years or older, the annual rates decreased by 42.1% **(data not shown)**. The incidence rate in men was 45.1% higher than in women (16.1 cases per 1,000 p-yrs vs. 11.1 cases per 1,000 p-yrs) **(Table 2)**. Annual incidence rates of hypertension declined in

FIGURE 1. Annual incidence rates of cardiovascular disease risk factors and conditions, active component, U.S. Armed Forces, 2007–2016

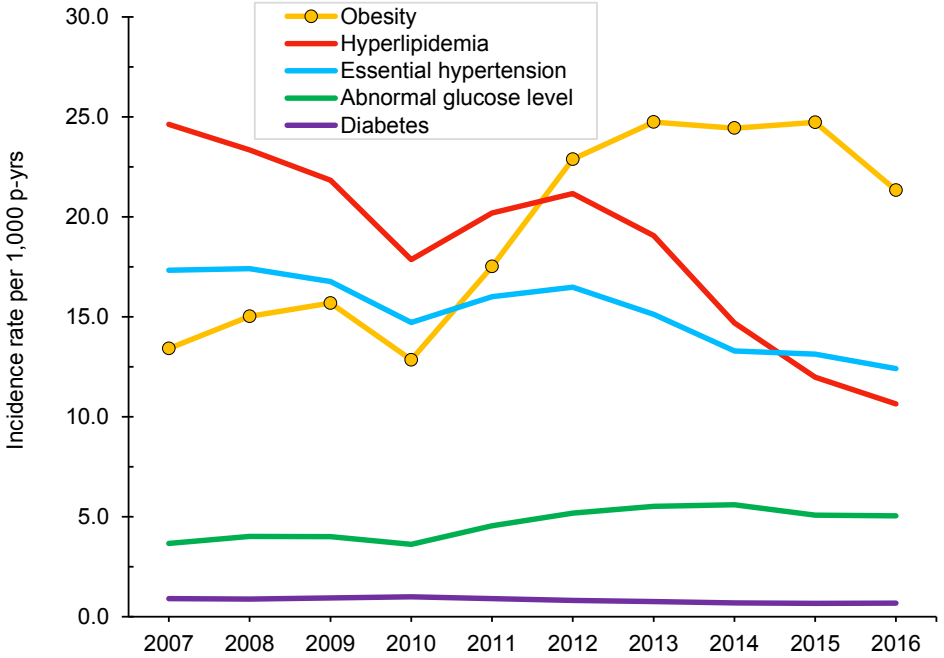
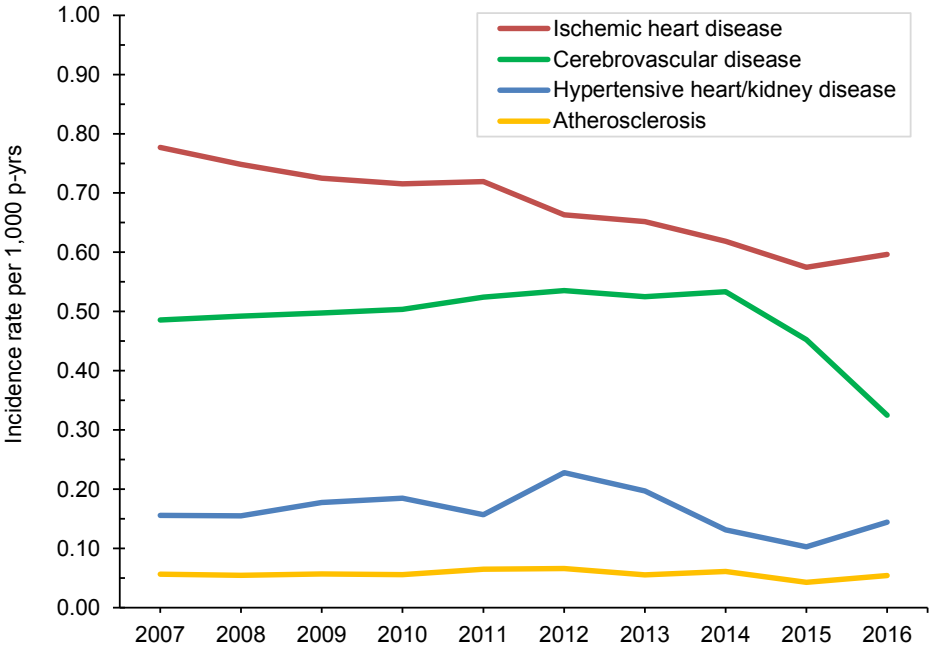


TABLE 3. Incident counts and incidence rates of cardiovascular diseases by type and demographic/military characteristics, active component, U.S. Armed Forces, 2007–2016

	Ischemic heart disease		Cerebrovascular disease		Hypertensive heart/kidney disease		Atherosclerosis	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	9,275	0.68	6,667	0.49	2,241	0.16	779	0.06
Inpatient	2,793	0.20	1,778	0.13	344	0.03	61	0.00
Outpatient	6,482	0.48	4,889	0.36	1,897	0.14	718	0.05
Sex								
Male	8,518	0.73	5,621	0.48	2,037	0.17	663	0.06
Female	757	0.38	1,046	0.52	204	0.10	116	0.06
Race/ethnicity								
Non-Hispanic white	5,369	0.65	4,135	0.50	872	0.10	462	0.06
Non-Hispanic black	2,143	0.97	1,221	0.55	1,012	0.46	180	0.08
Hispanic	813	0.48	647	0.38	172	0.10	61	0.04
Asian/Pacific Islander	436	0.85	239	0.47	74	0.14	25	0.05
Other/unknown	514	0.56	425	0.46	111	0.12	51	0.06
Age								
<20	86	0.10	194	0.22	7	0.01	6	0.01
20–29	1,355	0.18	2,432	0.32	437	0.06	152	0.02
30–39	2,827	0.77	2,031	0.55	824	0.22	245	0.07
40–49	3,916	3.01	1,633	1.25	809	0.62	286	0.22
50+	1,091	8.54	377	2.89	164	1.25	90	0.68
Service								
Army	4,657	0.89	3,073	0.59	1,081	0.21	370	0.07
Navy	1,677	0.52	1,309	0.41	417	0.13	153	0.05
Air Force	2,350	0.73	1,543	0.48	624	0.19	195	0.06
Marine Corps	591	0.31	742	0.38	119	0.06	61	0.03
Status								
Recruit	37	0.14	37	0.14	4	0.01	1	0.00
Nonrecruit	9,238	0.69	6,630	0.50	2,237	0.17	778	0.06
Rank								
Junior enlisted (E1–E4)	1,316	0.22	1,962	0.33	332	0.06	114	0.02
Senior enlisted (E5–E9)	5,464	1.02	3,297	0.61	1,461	0.27	480	0.09
Junior officer (O1–O3)	429	0.34	482	0.38	118	0.09	36	0.03
Senior officer (O4–O10)	1,780	2.09	801	0.94	268	0.31	125	0.15
Warrant officer (W01–W05)	286	1.52	125	0.66	62	0.33	24	0.13
Occupation								
Combat-specific[b]	1,072	0.53	1,012	0.50	243	0.12	93	0.05
Armor/motor transport	279	0.68	187	0.46	65	0.16	25	0.06
Pilot/air crew	281	0.55	211	0.41	43	0.08	20	0.04
Repair/engineering	2,411	0.61	1,769	0.45	614	0.16	183	0.05
Communications/intelligence	2,363	0.78	1,623	0.54	623	0.21	217	0.07
Healthcare	1,118	0.95	719	0.61	255	0.22	100	0.08
Other	1,751	0.68	1,146	0.45	398	0.15	141	0.05

[a]Rate per 1,000 person-years
[b]Infantry/artillery/combat engineering

FIGURE 2. Annual incidence rates of cardiovascular diseases, active component, U.S. Armed Forces, 2007–2016



a similar manner among both men (27.0%) and women (35.5%) during the period. Non-Hispanic black service members had a higher overall incidence rate of hypertension compared to service members in other race/ethnicity groups, but the annual incidence rates among black service members declined by 35.0% during the period **(data not shown)**.

Abnormal blood glucose level

Relative to hypertension and hyperlipidemia, fewer service members received incident diagnoses of abnormal glucose metabolism during the surveillance period (n=62,246; rate = 4.6 per 1,000 p-yrs) **(Table 2)**. However, annual incidence rates of diagnoses of abnormal glucose metabolism increased by 37.6% from 2007 (3.7 per 1,000 p-yrs) to 2016 (5.1 per 1,000 p-yrs) **(Figure 1)**. Women had slightly higher overall rates of incident diagnoses of abnormal glucose metabolism and both sexes demonstrated increasing annual rates during the surveillance period **(Table 2, data not shown)**. Asian/Pacific Islander and non-Hispanic black service members had higher overall rates of incident abnormal glucose metabolism diagnoses as compared to their counterparts.

Diabetes mellitus

Among the five risk factors examined, incident diagnoses of diabetes affected the fewest service members. The crude overall incidence rate was 0.8 cases per 1,000 p-yrs for the 11,269 service members who received a diagnosis of diabetes during the 10-year period. Unadjusted annual incidence rates of diabetes decreased by 25.9% during the period **(Figure 1)**. The overall incidence rates of diagnoses of diabetes increased dramatically with advancing age. Rates among non-Hispanic blacks and Asian/Pacific Islanders were double those of members of other race/ethnicity groups **(Table 2)**.

Cardiovascular Diseases

Overall, rates of CVD were low among AC service members during the surveillance period. Among the four categories of CVD that were examined, the largest numbers of service members were affected by ischemic heart disease (n=9,275), followed by cerebrovascular disease (n=6,667), hypertensive heart/kidney disease (n=2,241), and atherosclerosis (n=779) **(Table 3)**. The crude annual incidence rates of ischemic heart disease decreased 23.2% from 2007 (0.78 per 1,000 p-yrs) to 2016 (0.60 per 1,000 p-yrs) **(Figure 2)**. In contrast, the crude annual incidence of cerebrovascular disease increased slightly from 0.49 per 1,000 p-yrs in 2007 to 0.53 per 1,000 p-yrs in 2014, and then decreased to 0.33 per 1,000 p-yrs in 2016. Annual incidence rates of hypertensive heart/kidney disease and atherosclerosis remained relatively stable during the surveillance period.

For all CVDs, incidence increased with increasing age. Service men and women had similar rates of atherosclerosis and cerebrovascular disease, but men's rates of incident ischemic heart disease and hypertensive heart/kidney disease were more than 70% higher than the rates among women **(Table 3)**. Non-Hispanic black service members and service members in healthcare occupations had higher incidence rates than their respective counterparts for all CVDs.

EDITORIAL COMMENT

This analysis found that 18% of all individuals who served in the AC of the U.S. Armed Forces during 2007–2016 were diagnosed with at least one of the well-recognized risk factors for cardiovascular disease. During that decade, crude annual incidence rates declined for hyperlipidemia, essential hypertension, and diabetes mellitus but increased for obesity and abnormal glucose levels. The results are noteworthy for the decreases in the unadjusted incidence rates of diagnoses of hypertension in non-Hispanic black service members (35.0%) and in service members aged 50 years or older (42.1%). Of concern is the observation that the crude annual incidence rates of diagnoses of obesity rose 59.0%.

During the same 10-year period, 18,187 service members (0.6%) were diagnosed with at least one CVD. Crude annual incidence rates decreased steadily for diagnoses of ischemic heart disease (23.2%), the most frequently occurring CVD. Annual rates fluctuated for both hypertensive

heart/kidney disease and atherosclerosis and the net 10-year declines for those conditions were 7.4% and 4.0%, respectively. Annual rates of diagnoses of cerebrovascular disease slowly increased by 9.8% from 2007 to 2014 but then fell sharply in 2015 and 2016 to a 10-year low rate that represented an overall decline of 33.1%.

The observed declines in incidence for some CVD risk factors and CVD among service members mirror trends seen the U.S. population in recent years and, for that matter, recent decades.[1] For service members, the ready access to health care enables early detection of risk factors such as hypertension and hyperlipidemia for which therapeutic interventions can lessen the likelihood of subsequent development of certain CVDs. The early detection of obesity can inform service members' lifestyle changes (e.g., diet, exercise) aimed at weight reduction. The benefits of such interventions, if sustained, hold the promise of reducing, or at least delaying, the development of clinical CVDs during their military service as well as long after they have ended their active military careers.

This analysis did not attempt to determine whether risk factors were diagnosed before or after incident diagnoses of CVD. It is plausible that, for many service members, the diagnoses of risk factors were first recorded at the time of the earliest diagnoses of CVD. For that reason, the observed associations between increasing numbers of CVDs and the proportions who were diagnosed with at least one CVD risk factor are difficult to interpret. At the time service members were first diagnosed with CVDs they were very likely to have been thoroughly evaluated for the presence of known risk factors. Nevertheless, this analysis found that 23.6% of all service members with incident CVD diagnoses during the surveillance period did not have any documentation of diagnoses of risk factors in their records at any time during their careers. In contrast, ostensibly healthy service members never diagnosed with a CVD may not have been carefully evaluated for all of the five risk factors examined in this study. The presence of hypertension and obesity are readily observable during routine healthcare encounters, but the performance of blood testing is required to identify hyperlipidemia, elevated blood glucose, or diabetes.

The observation that incidence rates of all risk factors and CVDs were higher for service members in healthcare occupations than those in other occupations suggests that both ready access to health care and enhanced interest in personal health may have enabled this finding. Consistent with this interpretation is the observation that, for most of the diagnoses, the rates for healthcare personnel were only slightly higher than the rates for other occupational groups.

It should be emphasized that this study was not able to capture important risk factor information pertaining to smoking, levels of physical activity, diet, or family history of CVD. Previous surveys of military personnel have found that approximately 25% of service members were current cigarette smokers, a level higher than contemporaneous estimates of about 20% for U.S. civilians.[6,7] Data on these risk factors would have been highly relevant to the discussion about the occurrence of CVD in service members who ostensibly had no risk factors; for example, it is possible that many of these individuals were cigarette smokers, but data were not available to make this determination. The absence of data about smoking, physical activity, diet, and family history necessitates caution in interpreting the relative impact of risk factors on CVD incidence described in this analysis.

Except for the diagnosis of diabetes mellitus, the counts of risk factors required documentation of a risk factor diagnosis only once in a service member's health record. Some of these incident cases of risk factors may represent miscoded, erroneously coded, or "rule out" (tentative) diagnoses. Finally, it should be emphasized that service members who leave military service prior to receiving a diagnosis would not be captured in this report. This means that the true incidence of CVD could be underestimated among older service members if, for example, only healthier service members (e.g., those with fewer CVD risk factors) stay in military service during older age.

In summary, this analysis documented that diagnoses of CVD risk factors are relatively common in active component service members and that diagnoses of CVDs themselves are uncommon, but not rare. Because the incidence of CVDs tends to rise with advancing age, the identification of CVD risk factors among the relatively young and fit population of service members offers the opportunity for preventive interventions (medical, lifestyle) that can reduce the incidence of later onset of clinical CVD during, but especially after, military service.

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Herpes Zoster, Active Component, U.S. Armed Forces, 2000–2016

Valerie F. Williams, MA, MS; Shauna Stahlman, PhD, MPH; Saixia Ying, PhD

During 2000–2016, a total of 52,895 active component service members received incident diagnoses of herpes zoster (HZ), for an overall unadjusted incidence rate of 2.5 cases per 1,000 person-years. Compared to their respective counterparts, overall incidence rates of HZ were highest among females, those aged 50 years or older, and Air Force members. Overall rates generally increased with increasing age and were highest among non-Hispanic whites and Asian/Pacific Islanders and lowest among non-Hispanic blacks. Unadjusted annual incidence rates of HZ increased steadily from 2000 to a peak in 2014. From 2000 through 2016, annual rates of HZ increased in each service and increases in annual rates were seen in all race/ethnicity groups. Individuals who were identified as immunocompromised constituted 2.1% of the total incident HZ cases. During 2000–2016, the cumulative numbers of incident cases of HZ were highest during June, July, and August. The increase in HZ incidence observed in this and many other studies is a public health concern that requires a better understanding of key risk factors. Additional research focused on these factors could make trends more interpretable, suggest new approaches for prevention and treatment of HZ, and allow for better targeting of existing strategies.

Herpes zoster (HZ), also known as shingles, is a blistering, often painful rash caused by a reactivation of the varicella-zoster virus (VZV) that has remained dormant within the sensory ganglia following primary VZV infection (chickenpox).[1] HZ rash most commonly appears on the trunk along a thoracic dermatome.[1] In most cases, the rash does not cross the body's midline; however, in approximately one-fifth of HZ cases, the rash overlaps adjacent dermatomes.[1] The rash generally develops into vesicular lesions that form over 3–5 days and progressively dry and crust over, after which the lesions are no longer considered infectious.[1] HZ-infected individuals can spread the virus to those who are susceptible to varicella because they neither experienced chickenpox nor received the varicella vaccine.[2] VZV is transmitted by direct contact with active HZ lesions or by respiratory aerosols from infected individuals.[2-4] The most common complication of HZ is chronic pain (postherpetic neuralgia), which is related to inflammation of the dorsal spinal ganglion and hemorrhagic necrosis of peripheral nerve cells.[5] Although HZ seldom results in mortality, the morbidity of this disease can have significant negative effects on the functional status and health-related quality of life of affected individuals.[6,7]

In the U.S. general population, the incidence rate of HZ is between three and five cases per 1,000 person-years (p-yrs), with similar rates reported in Canada, Europe, and Asia-Pacific.[8,9] The incidence of HZ increases rapidly after age 50 and is correlated with waning cell-mediated immunity.[10] HZ incidence is also high among people with immunosuppressive conditions.[11]

There has been a gradual increase in HZ incidence rates among adults in the U.S. over the past several decades independent of the aging demographic.[12-16] Similar temporal increases have been reported in Canada, the U.K., Spain, Japan, Taiwan, and Australia.[17-26] The basis for the increase remains unclear, but hypotheses include the widespread use of childhood varicella vaccination, which might decrease the boosting of immunity from exposure to wild-type VZV; the introduction of antiviral therapy, which might increase the number of HZ-infected individuals who seek care; and the increased use of immunosuppressive therapies for numerous chronic conditions, which might increase susceptibility to HZ.[13,14,21,24,27]

In 2011, the *MSMR* reported information on the overall and annual incidence rates of HZ among active component members during 2000–2010.[28] That report documented consistently increasing numbers and rates (unadjusted) of HZ during the 11-year surveillance period.[28] The current analysis updates and expands on this earlier work by examining age of HZ onset, determining the number of active component service members with qualifying diagnoses of HZ during deployment (2008–2016), identifying the proportion of HZ cases classified as immunosuppressed, and describing the incidence of HZ during 2000–2016.

METHODS

The surveillance period was 1 January 2000 through 31 December 2016. The surveillance population consisted of active component service members of the U.S. Army, Navy, Air Force, or Marine Corps who served at any time during the surveillance period. Diagnoses were ascertained from administrative records of all medical encounters of individuals who received care in fixed (i.e., not deployed or at sea) medical facilities of the Military Health System (MHS) or civilian facilities in the

purchased care system. These data are maintained in the electronic database of the Defense Medical Surveillance System (DMSS). In-theater diagnoses were identified from the medical records of service members deployed to a U.S. Central Command area of responsibility and whose healthcare encounters were documented in the Theater Medical Data Store (TMDS).

An incident case of HZ was defined by the presence of any qualifying ICD-9 or ICD-10 diagnosis code in the 1st or 2nd diagnostic position of the record of a healthcare encounter in an outpatient or inpatient setting **(Table 1)**. A similar case definition was employed in several U.S. studies of HZ incidence using administrative data.[12,13,29] Because a previous *MSMR* analysis used a case definition that allowed for any qualifying diagnosis code in any diagnostic position, a sensitivity analysis was conducted to compare the incidence rates obtained from using the two different case definitions.[28] The incident date was considered the date of the case-defining diagnosis. An individual could be counted as an incident case of HZ once per lifetime. Service members with case-defining HZ diagnoses before the start of the surveillance period were excluded from the analysis because they were not considered at risk of incident (i.e., first ever) HZ.

Consistent with many published studies of HZ incidence,[13,14,18,28,29,30] individuals with episodes first denoted by a diagnosis code for postherpetic trigeminal neuralgia (ICD-9: 053.12; ICD-10: B02.22) or postherpetic polyneuropathy (ICD-9: 053.13; ICD-10: B02.23) were not included as incident HZ cases because of the increased potential that these diagnoses represent sporadic long-term follow-up for prior HZ episodes (HZ sequelae). Because the risk of HZ is markedly elevated in immunosuppressed individuals, service members who were diagnosed as incident HZ cases who were immunosuppressed in the year prior to their incident case diagnosis were identified. Immunosuppression status was determined by the presence of two ICD-9 or ICD-10 diagnostic, procedure, or CPT codes (in any position) denoting care for certain hematologic diseases (e.g., aplastic anemia), cancer, HIV infection, or transplantation (hematopoietic stem cell or solid organ) on different days during an inpatient or outpatient encounter **(Table 2)**.[18]

TABLE 1. ICD-9 and ICD-10 diagnostic codes used for herpes zoster case classification

ICD-9 codes	ICD-10 codes
053.0 (herpes zoster with meningitis)	B02.1 (zoster meningitis)
053.1 (herpes zoster with nervous system complications)	
- 053.10 (herpes zoster with unspecified nervous system complication)	- B02.29 (other postherpetic nervous system involvement)
- 053.11 (geniculate herpes zoster – herpetic geniculate ganglionitis)	- B02.21 (postherpetic geniculate ganglionitis)
- 053.14 (herpes zoster myelitis)	- B02.24 (postherpetic myelitis)
- 053.19 (herpes zoster with other nervous system complications – other)	B02.0 (zoster encephalitis) B02.2 (zoster with other nervous system involvement)
053.2 (herpes zoster with ophthalmic complications)	B02.3 (zoster ocular disease)
- 053.20 (herpes zoster dermatitis of eyelid)	- B02.39 (other herpes zoster eye disease)
- 053.21 (herpes zoster keratoconjunctivitis)	- B02.33 (zoster keratitis)
- 053.22 (herpes zoster iridocyclitis)	- B02.32 (zoster iridocyclitis)
- 053.29 (herpes zoster with other ophthalmic complication)	- B02.30 (zoster ocular disease, unspecified) - B02.31 (zoster conjunctivitis) - B02.34 (zoster scleritis) - B02.39 (above)
053.7 (herpes zoster with other specified complications)	B02.8 (zoster with other complications)
- 053.71 (otitis externa due to herpes zoster)	B02.8 (above)
- 053.79 (herpes zoster with other specified complications)	B02.8 (above)
053.8 (herpes zoster with unspecified complication)	B02.7 (disseminated zoster) B02.8 (above)
053.9 (herpes zoster without mention of complication)	B02.9 (zoster without complications)

Incidence rates were calculated as incident HZ diagnoses per 1,000 p-yrs of active component service. Person-time was censored when any of the following conditions was met: an individual was identified as an HZ case; an individual left service or died; the surveillance period ended. Only non-deployed person-time was used in the denominator. If a service member had more than one case-defining encounter, an inpatient diagnosis was prioritized over an outpatient diagnosis.

HZ cases occurring during deployments were analyzed separately. To qualify as a case of HZ during deployment, an individual needed to have a medical encounter with a case-defining diagnosis of HZ documented in the TMDS. This medical encounter had to occur between the start and end dates of a deployment record. TMDS records that fell outside of the start and end dates of a deployment record were excluded from the analysis. The number of deployed service members in a given year was calculated as the total number of unique service members with a deployment record overlapping with each given calendar year. The surveillance period of 2008–2016 was used to examine cases during deployment because TMDS data first became available in the DMSS in 2008.

Median age at incident HZ diagnosis was computed overall and by race/ethnicity group. Finally, the cumulative total numbers of incident HZ cases per month were computed to identify any pattern of seasonality.

TABLE 2. Diagnostic, procedure, and CPT codes used in identification of prior immunosuppression

Condition grouping	ICD-9[a]	ICD-10[a]	Description
Blood-related	284.0–284.9	D60.*, D61.*	Aplastic anemia
	287.3–287.4	D47.3,D69.3,D69.4,D69.5	Primary and secondary thrombocytopenia
	288.0–288.9	D70.*, D71, D72.*, D76.*	Diseases of white blood cells
	289.4–289.59	D73.1, D73.2, D57.02, D57.212, D57.412, D73.81, D73.3, D73.4, D73.89	Diseases of spleen
	289.8–289.9	D68.5, D68.6, D75.81, D75.82, D75.89, D47.4, D89.2, D75.9	Other specified and unspecified diseases of blood-forming organs
Cancer	140.*–149.*	C00.*–C14.*	Malignant neoplasm of lip, oral cavity, pharynx
	150.*–159.*	C15.*–C26.*	Malignant neoplasm of digestive organs and peritoneum
	160.*–165.*	C30.*–C39.*	Malignant neoplasm of respiratory and intrathoracic organs
	170.*–172.*	C40.*–C41.*, C43.*–C44.*, D03.0, D03.10, D031.1, D03.12, D03.20, D03.21, D03.22, D03.30, D03.39, D0.34, D03.51, D03.52, D03.59, D03.60, D03.61, D03.62, D03.70, D03.71, D03.72, D03.8, D03.9	Malignant neoplasm of bone, connective tissue, melanoma
	174.*–175.*	C50.*	Malignant neoplasm of the breast
	179.*–189.*	C51.*–C58.*, C60.*–C63.*, C64.*–C68.*	Malignant neoplasm of genitourinary organs
	190.*–199.*	C69.*–C72.*, C73.*–C75.*, C76.*–C80.*	Malignant neoplasm of other and unspecified sites
	200.*–208.*	C81.*–C96.*	Malignant neoplasm of lymphatic and hematopoietic tissue
	235.*–238.*	D37.*–D41.*, D43.*–D48.*, C94.4, Q85.0	Neoplasms of uncertain behavior
	239.*	D49.*	Neoplasms of unspecified nature
	99.25 [procedure]	3E03305, 3E04305 [procedure]	Injection or infusion of cancer chemotherapeutic substance
	96400, 96408– 96425, 96520, 96530 [CPT]	Same CPT codes	
	V58.0	Z51.0	Radiotherapy
	V58.11	Z51.11	Encounter for antineoplastic chemotherapy
HIV	042.*	B20.*	HIV infection and disease
	79.53	B97.35	Human immunodeficiency virus, type 2 [HIV-2]
Transplant	99.28 [procedure]	3E00X0M, 3E0130M, 3E0230M, 3E03303, 3E0330M, 3E04303, 3E0430M, 3E05303, 3E0530M, 3E06303, 3E0630M	Injection/infusion of biologic response modifier [BRM] as an antineoplastic agent
	V42.0, V42.1; V42.3–V42.9	Z94.*	Organ/tissue replaced by transplant (excludes heart valve)

[a]An asterisk (*) indicates any digit/character in this position.

Note: Condition groupings and ICD-9 codes were taken from Marra, Chong, and Najafzadeh, 2016.[18]

RESULTS

In the sensitivity analysis, *case definition 1* (which required any qualifying HZ diagnosis code to be in the 1st or 2nd diagnostic position) identified 1,010 fewer incident cases of HZ than did *case definition 2* (which allowed for a qualifying diagnosis code in any diagnostic position) **(data not shown)**. The crude overall incidence rates generated by using the two (unadjusted) definitions were close in value (case definition 1=2.55 per 1,000 p-yrs; case definition 2=2.50 per 1,000 p-yrs). The unadjusted annual incidence rates obtained by using the two definitions also were very similar **(data not shown)**. Given the similarity of the resulting rates, case definition 1 (which is slightly more conservative) was used in the subsequent analysis.

During 2000–2016, a total of 52,895 active component service members received incident diagnoses of HZ, for a

TABLE 3. Incident cases and incidence rates of herpes zoster,[a] by demographic and military characteristics, active component, U.S. Armed Forces, 2000–2016

	No.	Rate[b]	IRR
Total	52,895	2.5	.
Sex			
Male	42,542	2.4	ref
Female	10,353	3.2	1.4
Age (years)			
<20	5,227	1.8	ref
20–24	11,922	2.2	1.2
25–29	11,677	2.5	1.4
30–34	8,322	2.6	1.5
35–39	7,383	2.8	1.6
40–49	7,191	3.5	2.0
50+	1,173	6.1	3.4
Race/ethnicity			
Non-Hispanic white	35,000	2.7	ref
Non-Hispanic black	6,901	1.9	0.7
Hispanic	5,610	2.3	0.9
Asian/Pacific Islander	2,060	2.6	1.0
Other/unknown	3,324	2.4	0.9
Service			
Army	19,210	2.6	ref
Navy	11,514	2.1	0.8
Air Force	16,295	3.0	1.2
Marine Corps	5,876	2.0	0.8
Military occupation			
Infantry/artillery/combat engineering	5,657	2.0	ref
Armor/motor transport	1,260	2.0	1.0
Pilot	1,382	2.8	1.4
Aircrew	842	2.7	1.3
Repair/engineer	14,585	2.3	1.2
Communications/intelligence	12,781	2.7	1.3
Healthcare	5,808	3.1	1.6
Other/unknown	10,580	2.6	1.3

[a]One inpatient or outpatient encounter with herpes zoster diagnosis in 1st or 2nd diagnostic position
[b]Rate per 1,000 person-years

crude overall incidence rate of 2.5 cases per 1,000 p-yrs **(Table 3)**. The vast majority (99.6%) of all incident HZ cases were diagnosed during outpatient visits **(data not shown)**. Compared to their respective counterparts, the overall incidence rates were highest among females (3.2 cases per 1,000 p-yrs), those aged 50 years or older (6.1 cases per 1,000 p-yrs), and Air Force members (3.0 cases per 1,000 p-yrs). Overall incidence rates generally increased with increasing age **(Table 3)**. Females aged 50 years or older had the highest subgroup-specific overall incidence rate (7.4 cases per 1,000 p-yrs) **(Figure 1)**. The overall rates of HZ were highest among non-Hispanic whites (2.7 cases per 1,000 p-yrs) and Asian/Pacific Islanders (2.6 cases per 1,000 p-yrs) and lowest among non-Hispanic blacks (1.9 cases per 1,000 p-yrs) **(Table 3)**. Across military occupations, crude overall incidence rates were highest among healthcare workers (3.1 cases per 1,000 p-yrs) and lowest among those working in infantry/artillery/combat engineering (2.0 cases per 1,000 p-yrs) and armor/motor transport (2.0 cases per 1,000 p-yrs).

Annual incidence rates of HZ increased steadily from 1.4 cases per 1,000 p-yrs in 2000 to a peak of 3.1 cases per 1,000 p-yrs in 2014, after which rates declined slightly to 2.8 cases per 1,000 p-yrs in 2016 **(Figure 2)**. This increasing trend was observed among both female and male service members, with annual rates of HZ among females consistently higher than among males **(Figure 2)**. During the 17-year surveillance period, annual incidence rates of HZ increased in each service; however, during each year of the period, HZ rates were markedly higher among Air Force members than among members of the other services **(Figure 3)**. Increases in annual HZ incidence rates occurred with increasing age in all but the youngest age group (less than 20 years), with the greatest increases observed among service members aged 30 years or older **(Figure 4)**. During the surveillance period, increases in annual rates were seen in all race/ethnicity groups; Asian/Pacific Islander, non-Hispanic white, and Hispanic service members showed the greatest increases over time and non-Hispanic black service members showed the smallest increase **(Figure 5)**.

Between 2008 and 2016, TMDS records documented a total of 1,658 cases of HZ among active component service members during deployment to a U.S. Central Command area of responsibility. During this period, the number of HZ cases per 10,000 deployed active component service members peaked at 6.8 in 2013 and subsequently declined to a low of 5.1 in 2016 **(Figure 6)**.

The median age at case-defining HZ diagnosis was 28 years (interquartile range [IQR]=23–36) **(data not shown)**. Crude comparisons of the age at HZ diagnosis by race/ethnicity group showed that Hispanic service members and those of other/unknown race/ethnicity had the youngest median age at diagnosis (median 27 years, IQR=23–34 for both groups), while Asian/Pacific Islander service members had the oldest median age of onset (median 30 years, IQR=24–38) **(data not shown)**.

The vast majority (89.7%) of incident HZ cases during the surveillance period had

FIGURE 1. Incidence rates of herpes zoster, total and by sex and age group, active component, U.S. Armed Forces, 2000–2016

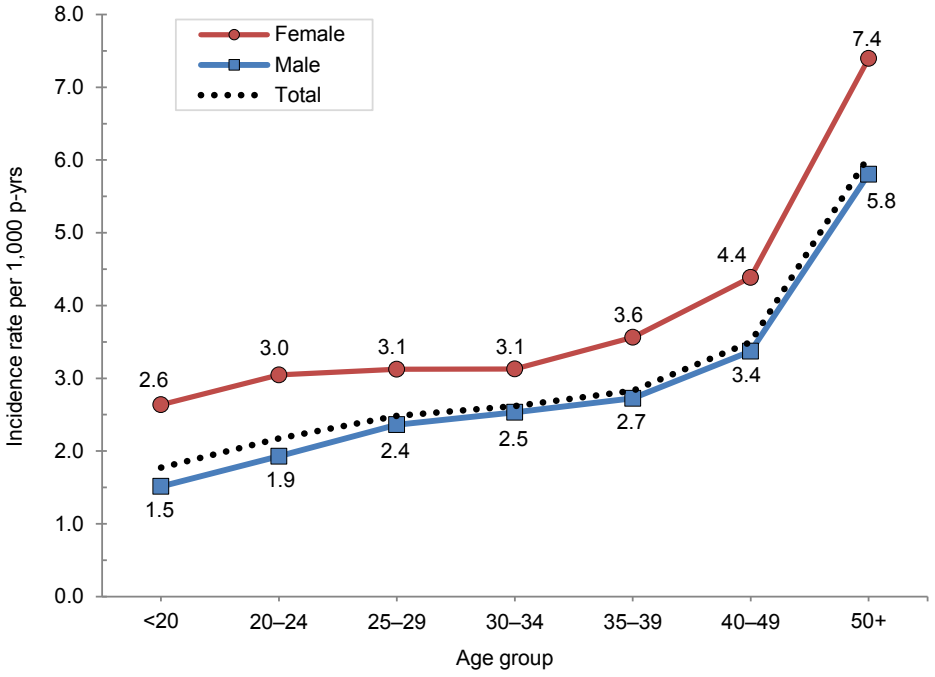
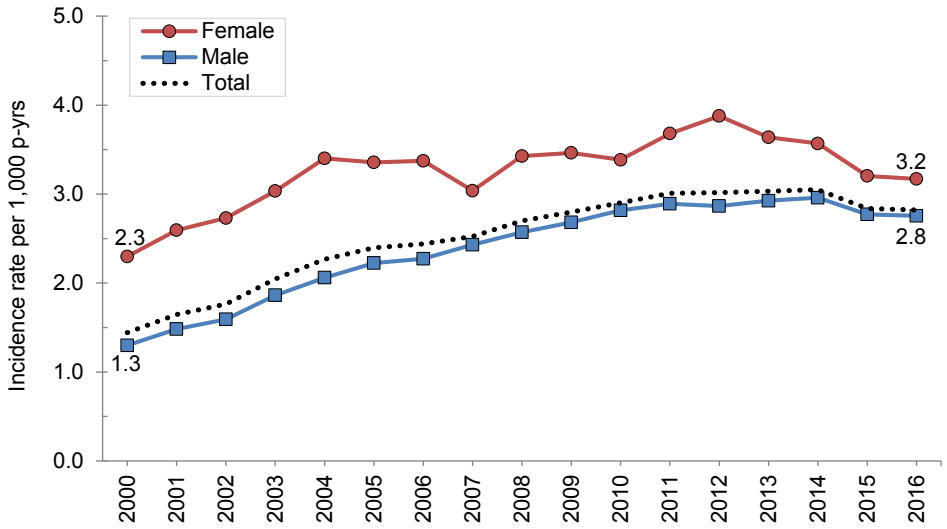


FIGURE 2. Annual incidence rates of herpes zoster, total and by sex, active component, U.S. Armed Forces, 2000–2016



uncomplicated HZ **(Table 4)**. Other nervous system involvement (3.8%), ophthalmic complications (3.3%), and zoster with other complications (2.7%) were relatively less frequent complications, while other zoster complications (meningitis [0.53%], encephalitis [0.01%]) were rare **(Table 4)**.

Between 2000 and 2016, 2.1% (n=1,118) of the total incident HZ cases were identified as immunocompromised during the year before their case-defining diagnoses **(data not shown)**. HZ cases that were classified as immunocompromised were due to cancer (62.9%), blood-related conditions (18.9%) such as diseases of white blood cells (neutropenia), HIV infection (14.6%), or transplant (3.7%) **(data not shown)**.

Overall during 2000–2016, cumulative monthly numbers of incident HZ cases ranged from 3,899 (February) to 4,834 (June and July). The cumulative numbers of incident cases of HZ were highest during June, July, and August **(Figure 7)**.

EDITORIAL COMMENT

The results of the current study show that the annual incidence rates of HZ diagnoses among active component service members doubled during the past 17 years. During this period, the incidence of HZ diagnoses increased in both sexes and in all but the youngest age groups. Increases in annual rates were seen over time in all race/ethnicity groups, with the greatest increases seen in Asian/Pacific Islander and Hispanic service members and the smallest increase seen in non-Hispanic black service members. The findings by sex and by age mirror the results of HZ incidence studies in the U.S. and elsewhere.[10-13,16-18,26,27,29,31-35] The cause of the increase in HZ incidence over time remains unclear.

The overall incidence of HZ increased with increasing age and was higher among females than males in all age groups. The age-related rise of HZ observed in many other studies has been attributed to a decline in cell-mediated immunity to VZV due to immunosenescence.[31,36] Differences in healthcare-seeking behavior and/or immunologic or hormonal mechanisms have been suggested as possible reasons underlying the differences in incidence by sex.[37] The overall rates of HZ were highest among non-Hispanic whites and lowest among non-Hispanic blacks. Several studies have found similar differences among race/ethnicity groups in the risk of HZ. Results of studies carried out in the U.S. and elsewhere suggest that blacks have about half the risk of HZ as whites.[10,14,17,20,38-40] Possible reasons for these risk differences could include differences in genetic risk, access to health care, and/or healthcare-seeking behavior.[37]

Similar to the findings of the 2011 *MSMR* analysis, annual incidence rates of HZ were consistently higher among members of the Air Force, compared to members of the other services throughout the surveillance period.[28] The Air Force has a relatively higher number of female service

FIGURE 3. Annual incidence rates of herpes zoster, by service, active component, U.S. Armed Forces, 2000–2016

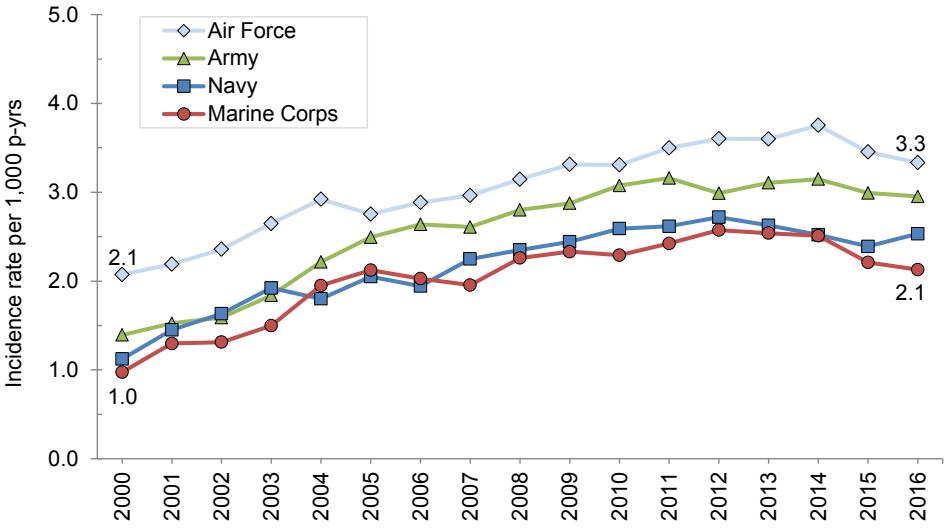
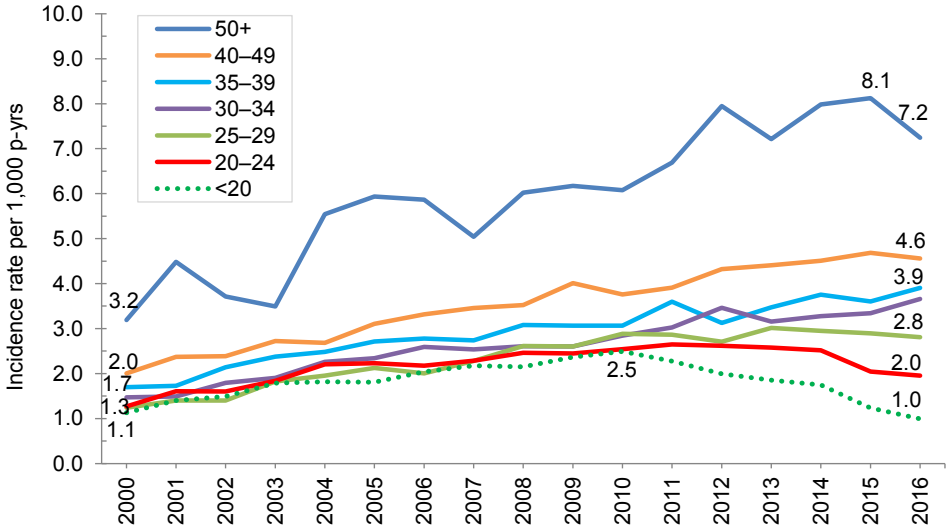


FIGURE 4. Annual incidence rates of herpes zoster, by age group, active component, U.S. Armed Forces, 2000–2016



members than the other services.[41] This demographic difference may explain, at least in part, the higher rates of HZ among Air Force members relative to those in the other services. In addition, differences in HZ rates across the services may reflect differences in occupational and leisure activities.[28] For example, results of several studies suggest that exposure to solar ultraviolet radiation may suppress cell-mediated immunity and possibly trigger reactivation of latent VZV.[42,43] Given these findings, Air Force members, particularly high altitude (fixed-wing) aviators, would be at increased occupational risk of HZ.

Another finding consistent with the results of the 2011 *MSMR* analysis was that the overall incidence rate of HZ was highest among healthcare workers. Survey-based studies suggested that physicians' exposure to VZV may boost immunity to latent VZV and thus confers a protective effect. However, these studies reported relatively low response rates and resultant small sample sizes.[44,45] A more recent large population-based study conducted in Taiwan found that healthcare workers (including dermatologists and pediatricians) had a significantly higher incidence of HZ than the general population.[46]

Crude comparisons of the age at diagnosis by race/ethnicity group showed that Asian/Pacific Islander service members had the oldest median age at HZ diagnosis, while Hispanic service members and those of other/unknown race/ethnicity had the youngest median age at onset. However, this difference could be due, at least in part, to underlying differences in the age distributions of the race/ethnicity groups. There is limited evidence that race/ethnicity is associated with age at HZ onset. A report of individuals with incident HZ participating in antiviral trials showed that being non-white and a resident of a tropical country were independently associated with younger age at HZ onset, although it was noted that this association could reflect participation bias or undiagnosed HIV infection.[47]

The most common HZ complications were other nervous system involvement and zoster ophthalmicus, which also have been reported from a few previous studies conducted in the U.S. and elsewhere.[11,48,49] The percentage of HZ cases who were immunocompromised at the time of HZ diagnosis is relatively well documented in the U.S. over the past two decades and ranged from 6% to 11% in those studies whose populations included individuals younger than 65 years of age.[11,50-52] It is important to note that the much lower percentage of total HZ cases classified as immunocompromised in the current study (2.1%) likely reflects differences between the U.S. active component military population and the more specialized and relatively older populations used in other studies.

Results of studies of a seasonal pattern to HZ incidence are mixed. Studies from the U.S., Japan, Poland, Taiwan, and Australia reported that incidence of HZ was higher in the summer, particularly for exposed skin sites.[22,24,25,28,42,46] However, several other studies reported no seasonal pattern.[10,17,53] It has been posited that high exposure to ultraviolet radiation during summer months may suppress cell-mediated immunity and possibly trigger reactivation of latent VZV.[24,42,43,54,55] Herpes simplex virus,

FIGURE 5. Annual incidence rates of herpes zoster, by race/ethnicity, active component, U.S. Armed Forces, 2000–2016

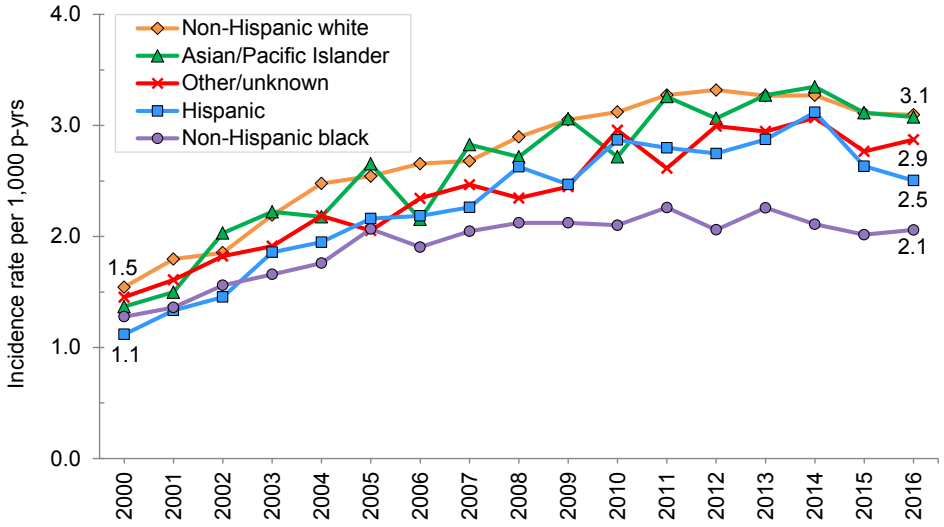


TABLE 4. Incident counts of herpes zoster, by diagnostic type (4th digit level), active component, U.S. Armed Forces, 2000–2016

	Total 2000–2016	
Diagnostic type	No.	% of total cases
Zoster with other nervous system involvement (ICD-9: O53.10, O53.11, O53.14, O53.19; ICD-10: B02.21, B02.24, B02.29)	1,983	3.7
Zoster ocular disease/with opthalmic complications (ICD-9: O53.2*; ICD-10: B02.3*)	1,771	3.3
Disseminated, unspecified or other complication (ICD-9: O53.7*, 053.8, O53.9; ICD-10: B02.7, B02.8)	1,424	2.7
Zoster meningitis (ICD-9: O53.0; ICD-10: B02.1)	278	0.5
Zoster encephalitis (ICD-9: O53.19; ICD-10: B02.0)	4	0.01
Without mention of complication (ICD-9: O53.9; ICD-10: B02.9)	47,435	89.7
Total	52,895	100.0

which belongs to the same alpha subfamily of herpes viruses as VZV, is reactivated by ultraviolet light.[43] Although some slight seasonal variation in the numbers of HZ cases was observed in the current study, the possible role of other environmental factors in reactivation cannot be ruled out. Additional research is needed to understand potential environmental factors associated with risk of HZ.

The current study had several limitations. The analysis did not capture service members with HZ who did not seek medical care or who sought care outside the MHS, but both groups are anticipated to be small. In addition, as incident cases were identified based on the presence of a qualifying ICD-9 or ICD-10 diagnosis code for HZ recorded during a healthcare encounter, the validity of the results depends upon the accuracy of a physician-assigned diagnosis of HZ and the resultant diagnostic coding generated by a given encounter. Misclassification between HZ and herpes simplex virus has been reported[56]; however, the routine clinical diagnosis of HZ is generally regarded as reliable.[1] Furthermore, previous studies have found that the positive predictive value of ICD-9 diagnostic codes for HZ in administrative claims data is relatively high (84%–94%).[30,57,58] Finally, crude HZ incidence rate differences may have been due, at least in part, to differences in the demographic factors of age, sex, and race/ethnicity. Observed differences in incidence rates of HZ by service and occupational category warrant further analysis to examine adjusted (e.g., by age, sex, race/ethnicity) incidence rates among service members within these groups.

HZ-related pain and discomfort can have significant negative effects on employment-related productivity, activities of daily living, and quality of life.[6,7] Depending on the location, extent and severity of the lesions, service members affected by HZ may experience debilitating pain and sequelae that could prevent them from carrying out their daily duties, particularly in field operational settings. Furthermore, the management of HZ and its complications impose considerable economic burden on the MHS. In the U.S., the annual cost of medical care for incident HZ cases has been estimated at $1.1 billion.[59] The increase in HZ incidence observed in this and many other studies is a public health concern that requires better recognition and understanding of key risk factors. Additional research focused on these factors could make trends more interpretable, suggest new approaches for prevention and treatment of HZ, and allow for better targeting of existing strategies.

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FIGURE 6. Numbers of herpes zoster cases per 10,000 service members deployed to a U.S. Central Command area of responsibility, 2008–2016

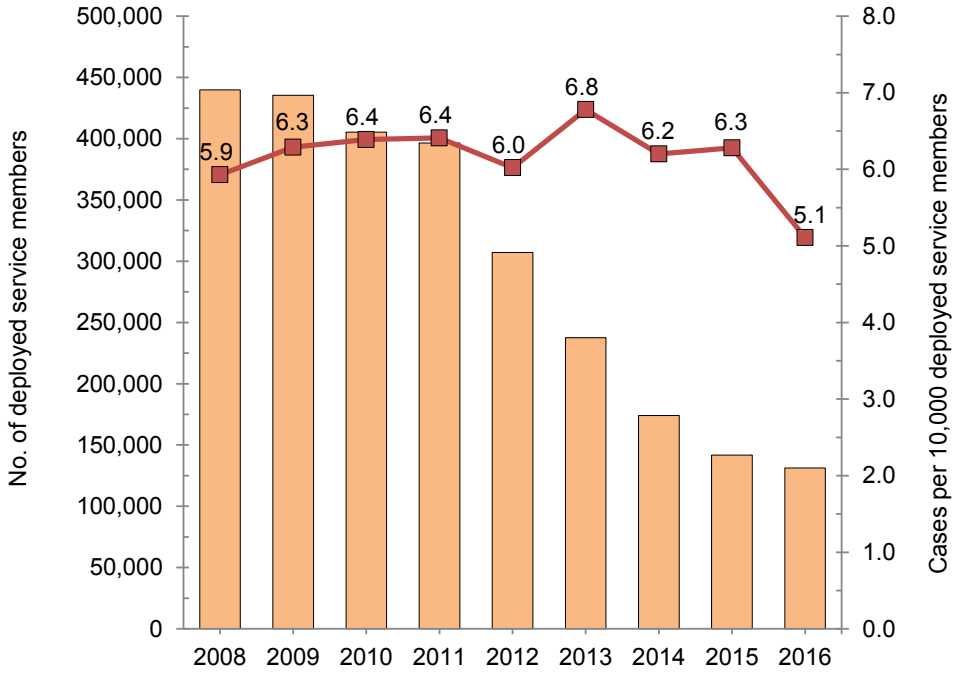
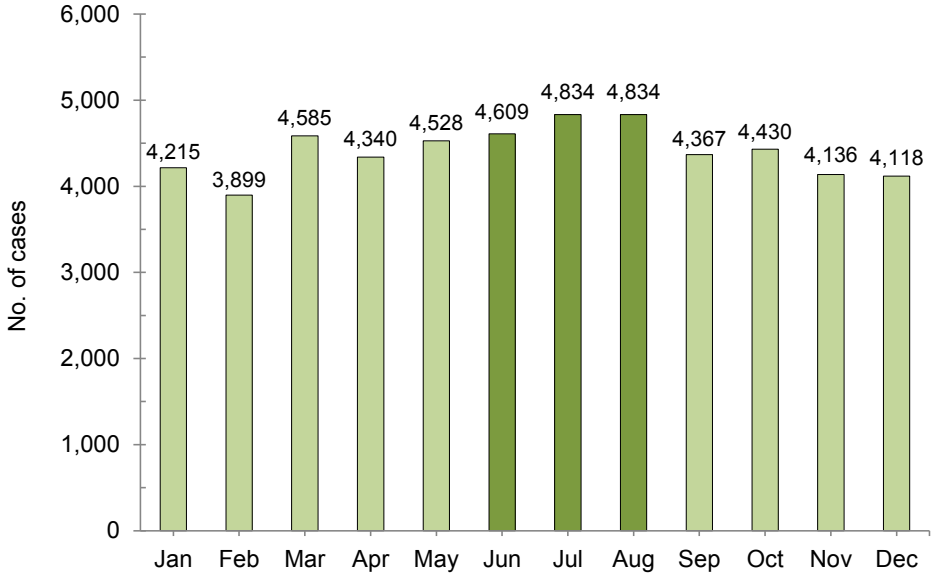


FIGURE 7. Cumulative numbers of incident cases of herpes zoster, by month of diagnosis, active component, U.S. Armed Forces, 2000–2016



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