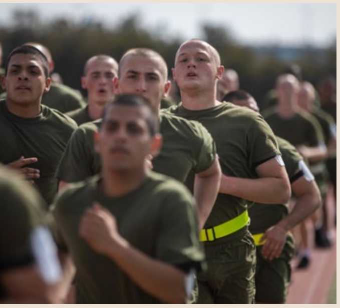
APRIL 2021

Volume 28
Number 04

MSMR

MEDICAL SURVEILLANCE MONTHLY REPORT

iStock.com/andriano_cz



A publication of the Armed Forces Health Surveillance Division

Disparities in COVID-19 Vaccine Initiation and Completion Among Active Component Service Members and Health Care Personnel, 11 December 2020–12 March 2021

Michael A. Lang, MD (Maj, MC, USAF); Shauna Stahlman, PhD, MPH; Natalie Y. Wells, MD, MPH (CAPT, MC, USN); Alyssa A. Fedgo, MPH; Deven M. Patel, PhD, MPH; Aparna Chauhan, PhD, MPH; James D. Mancuso, MD, DrPH, MPH (COL, MC, USA)

The objective of this study was to assess overall vaccine initiation and completion in the active component U.S. military, with a focus on racial/ethnic disparities. From 11 December 2020 through 12 March 2021, a total of 361,538 service members (27.2%) initiated a COVID-19 mRNA vaccine. Non-Hispanic Blacks were 28% less likely to initiate vaccination (95% confidence interval: 25%–29%) in comparison to non-Hispanic Whites, after adjusting for potential confounders. Increasing age, higher education levels, higher rank, and Asian/Pacific Islander race/ethnicity were also associated with increasing incidence of initiation after adjustment. When the analysis was restricted to active component health care personnel, similar patterns were seen. Overall, 93.8% of those who initiated the vaccine series completed it during the study period, and only minor differences in completion rates were noted among the demographic subgroups. This study suggests additional factors, such as vaccine hesitancy, influence COVID-19 vaccination choices in the U.S. military. Military leadership and vaccine planners should be knowledgeable about and aware of the disparities in vaccine series initiation.

WHAT ARE THE NEW FINDINGS?

Non-Hispanic Blacks, as well as those who were female, younger, of lower rank, with lower education levels, and those serving in the Army were less likely to initiate COVID-19 vaccination after adjusting for other factors. Once initiated, completion of the vaccine series was similar across demographic groups.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

Vaccination is an important intervention to mitigate the threat of COVID-19 to the U.S. military. Significant disparities in vaccination by race, sex, and other factors exist in military populations. The U.S. military must continue to assess and address factors associated with COVID-19 vaccine hesitancy, including disparities, to ensure maximum force health protection against the virus.

Severe Acute Respiratory Syndrome 2 (SARS-CoV-2), the virus responsible for coronavirus disease 2019 (COVID-19) has dramatically affected the global population. Its impact on the health and readiness of the U.S. military has been demonstrated in several important populations such as shipboard sailors and trainees.[1-3] The virus has affected the full range of military operations through restrictions of movement, workspace capacity limits, and testing protocols imposed upon service members.[4-8] Incidence of COVID-19 has been shown to be higher in non-Hispanic Blacks and Hispanics in the U.S., and it has also been shown that non-Hispanic Blacks have a higher risk of COVID-19 related hospitalization.[9] In the U.S. military, unpublished analyses have indicated higher rates of infection and hospitalization among non-Hispanic Black and Hispanic U.S. service members (John Young, DProf, EML, email communication, March 2021).

Three vaccines are currently available for COVID-19, authorized under emergency use. Two mRNA vaccines were approved in December 2020, and an adenovirus-vectored vaccine was approved in late February 2021. The mRNA vaccines from Pfizer and Moderna are over 90% effective and are recommended by the Centers for Disease Control and Prevention (CDC) to prevent symptomatic COVID-19.[10-12] They were immediately made available for health care personnel (HCP) within the active component U.S. military, and have subsequently been allocated according to occupational risk during initial phases as defined in the Department of Defense (DoD) COVID-19 Vaccination Population Schema which is consistent with the prioritization recommended by the Centers for Disease Control and Prevention (CDC).[13,14]

Prior to vaccine availability, a number of surveys in the general U.S. population suggested that racial and ethnic minorities were less willing to accept the COVID-19 vaccine.[15, 16] Although recent evidence suggests that vaccine hesitancy, characterized by vaccine delay or vaccine refusal,[17] may be decreasing in all groups, non-Hispanic Blacks continue to report higher levels of vaccine hesitancy. The CDC has reported that among HCP and long-term care facility residents whose race/ethnicity was known, only 5.4% of vaccine recipients were non-Hispanic Black even though 16% of the health care workforce and 14% of residents of long-term care facilities were non-Hispanic Blacks.[18] Other preliminary data have suggested that non-Hispanic Blacks had a 29% lower odds of vaccination.[19] However, the CDC has also reported that 88% of those who received a first dose of COVID-19 vaccination completed the series, with only small differences by race, age, and sex.[20]

Many media reports stated that 33% or more of military service members are refusing the vaccine, but these reports have focused on anecdotes and preliminary data coming out of Fort Bragg or other specific locations.[21] Currently, no data on DoD-wide COVID-19 vaccine initiation or completion in military populations are publicly available. The objective of this study was not only to understand overall COVID-19 vaccine initiation and completion in the active component U.S. military, but also to investigate factors associated with vaccine initiation and completion, with special attention to assessing racial and ethnic disparities. As HCP were the focus of the first phase of vaccinations, this study also was intended to specifically assess vaccination initiation and completion among active component HCP.

METHODS

Data for this study were obtained from the Defense Medical Surveillance System (DMSS), which relates demographic information to health care encounters involving active component service members (ACSMs) of the U.S. Armed Forces in direct and purchased care. The DMSS also contains administrative records for vaccinations received from the immunization database of the Defense Enrollment Eligibility Reporting System (DEERS).

For the primary analysis, all ACSMs serving in the Army, Navy, Air Force, or Marine Corps in December 2020 were followed through March 12, 2021 for initiation and completion of the Moderna (CVX code=207) or Pfizer (CVX code=208) COVID-19 mRNA vaccine series. Only small quantities of the Johnson & Johnson vaccine had been used in the U.S. military prior to the end of the study period, so its use was excluded from this analysis. Initiation was defined as having received at least one dose by 12 March 2021. Among those who initiated, completion was measured by identifying those who completed a second dose at least 17 days after the first dose of the Pfizer vaccine or 24 days for the Moderna vaccine.[14] Completion was assessed only among the population of ACSMs who initiated prior to January 29, 2021 in order to allow 6 weeks to assess completion only among those who would have been eligible to complete the dose series by 12 March 2021, which was the end of the study surveillance period. Using these criteria, the proportion of service members who initiated or completed the dose series was described. The following racial and ethnic groups were used for categorization: Non-Hispanic Whites, non-Hispanic Blacks, Hispanics, Asians/Pacific Islanders, and Other (Other race/ethnicity includes those with an unknown race/ethnicity). Covariates included sex, service, age, military rank, military occupation, marital status, education level, geographic region of assignment, prior history of positive COVID-19 test, and comorbidities. Individuals were considered to have a comorbidity if they had an inpatient or outpatient medical encounter with an eligible International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis code recorded in any diagnostic position. The list of ICD-10 codes for each comorbidity is presented in **Table 1**. Adjusted risk ratio (ARR) estimates were calculated using Poisson regression with robust error variance, and the adjusted models controlled for all the covariates previously described. All analyses were performed using SAS/STAT software, version 9.4 (SAS Institute, Cary, NC).

A secondary analysis was accomplished by replicating the primary analysis in the HCP subgroup within the ACSM population. HCP were categorized according to their primary DoD occupation codes. These occupation codes were grouped into subcategories that included: Physicians and Physician Assistants, Dentists, Nurses, Biomedical Sciences and Allied Health Personnel (includes technicians ranging from clinical technicians to laboratory and materiel support), Healthcare Administration, and Preventive Medicine elements. Preventive Medicine elements included: Undersea/Aviation Medicine, Aviation/Aerospace Medicine, Undersea Medicine, Occupational Medicine, and Preventive Medicine. Although veterinarians are coded as health care personnel, they were excluded from

TABLE 1. ICD-10 diagnosis codes used in defining comorbidities associated with increased risk of severe COVID-19

Condition	ICD-10 code
Hypertension	I10*-I16*, O10*-O16*
Any cardiovascular disease	I05*-I89*, Z95*
Chronic lower respiratory disease	J40*-J44*
Asthma	J45*
Any lung disease	J40*-J99*
Metabolic disease	E08*-E13*, O24*, Z794*, E00*-E07*, E50*-E64*, E88.81
Immune compromising conditions	B20, D55*-D77*, D80*-D89*, Z94*, Z795*, L40*, M04*-M08*, K50*-K52*
Substance use disorders including nicotine dependence	F10*-F16*, F18*-F19*, F17*
Chronic liver disease	K70*-K77*, B18*
Chronic kidney disease	N03*-N16*, N18*-N19*
Chronic neurologic disorders	G10*-G40*
Neoplasms	C00*-D49*
Obesity or overweight	E66.0*, E66.1, E66.2, E66.3, E66.8, E66.9, Z68.3*, Z68.4*, Z68.25- Z68.29

COVID-19, coronavirus disease 2019; ICD, International Classification of Diseases.

this portion of the analysis. ARR estimates were calculated adjusting for the same covariates as in the primary analysis.

RESULTS

Active component service members

Among 1,331,523 ACSMs in service during December 2020, 361,538 (27.2%) initiated COVID-19 vaccination by 12 March 2021 **(Table 2)**. Of the non-Hispanic Whites, 29% initiated, compared to 18.7% of non-Hispanic Blacks and 25.5% of Hispanics. The reduction in COVID-19 vaccine initiation seen among non-Hispanic Blacks persisted in the adjusted analysis, with non-Hispanic Blacks being 28% less likely to initiate compared to non-Hispanic Whites (95% confidence interval [CI]: 27%–29%). However, Hispanics had a similar rate of initiation compared to non-Hispanic Whites (ARR=0.99; 95% CI: 0.98–1.00). It is notable that Asian/Pacific Islanders were the only race/ethnicity group to have had a higher rate of initiation (ARR=1.02; 95% CI: 1.01–1.03) compared to non-Hispanic Whites. After adjusting for other factors, females were 10% less likely to initiate than males (95% CI: 9%–10%), and service members who had a history of COVID-19 infection were 20% less likely to initiate compared to those without prior COVID-19 infection (95% CI: 19%–21%). Navy, Air Force, and Marine Corps members were 45%, 15% and 52% more likely, respectively, to initiate compared to Army members in the adjusted model. Increasing age, greater education levels, and higher rank were also associated with increasing proportions of initiation after adjustment. Service members assigned to southern and midwestern regions had the lowest incidence of initiation. Among all DoD occupation categories, HCP and pilots had the highest incidence of initiation. In general, service members with comorbidities initiated at a slightly higher proportion compared to those who did not have a comorbidity. However, those with a diagnosed substance use disorder (including nicotine dependence), had lower initiation rates compared to those without this diagnosis (24.7% vs. 27.5%, respectively).

Among 181,127 ACSMs who initiated COVID-19 vaccination by 29 January 2021, 169,906 (93.8%) completed the COVID-19 vaccine series by 12 March 2021 **(Table 3)**. Crude differences in vaccine completion were small, and no significant associations with race/ethnicity group or sex were seen in the adjusted model. Following adjustment, individuals in the Army were slightly less likely to complete the series, as were individuals vaccinated at midwestern locations (and to a lesser extent, locations in the west and overseas).

Active component health care personnel

Among the 110,456 active component HCP, 60,763 (55.0%) initiated a COVID-19 vaccine series **(Table 4)**. As previously noted, this population excludes veterinarians. The associations seen between initiation and demographic and clinical factors in the HCP population were similar to those seen in the broader ACSM population **(Table 4)**. Of note, non-Hispanic Black HCP were 23% (95% CI: 22%–25%) less likely to initiate vaccination compared to non-Hispanic White HCP in adjusted analysis, but Asian/Pacific Islanders again were 7% more likely. Female HCP were 8% (95% CI: 7%–9%) less likely to initiate than male HCP. Within the HCP subgroup, physicians and Preventive Medicine elements had the highest incidence of vaccination (83.2% and 81.6%, respectively), followed by dentists, nurses, health care administrators, and allied biomedical sciences personnel. Of note, those who had a history of COVID-19 infection were 22% (95% CI: 20%–24%) less likely to initiate compared to those who were not. Among HCP who initiated COVID-19 vaccination by 29 January 2021, 92% completed the COVID-19 vaccine series by 12 March 2021 **(data not shown)**. The demographic differences were similar to those seen in the broader ACSM population.

EDITORIAL COMMENT

This interim report describes COVID-19 vaccine uptake within the first three months of vaccine availability. Findings from this study indicate that from 11 December 2020 through 12 March 2021, a total of 361,538 (27.2%) ACSMs initiated a COVID-19 mRNA vaccine series, including 60,763 (54.8%) HCP. Non-Hispanic Black service members were 28% less likely to initiate compared to non-Hispanic White service members, and non-Hispanic Black HCP were 23% less likely than non-Hispanic White HCP, after adjusting for potential confounders. In addition, females were 10% less likely to initiate than males, and service members who had a history of COVID-19 infection were 20% less likely to initiate. Navy, Air Force, and Marine Corps members were 45%, 15% and 52% more likely, respectively, to initiate compared to soldiers. Increasing age, greater education levels, higher rank, and Asian/Pacific Islander race/ethnicity were also associated with increasing incidence of COVID-19 vaccine initiation after adjustment. In the analysis restricted to ACSM health care personnel, the first occupational group to be offered the vaccine, similar associations were demonstrated as were seen in the broader active component population. Overall, 93.8% of those who initiated a COVID-19 vaccine series completed it, and only minor differences between demographic groups were found in vaccine completion.

Little published literature exists on current COVID-19 vaccination initiation or completion with which to compare this study. In a recent *Morbidity and Mortality Weekly Report*, non-Hispanic Blacks were found to constitute a lower proportion of vaccinees (5.4%) than would have been expected on the basis of the proportions of non-Hispanic Blacks among populations of health care workers (16%) and nursing home residents (14%).[18] In that same study, females were found to constitute a lower proportion of vaccinees (63%) despite constituting nearly 75% of both populations.. Additionally, recent preliminary data obtained from survey responses to a smartphone application suggest a 29% lower odds of having received the vaccination among non-Hispanic Black U.S. participants in comparison to non-Hispanic Whites, which was similar between the general community and among heallth care workers.[19] Despite the differences in methodology and study population sizes, the

TABLE 2. Incidence of and factors associated with initiation of COVID-19 Pfizer or Moderna vaccine series among active component service members, 11 December 2020–12 March 2021

Variable	Population	No. initiated	%	Crude risk ratio	Adjusted risk ratio (ARR)[a]	ARR 95% CI
Total	1,331,523	361,538	27.2	---	---	---
Sex						
Male	1,101,500	299,700	27.2	ref	ref	ref
Female	230,023	61,838	26.9	0.99	0.90	(0.89–0.90)
Age group (years)						
<20	135,111	11,218	8.3	ref	ref	ref
20–24	442,203	85,552	19.3	2.33	1.25	(1.23–1.27)
25–29	298,904	78,349	26.2	3.16	1.47	(1.45–1.49)
30–34	203,887	67,033	32.9	3.96	1.71	(1.68–1.74)
35–39	146,863	59,475	40.5	4.88	1.94	(1.91–197)
40–44	66,474	34,958	52.6	6.33	2.09	(2.05–2.12)
45+	38,081	24,953	65.5	7.89	2.18	(2.14–2.22)
Race/ethnicity group						
Non-hispanic White	732,210	212,021	29.0	ref	ref	ref
Non-hispanic Black	215,099	40,320	18.7	0.65	0.72	(0.71-0.73)
Hispanic	231,150	59,043	25.5	0.88	0.99	(0.98-1.00)
Asian/Pacific Islander	58,730	19,289	32.8	1.13	1.02	(1.01-1.03)
Other/unknown	94,334	30,865	32.7	1.13	1.00	(0.99-1.01)
Service						
Army	478,191	104,667	21.9	ref	ref	ref
Navy	342,059	119,655	35.0	1.60	1.45	(1.44-1.46)
Air Force	330,244	87,927	26.6	1.22	1.15	(1.14-1.16)
Marine Corps	181,029	49,289	27.2	1.24	1.52	(1.50-1.53)
Rank						
Enlisted	1,097,690	250,563	22.8	ref	ref	ref
Officer	233,833	110,975	47.5	2.08	1.31	(1.30-1.32)
Education level						
High school or less	846,987	174,145	20.6	ref	ref	ref
Some college	159,707	45,909	28.7	1.40	1.19	(1.18-1.20)
Bachelor's or advanced degree	300,120	130,985	43.6	2.12	1.33	(1.32-1.34)
Other/unknown	24,709	10,499	42.5	2.07	1.13	(1.11-1.15)
Marital status						
Single, never married	600,360	137,266	22.9	ref	ref	ref
Married	664,936	205,701	30.9	1.35	0.91	(0.91-0.92)
Other/unknown	66,227	18,571	28.0	1.23	0.92	(0.91-0.93)
Geographic region						
Northeast	37,473	11,012	29.4	1.29	1.28	(1.26-1.30)
Midwest	87,384	17,492	20.0	0.88	0.96	(0.95-0.98)
South	615,078	139,908	22.7	ref	ref	ref
West	345,298	104,283	30.2	1.33	1.30	(1.29-1.31)
Overseas	146,499	50,262	34.3	1.51	1.47	(1.46-1.48)
Other/unknown	99,791	38,581	38.7	1.70	1.73	(1.71-1.75)
Military occupation						
Combat-specific[b]	182,886	45,713	25.0	0.46	0.53	(0.52-0.53)
Motor transport	40,256	6,942	17.2	0.31	0.39	(0.39-0.40)
Pilot/air crew	46,846	21,354	45.6	0.83	0.58	(0.58-0.59)
Repair/engineering	398,309	91,729	23.0	0.42	0.46	(0.46-0.46)
Communications/intelligence	287,075	72,830	25.4	0.46	0.54	(0.53-0.54)
Health care	113,635	62,280	54.8	ref	ref	ref
Other/unknown	262,516	60,690	23.1	0.42	0.46	(0.46-0.47)
Comorbidities (Yes vs. No)						
Yes	613,933	182,341	29.7	1.19	1.01	(1.01-1.02)
No	717,590	179,197	25.0	ref	ref	ref
Prior COVID-19 case						
Yes	107,149	20,665	19.3	0.69	0.80	(0.79-0.81)
No	1,224,374	340,873	27.8	ref	ref	ref

[a]Adjusted rate ratios were adjusted for all shown covariates.
[b]Infantry/artillery/combat engineering/armor.
COVID-19, coronavirus disease 2019; No., number; CI, confidence interval.

TABLE 3. Incidence of and factors associated with completion of COVID-19 Pfizer or Moderna vaccine among active component service members who initiated the vaccine, 11 December 2020–12 March 2021

Variable	Population	No. completed	%	Crude risk ratio	Adjusted risk ratio (ARR)[a]	ARR 95% CI
Total	181,127	169,906	93.8	---	---	---
Sex						
Male	147,164	138,156	93.9	ref	ref	ref
Female	33,963	31,750	93.5	1.00	1.00	(1.00-1.00)
Age group (years)						
<20	4,425	4,081	92.2	ref	ref	ref
20–24	37,074	34,228	92.3	1.00	1.00	(0.99-1.01)
25–29	38,491	35,961	93.4	1.01	1.00	(1.00-1.01)
30–34	35,322	33,441	94.7	1.03	1.02	(1.01-1.03)
35–39	31,893	30,214	94.7	1.03	1.02	(1.01-1.03)
40–44	19,175	18,120	94.5	1.02	1.02	(1.01-1.03)
45+	14,747	13,861	94.0	1.02	1.02	(1.00-1.03)
Race/ethnicity group						
Non-hispanic White	109,722	103,184	94.0	ref	ref	ref
Non-hispanic Black	17,577	16,302	92.7	1.00	0.99	(0.99-1.00)
Hispanic	27,614	25,715	93.1	1.00	1.00	(0.99-1.00)
Asian/Pacific Islander	9,667	9,040	93.5	1.01	1.01	(1.00-1.01)
Other/unknown	16,547	15,665	94.7	1.02	1.00	(1.00-1.00)
Service						
Army	50,947	46,012	90.3	ref	ref	ref
Navy	60,973	57,813	94.8	1.00	1.05	(1.04-1.05)
Air Force	50,643	48,729	96.2	1.01	1.07	(1.07-1.08)
Marine Corps	18,564	17,352	93.5	0.99	1.04	(1.03-1.04)
Rank						
Enlisted	116,843	109,236	93.5	ref	ref	ref
Officer	64,284	60,670	94.4	1.01	1.00	(1.00-1.00)
Education level						
High school or less	77,407	71,934	92.9	ref	ref	ref
Some college	23,566	22,227	94.3	1.00	1.01	(1.01-1.01)
Bachelor's or advanced degree	73,868	69,707	94.4	1.00	1.01	(1.01-1.02)
Other/unknown	6,286	6,038	96.1	1.02	1.02	(1.01-1.03)
Marital status						
Single, never married	63,361	59,004	93.1	ref	ref	ref
Married	108,371	102,096	94.2	1.01	1.00	(1.00-1.01)
Other/unknown	9,395	8,806	93.7	1.01	1.00	(0.99-1.01)
Geographic region						
Northeast	4,201	3,994	95.1	1.01	1.01	(1.00-1.02)
Midwest	10,391	9,187	88.4	0.94	0.93	(0.92-0.93)
South	70,442	66,571	94.5	ref	ref	ref
West	51,602	48,367	93.7	1.00	0.99	(0.98-0.99)
Overseas	28,206	26,177	92.8	0.99	0.98	(0.97-0.98)
Other/unknown	16,285	15,610	95.9	1.02	1.00	(1.00-1.01)
Military occupation						
Combat-specific[b]	19,597	18,272	93.2	0.99	1.03	(1.02-1.03)
Motor transport	2,475	2,280	92.1	0.98	1.01	(1.00-1.02)
Pilot/air crew	10,754	10,377	96.5	1.03	1.02	(1.02-1.03)
Repair/engineering	38,143	36,111	94.7	1.01	1.02	(1.02-1.03)
Communications/intelligence	31,579	29,781	94.3	1.00	1.02	(1.02-1.03)
Health care	48,962	45,214	92.3	ref	ref	ref
Other/unknown	29,617	27,871	94.1	1.00	1.02	(1.01-1.02)
Comorbidities (Yes vs. No)						
Yes	96,420	90,353	93.7	1.00	0.99	(0.99-1.00)
No	84,707	79,553	93.9	ref	ref	ref
Prior COVID-19 case						
Yes	8,234	7,667	93.1	0.99	1.00	(0.99-1.00)
No	172,893	162,239	93.8	ref	ref	ref

[a]Adjusted rate ratios were adjusted for all shown covariates.
[b]Infantry/artillery/combat engineeringarmor.
COVID-19, coronavirus disease 2019; No., number; CI, confidence interval.

TABLE 4. Incidence of and factors associated with initiation of COVID-19 Pfizer or Moderna vaccine series among active component service members in health care occupations, 11 December 2020–12 March 2021

Variable	Population	No. initiated	%	Crude risk ratio	Adjusted risk ratio (ARR)[a]	ARR 95% CI
Total	110,456	60,763	55.0	---	---	---
Sex						
Male	69,664	39,376	56.5	ref	ref	ref
Female	40,792	21,387	52.4	0.93	0.92	(0.91-0.93)
Age group (years)						
<20	6,285	1,101	17.5	ref	ref	ref
20–24	26,457	10,554	39.9	1.00	1.16	(1.12-1.20)
25–29	25,323	12,488	49.3	1.24	1.26	(1.21-1.30)
30–34	21,036	12,570	59.8	1.50	1.34	(1.29-1.39)
35–39	15,772	10,872	68.9	1.73	1.42	(1.36-1.48)
40–44	8,454	6,655	78.7	1.97	1.45	(1.39-1.51)
45+	7,129	6,523	91.5	2.29	1.48	(1.42-1.54)
Race/ethnicity group						
Non-hispanic White	56,841	33,137	58.3	ref	ref	ref
Non-hispanic Black	17,512	7,000	40.0	1.00	0.77	(0.75-0.78)
Hispanic	17,879	9,148	51.2	1.28	1.01	(0.99-1.02)
Asian/Pacific Islander	7,163	4,508	62.9	1.57	1.07	(1.05-1.09)
Other/unknown	11,061	6,970	63.0	1.58	1.02	(1.00-1.03)
Service						
Army	45,009	21,727	48.3	ref	ref	ref
Navy	36,143	22,515	62.3	1.00	1.26	(1.24-1.28)
Air Force	29,304	16,521	56.4	0.91	1.12	(1.10-1.13)
Rank						
Enlisted	75,001	33,948	45.3	ref	ref	ref
Officer	35,455	26,815	75.6	1.67	1.35	(1.32-1.38)
Education level						
High school or less	46,971	19,982	42.5	ref	ref	ref
Some college	16,614	7,944	47.8	1.00	1.07	(1.05-1.10)
Bachelor's or advanced degree	42,881	29,809	69.5	1.45	1.17	(1.15-1.20)
Other/unknown	3,990	3,028	75.9	1.59	1.12	(1.09-1.15)
Marital status						
Single, never married	38,609	19,258	49.9	ref	ref	ref
Married	64,938	37,894	58.4	1.17	0.93	(0.91-0.94)
Other/unknown	6,909	3,611	52.3	1.05	0.96	(0.94-0.98)
Geographic region						
Northeast	2,606	1,445	55.4	0.91	1.14	(1.10-1.18)
Midwest	6,449	3,284	50.9	0.83	1.02	(1.00-1.05)
South	57,520	28,328	49.2	ref	ref	ref
West	28,304	17,307	61.1	1.00	1.18	(1.16-1.19)
Overseas	13,455	8,965	66.6	1.09	1.32	(1.30-1.34)
Other/unknown	2,122	1,434	67.6	1.11	1.25	(1.21-1.29)
DOD Occupation[b]						
Physician or PA	12,087	10,053	83.2	1.59	1.08	(1.06-1.10)
Dentist	3,190	2,538	79.6	1.52	1.02	(0.99-1.04)
Nurse	11,156	7,480	67.0	1.28	0.98	(0.96-1.00)
Biomedical Sciences and Allied Health Officers	72,059	34,336	47.6	ref	ref	ref
Healthcare Administration	11,616	6,072	52.3	1.00	0.84	(0.82-0.86)
Preventive Medicine Element	348	284	81.6	1.56	1.07	(1.02-1.13)
Comorbidities (Yes vs. No)						
Yes	66,331	37,235	56.1	1.05	1.01	(1.00-1.02)
No	44,125	23,528	53.3	ref	ref	ref
Prior COVID-19 case						
Yes	8,431	3,250	38.5	0.68	0.78	(0.76-0.80)
No	102,025	57,513	56.4	ref	ref	ref

[a]Adjusted rate ratios were adjusted for all shown covariates.
[b]Veterinarians are excluded from this portion of the analysis
COVID-19, coronavirus disease 2019; No., number; CI, confidence interval; PA, Physician Assistant.

findings from this study were very similar to the smartphone study, which did not report differences in vaccination by sex. Finally, the CDC report of 88% completion of vaccine series was similar to but slightly lower than that found in this study.[20] This small difference may be due to the different lengths of the follow-up periods or the different demographic and behavioral characteristics between the populations. Both the CDC report and this study found only minor differences in groups with respect to vaccine series completion.

A key strength of this study is its large, enumerated study population. This is the first study to investigate determinants of vaccine receipt for a vaccine authorized under emergency use and intended for all ACSMs. U.S. military ACSMs are provided universal eligibility for health care, reducing potential sources of systemic differences in health care access related to transportation, insurance, availability, or age which may be seen in civilian populations, and which may lead to health care disparities. Compared to other studies with higher rates of unknown race approximating 50% in some cases,[18] only 2% of ACSMs have unknown race/ethnicity in the demographic records contained in DMSS. Finally, vaccine initiation and completion outcome data are based on observation rather than self-report.

This study is not without limitations. First, as these vaccines were approved under Emergency Use Authorization, by military regulation they were offered on a voluntary basis only. In addition, ACSMs in certain populations and roles were not eligible for vaccination during the surveillance period.[22] Because data were not available on specifically who was offered vaccination, this could not be adjusted for and to some extent this may confound the association between race/ethnicity and vaccine initiation. This voluntary immunization program is distinct from immunization programs governing vaccines for other respiratory pathogens in the DOD which are considered mandatory, such as vaccines for influenza and measles, mumps, and rubella.[23] There are many complex individual, interpersonal, military, and societal factors influencing access to and willingness to receive this voluntary vaccination which were not measured here. Second, there is potential for misclassification of vaccination status if significant errors or delays in documentation existed. Covariates such as geographic region, marital status, occupation, etc., may have changed between December 2020 and the time of vaccine receipt; however, these differences are expected to be small due to the short surveillance period. In addition, race is self-reported, in contrast to other objective covariates such as age and rank. Importantly, the results presented here may change after more time has passed and more vaccines become available or accessible. The findings from recent surveys of waning vaccine hesitancy over time suggest that the associations from this study could be further attenuated as behaviors change over time.[19] Finally, vaccine declination was not assessed in this study because these data were not available.

Vaccination is an important intervention to mitigate the threat of COVID-19 to the U.S. military. Despite universal eligibility for health care in the U.S. military, disparities in COVID-19 vaccine initiation exist by race, as well as by sex, rank, and education. Among both the entire ACSM population and its HCP subgroup, vaccine hesitancy among racial and ethnic groups mirror that which has been observed within the U.S. population. This suggests that forces external to the U.S. military, such as interpersonal and societal factors, also contribute towards vaccine hesitancy among military service members, as has been suggested for other disease processes.[24] Military leadership and vaccine planners should be knowledgeable about and aware of the disparities in vaccine initiation. Messaging and other outreach efforts should aim to reduce or eliminate vaccine hesitancy in general, with attention focused on reducing vaccine disparities. Vaccine declinations should be addressed, with further description of reasoning for declinations, as this would serve to better understand the most common behaviors and beliefs of key demographic groups. Surveys and mixed-methods participatory research are potential avenues to identify factors which mitigate vaccine hesitancy. The U.S. military must continue to assess and address factors associated with COVID-19 vaccine hesitancy, including disparities, to ensure maximum force health protection against the virus.

Author affiliations: Department of Preventive Medicine and Biostatistics at the Uniformed Services University of the Health Sciences, Bethesda, MD (Drs. Mancuso and Lang); Armed Forces Health Surveillance Division, Silver Spring, MD (Drs. Stahlman, Wells, Chauhan, Patel, and Ms. Fedgo)

Acknowledgements: The authors thank Amy Costello, MD, MPH (Col, USAF) and Margaret Ryan, MD, MPH (CAPT USN [ret], DHA/IHD) for substantial contributions including proofreading and providing critical details related to the study background and design. They also thank John Young, DProf, EML (USUHS) for critical details related to the background of this study.

Disclaimer: The opinions and assertions expressed herein are those of the authors and do not necessarily reflect the official policy or position of the Department of Defense or the U.S. Government.

REFERENCES

1. Kasper MR, Geibe JR, Sears CL, et al. An Outbreak of Covid-19 on an Aircraft Carrier. *N Engl J Med*. 2020;383(25):2417–2426.
2. Letizia AG, Ge Y, Goforth CW, et al. SARS-CoV-2 Seropositivity among US Marine Recruits Attending Basic Training, United States, Spring–Fall 2020. *Emerg Infect Dis*. 2021;27(4):1188–1192.
3. Letizia AG, Ramos I, Obla A, et al. SARS-CoV-2 Transmission among Marine Recruits during Quarantine. *N Engl J Med*. 2020;383(25):2407–2416.
4. Office of the Under Secretary of Defense, Personnel and Readiness. Force Health Protection Guidance (Supplement 11) – Department of Defense Guidance for Coronavirus Disease 2019 Surveillance and Screening with Testing. 12 June 2020.
5. Office of the Under Secretary of Defense, Personnel and Readiness. Force Health Protection Guidance (Supplement 14) – Department of Defense Guidance for Personnel Traveling During the Coronavirus Disease 2019 Pandemic. 29 December 2020.
6. Office of the Under Secretary of Defense, Personnel and Readiness. Force Health Protection Guidance (Supplement 16) – Department of Defense Guidance for Deployment and Redeployment of Individuals and Units During the Coronavirus Disease 2019 Pandemic. 16 March 2021.
7. Office of the Under Secretary of Defense, Personnel and Readiness. Force Health Protection Guidance (Supplement 17) – Department of Defense Guidance for the Use of Masks, Personal Protective Equipment, and Non-Pharmaceutical Interventions During the Coronavirus Disease 2019 Pandemic. 17 March 2021.
8. Office of the Under Secretary of Defense,

Personnel and Readiness. Force Health Protection Guidance (Supplement 18) – Department of Defense Guidance for Protecting All Personnel in Department of Defense Workplaces During the Coronavirus Disease 2019 Pandemic. 17 March 2021.
9. Price-Haywood EG, Burton J, Fort D, Seoane L. Hospitalization and Mortality among Black Patients and White Patients with Covid-19. *N Engl J Med*. 2020;382(26):2534–2543.
10. Oliver SE, Gargano JW, Marin M, et al. The Advisory Committee on Immunization Practices' Interim Recommendation for Use of Pfizer-BioNTech COVID-19 Vaccine - United States, December 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(50):1922–1924.
11. Oliver SE, Gargano JW, Marin M, et al. The Advisory Committee on Immunization Practices' Interim Recommendation for Use of Moderna COVID-19 Vaccine - United States, December 2020. *MMWR Morb Mortal Wkly Rep*. 2021;69(5152):1653–1656.
12. Jones NK, Rivett L, Seaman S, et al. Single-dose BNT162b2 vaccine protects against asymptomatic SARS-CoV-2 infection. *Elife*. 2021;10:e68808.
13. Defense Health Agency-Interim Procedures Memorandum 20-004: Department of Defense (DOD) Coronavirus Disease 2019 (COVID-19) Vaccination Program Implementation. 2021.
14. Interim Clinical Considerations for Use of mRNA COVID-19 Vaccines Currently Authorized in the United States. Accessed 25 March 2021. https://www.cdc.gov/vaccines/covid-19/info-by-product/clinical-considerations.html
15. Daly M, Robinson E. Willingness to vaccinate against COVID-19 in the US: Longitudinal evidence from April–October 2020. *Am J Prev Med*. 2021; S0749-3797(21)00088-X.
16. Nguyen KH, Srivastav A, Razzaghi H, et al. COVID-19 Vaccination Intent, Perceptions, and Reasons for Not Vaccinating Among Groups Prioritized for Early Vaccination - United States, September and December 2020. *MMWR Morb Mortal Wkly Rep*. 2021;70(6):217–222.
17. Dube E, Laberge C, Guay M, Bramadat P, Roy R, Bettinger J. Vaccine hesitancy: an overview. *Hum Vaccin Immunother*. 2013;9(8):1763–1773.
18. Painter EM, Ussery EN, Patel A, et al. Demographic Characteristics of Persons Vaccinated During the First Month of the COVID-19 Vaccination Program - United States, December 14, 2020–January 14, 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(5):174–177.
19. Nguyen LH, Joshi AD, Drew DA, et al. Racial and ethnic differences in COVID-19 vaccine hesitancy and uptake. *medRxiv*. 2021.02.25.21252402.
20. Kriss JL, Reynolds LE, Wang A, et al. COVID-19 Vaccine Second-Dose Completion and Interval Between First and Second Doses Among Vaccinated Persons - United States, December 14, 2020–February 14, 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(11):389–395.
21. Myers M. About a third of troops have turned down the COVID-19 vaccine. *Military Times*. 17 February 2021. Accessed 24 March 2021. https://www.militarytimes.com/news/your-military/2021/02/17/about-a-third-of-troops-have-turned-down-the-covid-19-vaccine/
22. Office of the Under Secretary of Defense, Personnel and Readiness. Department of Defense Instruction 6200.02. Application of Food and Drug Administration (FDA) Rules to Department of Defense Force Health Protection Programs. 27 February 2008
23. Headquarters, Departments of the Army, the Navy, the Air Force, and the Coast Guard. Army Regulation 40–562. Immunizations and Chemoprophylaxis for the Prevention of Infectious Diseases. 7 October 2013.
24. Harris GL. Reducing Healthcare Disparities in the Military Through Cultural Competence. *J Health Hum Serv Adm*. 2011;34(2):145–181.

Update: Heat Illness, Active Component, U.S. Armed Forces, 2020

In 2020, there were 475 incident cases of heat stroke and 1,667 incident cases of heat exhaustion among active component service members. The overall crude incidence rates of heat stroke and heat exhaustion were 0.36 cases and 1.26 cases per 1,000 person-years; both were the lowest annual rates in the 2016-2020 surveillance period. In 2020, subgroup-specific rates of both incident heat stroke and heat exhaustion were highest among males, those less than 20 years old, Asian/Pacific Islanders, Marine Corps and Army members, recruit trainees, and those in combat-specific occupations. During 2016–2020, a total of 341 heat illnesses were documented among service members in Iraq and Afghanistan; 7.0% (n=24) were diagnosed as heat stroke. Commanders, small unit leaders, training cadre, and supporting medical personnel must ensure that the military members whom they supervise and support are informed about the risks, preventive countermeasures, early signs and symptoms, and first-responder actions related to heat illnesses.

WHAT ARE THE NEW FINDINGS?

During 2016–2020, annual rates of both heat stroke and heat exhaustion among active component service members peaked in 2018 but were the lowest in 2020. The annual numbers of heat illnesses diagnosed in Iraq and Afghanistan have trended downward since 2016.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

This analysis demonstrates again the magnitude of risks of heat illnesses among active component service members and the enhanced risks associated with sex age, location of assignment, and occupational categories. Recognition of these risk factors should inform the preventive measures that military leaders, trainers, and service members routinely employ.

Heat illness refers to a group of disorders that occur when the elevation of core body temperature surpasses the compensatory limits of thermoregulation.[1] Heat illness is the result of environmental heat stress and/or exertion and represents a set of conditions that exist along a continuum from less severe (heat exhaustion) to potentially life threatening (heat stroke).

Heat exhaustion is caused by the inability to maintain adequate cardiac output because of strenuous physical exertion and environmental heat stress.[1,2] Acute dehydration often accompanies heat exhaustion but is not required for the diagnosis.[3] The clinical criteria for heat exhaustion include a core body temperature greater than 100.5 °F/38 °C and less than 104 °F/40 °C at the time of or immediately after exertion and/or heat exposure, physical collapse at the time of or shortly after physical exertion, and no significant dysfunction of the central nervous system. If any central nervous system dysfunction develops (e.g., dizziness or headache), it is mild and rapidly resolves with rest and cooling measures (e.g., removal of unnecessary clothing, relocation to a cooled environment, and oral hydration with cooled, slightly hypotonic solutions).[1–4]

Heat stroke is a debilitating illness characterized clinically by severe hyperthermia (i.e., a core body temperature of 104 °F/40 °C or greater), profound central nervous system dysfunction (e.g., delirium, seizures, or coma), and additional organ and tissue damage.[1,4,5] The onset of heat stroke should prompt aggressive clinical treatments, including rapid cooling and supportive therapies such as fluid resuscitation to stabilize organ function.[1,5] The observed pathologic changes in several organ systems are thought to occur through a complex interaction between heat cytotoxicity, coagulopathies, and a severe systemic inflammatory response.[1,5] Multiorgan system failure is the ultimate cause of mortality due to heat stroke.[5]

Timely medical intervention can prevent milder cases of heat illness (e.g., heat exhaustion) from becoming severe (e.g., heat stroke) and potentially life threatening. However, even with medical intervention, heat stroke may have lasting effects, including damage to the nervous system and other vital organs and decreased heat tolerance, making an individual more susceptible to subsequent episodes of heat illness.[6–8] Furthermore, the continued manifestation of multiorgan system dysfunction after heat stroke increases patients' risk of mortality during the ensuing months and years.[9,10]

Strenuous physical activity for extended durations in occupational settings as well as during military operational and training exercises exposes service members to considerable heat stress because of high environmental heat and/or a high rate of metabolic heat production.[11,12] In some military settings, wearing needed protective clothing or equipment may make it biophysically difficult to dissipate body heat.[13,14] The resulting body heat burden and associated cardiovascular strain reduce exercise performance and increase the risk of heat-related illness.[11,15]

Over many decades, lessons learned during military training and operations in hot environments as well as a substantial body of research findings have resulted in doctrine, equipment, and preventive measures that can significantly reduce the adverse health effects of military activities in hot weather.[16–22] Although numerous effective countermeasures are available, heat-related illness remains a significant threat to the health and operational effectiveness of military members and their units and accounts for considerable morbidity, particularly during recruit training in the

U.S. military.[11,23] Moreover, with the projected rise in the intensity and frequency of extreme heat conditions associated with global climate change, heat-related illnesses will likely represent an increasing challenge to the military.[24–26]

In the U.S. Military Health System (MHS), the most serious types of heat-related illness are considered notifiable medical events. Notifiable cases of heat illness include heat exhaustion and heat stroke. All cases of heat illness that require medical intervention or result in change of duty status are reportable.[4]

This report summarizes reportable medical events of heat illness as well as heat illness-related hospitalizations and ambulatory visits among active component service members during 2020 and compares them to the previous 4 years. Episodes of heat stroke and heat exhaustion are summarized separately.

METHODS

The surveillance period was 1 January 2016 through 31 December 2020. 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 heat illness diagnoses were derived from records routinely maintained in the Defense Medical Surveillance System (DMSS). These records document both ambulatory encounters and hospitalizations of active component service members of the U.S. Armed Forces in fixed military and civilian (if reimbursed through the MHS) treatment facilities worldwide. In-theater diagnoses of heat illness were identified from medical records of service members deployed to Southwest Asia or the Middle East and whose health care encounters were documented in the Theater Medical Data Store. Because heat illnesses represent a threat to the health of individual service members and to military training and operations, the Armed Forces require expeditious reporting of these reportable medical events through any of the service-specific electronic reporting systems; these reports are routinely transmitted and incorporated into the DMSS.

For this analysis, a case of heat illness was defined as an individual with 1) a hospitalization or outpatient medical encounter with a primary (first-listed) or secondary (second-listed) diagnosis of heat stroke (International Classification of Diseases, 9th Revision [ICD-9]: 992.0; International Classification of Diseases, 10th Revision [ICD-10]: T67.0*) or heat exhaustion (ICD-9: 992.3–992.5; ICD-10: T67.3*–T67.5*) or 2) a reportable medical event record of heat exhaustion or heat stroke.[27] Because of an update to the Disease Reporting System internet (DRSi) medical event reporting system in July 2017, the type of reportable medical events for heat illness (i.e., heat stroke or heat exhaustion) could not be distinguished using reportable medical event records in DMSS data. Instead, information on the type of reportable medical event for heat illness during the entire 2016–2020 surveillance period was extracted directly from the records of the DRSi. It is important to note that *MSMR* analyses carried out before 2018 included diagnosis codes for other and unspecified effects of heat and light (ICD-9: 992.8 and 992.9; ICD-10: T67.8* and T67.9*) within the heat illness category "other heat illnesses." These codes were excluded from the current analysis and the April *MSMR* analyses of 2018, 2019, and 2020. If an individual had a diagnosis for both heat stroke and heat exhaustion during a given year, only 1 diagnosis was selected, prioritizing heat stroke over heat exhaustion. Encounters for each individual within each calendar year then were prioritized in terms of record source with hospitalizations prioritized over reportable events, which were prioritized over ambulatory visits.

For surveillance purposes, a "recruit trainee" was defined as an active component service member (grades E1–E4) who was assigned to 1 of the services' 8 recruit training locations (per the individual's initial military personnel record). For this report, each service member was considered a recruit trainee for the period corresponding to the usual length of recruit training in his or her service. Recruit trainees were considered a separate category of enlisted service members in summaries of heat illnesses by military grade overall.

Records of medical evacuations from the U.S. Central Command (CENTCOM) area of responsibility (AOR) (e.g., Iraq or Afghanistan) to a medical treatment facility outside the CENTCOM AOR were analyzed separately. Evacuations were considered case defining if affected service members had at least 1 inpatient or outpatient heat illness medical encounter in a permanent military medical facility in the U.S. or Europe from 5 days before to 10 days after their evacuation dates.

It should be noted that medical data from sites that were using the new electronic health record for the Military Health System, MHS GENESIS, between July 2017 and October 2019 are not available in the DMSS. These sites include Naval Hospital Oak Harbor, Naval Hospital Bremerton, Air Force Medical Services Fairchild, and Madigan Army Medical Center. Therefore, medical encounter data for individuals seeking care at any of these facilities from July 2017 through October 2019 were not included in the current analysis.

RESULTS

In 2020, there were 475 incident cases of heat stroke and 1,667 incident cases of heat exhaustion among active component service members **(Table 1)**. The crude overall incidence rates of heat stroke and heat exhaustion were 0.36 and 1.26 per 1,000 person-years (p-yrs), respectively. In 2020, subgroup-specific incidence rates of heat stroke were highest among males, those less than 20 years old, Asian/Pacific Islanders, Marine Corps and Army members, recruit trainees, and those in combat-specific occupations **(Table 1)**. The rates of incident heat stroke among Marine Corps and Army members were more than 9 times the rates among Air Force and Navy members. The incidence rate of heat stroke among female service members was 48.2% lower than the rate among male service members. There were only 19 cases of heat stroke reported among recruit trainees, but their incidence rate was more than 2 times that of other enlisted members and officers.

The crude overall incidence rate of heat exhaustion among females was 22.0% lower than the rate among males **(Table 1)**. In 2020, compared to their respective counterparts, service members less than 20 years old, Asian/Pacific Islanders, Marine Corps and Army members, recruit trainees, and service members in combat-specific occupations had notably higher rates of incident heat exhaustion.

Crude (unadjusted) annual incidence rates of heat stroke increased steadily from 0.37 per 1,000 p-yrs in 2016 to 0.46 cases per 1,000 p-yrs in 2018 but then dropped to 0.41 cases per 1,000 p-yrs in 2019 and then to 0.36 cases per 1,000 p-yrs in 2020 **(Figure 1)**. In the last year of the surveillance period, there were fewer heat stroke-related ambulatory visits than in any of the previous 4 years. Reportable medical events of heat stroke in 2020 (n=132) were the fewest since 2016 (n=93).

Crude annual rates of incident heat exhaustion were stable during 2016–2017, increased to a peak of 1.73 cases per 1,000 p-yrs in 2018, fell slightly in 2019, and then dropped sharply to the lowest value in the surveillance period, 1.26 per 1,000 p-yrs, in 2020 **(Figure 2)**.

Heat illnesses by location

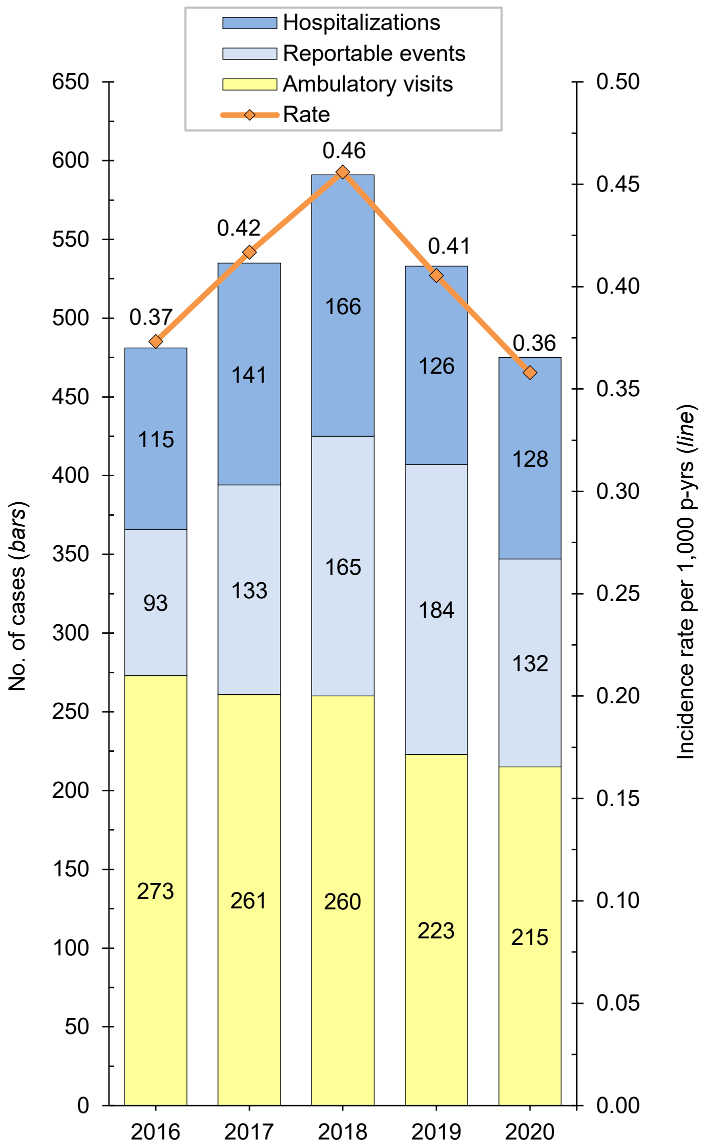
During the 5-year surveillance period, a total of 12,484 heat-related illnesses were diagnosed at more than 250 military installations and geographic locations worldwide **(Table 2)**. Of the total heat illness cases, 6.2% occurred outside of the U.S., including 315 in Okinawa and 463 at 59 other locations in Europe, East Asia, Southwest Asia, Africa, and Cuba. Four Army installations in the U.S. accounted for slightly more than one-third (34.0%) of all heat illnesses during the period: Fort Benning, GA (n=1,849); Fort Bragg, NC (n=971); Fort Campbell, KY (n=756); and Fort Polk, LA (n=674). Six other locations accounted for an additional one-quarter (26.5%) of heat illness events: Marine Corps Base (MCB) Camp Lejeune/Cherry Point, NC (n=1,050); Marine Corps Recruit Depot Parris Island/Beaufort, SC (n=576); Naval Medical Center San Diego, CA (n=531); MCB Camp Pendleton, CA (n=467); Fort Hood, TX (n=365); and Okinawa, Japan (n=315). Of these 10 locations with the most heat illness events, 6 are located in the southeastern U.S. During the surveillance period, 20 locations had more than 100 cases each; together, these locations accounted for over

TABLE 1. Incident cases[a] and incidence rates[b] of heat illness, by demographic and military characteristics, active component, U.S. Armed Forces, 2020

	Heat stroke		Heat exhaustion		Total heat illness diagnoses	
	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]
Total	475	0.36	1,667	1.26	2,142	1.61
Sex						
Male	429	0.39	1,435	1.31	1,864	1.70
Female	46	0.20	232	1.02	278	1.22
Age group (years)						
<20	88	0.88	457	4.58	545	5.47
20–24	221	0.52	760	1.78	981	2.30
25–29	106	0.34	284	0.92	390	1.27
30–34	39	0.19	87	0.42	126	0.60
35–39	14	0.09	49	0.31	63	0.40
40+	7	0.06	30	0.24	37	0.29
Race/ethnicity group						
Non-Hispanic White	279	0.38	931	1.27	1,210	1.65
Non-Hispanic Black	70	0.33	254	1.18	324	1.51
Hispanic	74	0.33	307	1.35	381	1.68
Asian/Pacific Islander	32	0.55	106	1.83	138	2.38
Other/unknown	20	0.21	69	0.72	89	0.93
Service						
Army	285	0.60	950	1.99	1,235	2.59
Navy	22	0.07	98	0.29	120	0.36
Air Force	15	0.05	126	0.38	141	0.43
Marine Corps	153	0.84	493	2.70	646	3.53
Military status						
Recruit	19	0.76	207	8.26	226	9.02
Enlisted	375	0.35	1,312	1.23	1,687	1.58
Officer	81	0.35	148	0.63	229	0.98
Military occupation						
Combat-specific[c]	229	1.26	616	3.38	845	4.64
Motor transport	12	0.30	43	1.07	55	1.37
Pilot/air crew	3	0.06	5	0.11	8	0.17
Repair/engineering	45	0.11	232	0.59	277	0.70
Communications/intelligence	56	0.20	203	0.71	259	0.90
Health care	26	0.23	85	0.74	111	0.97
Other/unknown	104	0.40	483	1.85	587	2.25
Home of record[d]						
Midwest	91	0.40	350	1.53	441	1.93
Northeast	69	0.42	182	1.10	251	1.52
South	198	0.34	725	1.26	923	1.61
West	110	0.35	382	1.21	492	1.55
Other/unknown	7	0.17	28	0.67	35	0.84

[a]One case per person per year.
[b]Number of cases per 1,000 person-years.
[c]Infantry/artillery/combat engineering/armor.
[d]As self-reported at time of entry into service.
No., number.

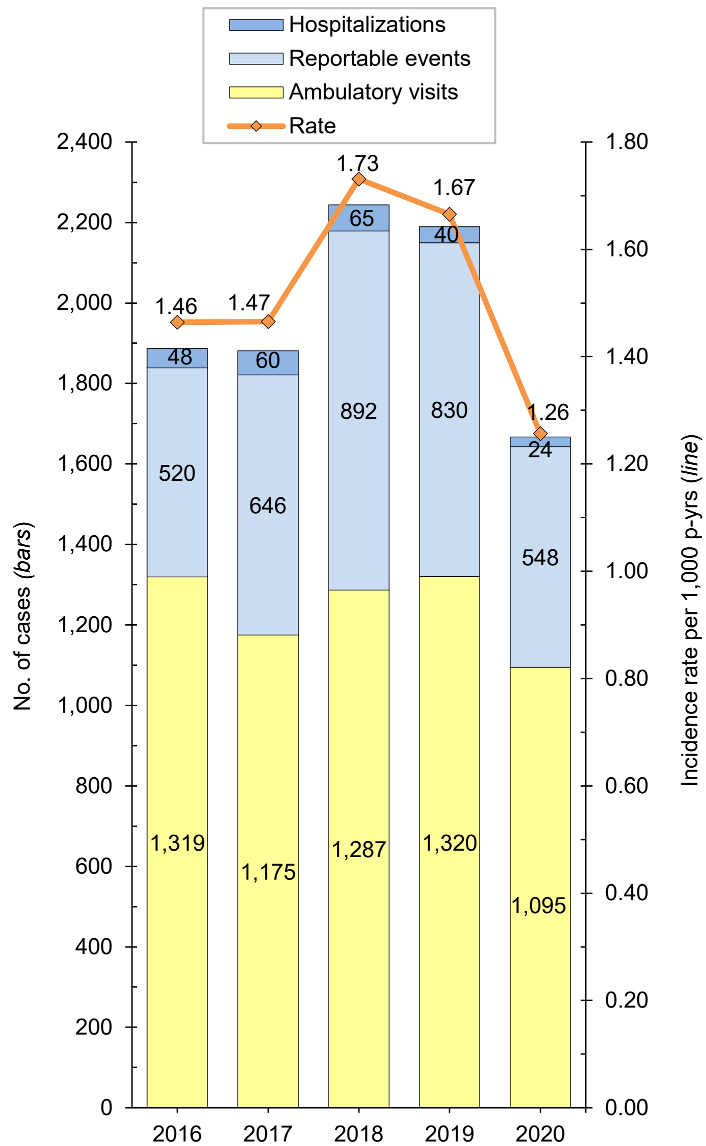
FIGURE 1. Incident cases[a] and incidence rates of heat stroke, by source of report and year of diagnosis, active component, U.S. Armed Forces, 2016–2020



[a]Diagnosis codes were prioritized by severity and record source (heat stroke > heat exhaustion; hospitalizations > reportable events > ambulatory visits).

No., number; p-yrs, person-years.

FIGURE 2. Incident cases[a] and incidence rates of heat exhaustion, by source of report and year of diagnosis, active component, U.S. Armed Forces, 2016–2020



[a]Diagnosis codes were prioritized by severity and record source (heat stroke > heat exhaustion; hospitalizations > reportable events > ambulatory visits).

No., number; p-yrs, person-years.

three-quarters (76.6%) of all cases among active component members.

Heat illnesses in Iraq and Afghanistan

During the 5-year surveillance period, a total of 341 heat illnesses were diagnosed and treated in Iraq and Afghanistan **(Figure 3)**. Of the total cases, 7.0% (n=24) were diagnosed as heat stroke. Deployed service members who were affected by heat illnesses were most frequently male (n=279; 81.8%); non-Hispanic white (n=204; 59.8%); 20–24 years old (n=188; 55.1%); in the Army (n=163; 47.8%); enlisted (n=330; 96.8%); and in repair/engineering (n=109; 32.0%) or combat-specific (n=85; 24.9%) occupations **(data not shown)**. During the surveillance period, 3 service members were medically evacuated for heat illnesses from Iraq or Afghanistan; 2 of the evacuations took place in the summer months (May 2017 and July 2016) and 1 in November 2020.

EDITORIAL COMMENT

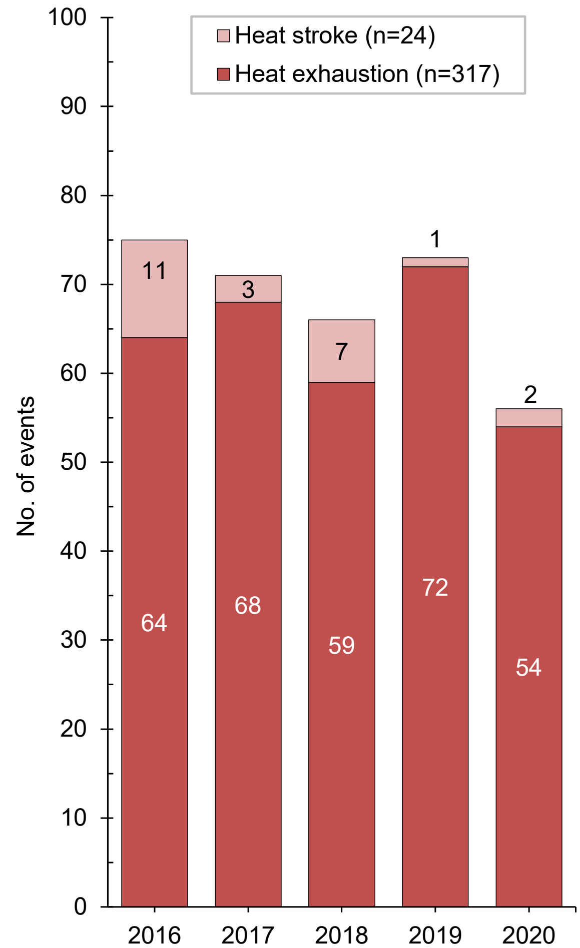
This annual update of heat illnesses among service members in the active component documented that the unadjusted annual rates of incident heat stroke and heat exhaustion peaked in 2018 and then declined in 2019 and 2020. In fact the crude annual incidence rates of heat stroke and heat exhaustion in 2020 represent the lowest rates of the 5-year surveillance period.

TABLE 2. Heat injury events[a], by location of diagnosis/report (with at least 100 cases during the period), active component, U.S. Armed Forces, 2016–2020

Location of diagnosis	No.	% total
Fort Benning, GA	1,849	14.8
MCB Camp Lejeune/Cherry Point, NC	1,050	8.4
Fort Bragg, NC	971	7.8
Fort Campbell, KY	756	6.1
Fort Polk, LA	674	5.4
MCRD Parris Island/Beaufort, SC	576	4.6
NMC San Diego, CA	531	4.3
MCB Camp Pendleton, CA	467	3.7
Fort Hood, TX	365	2.9
Okinawa, Japan	315	2.5
JBSA-Lackland, TX	290	2.3
MCB Quantico, VA	277	2.2
Fort Jackson, SC	249	2.0
Fort Stewart, GA	239	1.9
NH Twentynine Palms, CA	211	1.7
Fort Shafter, HI	170	1.4
Fort Leonard Wood, MO	169	1.4
Fort Sill, OK	148	1.2
Fort Irwin, CA	139	1.1
Fort Bliss, TX	118	0.9
Outside the U.S.[b]	463	3.7
All other locations	2,457	19.7
Total	12,484	100.0

[a]One heat injury per person per year.
[b]Excluding Okinawa, Japan
No., number; MCB, Marine Corps Base; MCRD, Marine Corps Recruit Depot; NMC, Naval Medical Center; JBSA, Joint Base San Antonio; NH, Naval Hospital.

FIGURE 3. Numbers of heat illnesses diagnosed in Iraq/Afghanistan, active component, U.S. Armed Forces, 2016–2020



No., number

There are significant limitations to this update that should be considered when interpreting the results. Similar heat-related clinical illnesses are likely managed differently and reported with different diagnostic codes at different locations and in different clinical settings. Such differences undermine the validity of direct comparisons of rates of nominal heat stroke and heat exhaustion events across locations and settings. Also, heat illnesses during training exercises and deployments that are treated in field medical facilities are not completely ascertained as cases for this report. In addition, it should be noted that the guidelines for mandatory reporting of heat illnesses were modified in the 2017 revision of the Armed Forces guidelines and case definitions for reportable medical events and carried into the 2020 revision.[4] In this updated version of the guidelines and case definitions, the heat injury category was removed, leaving only case classifications for heat stroke and heat exhaustion. To compensate for such possible variation in reporting, the analysis for this update, as in previous years, included cases identified in DMSS records of ambulatory care and hospitalizations using a consistent set of ICD-9/ICD-10 codes for the entire surveillance period. However, it also is important to note that the exclusion of diagnosis codes for other and unspecified effects of heat and light (formerly included within the heat illness category "other heat illnesses") in the current analysis precludes the direct comparison of numbers and rates of cases of heat exhaustion to the numbers and rates of "other heat illnesses" reported in *MSMR* updates before 2018.

As has been noted in previous *MSMR* heat illness updates, results indicate that a sizable proportion of cases identified through DMSS records of ambulatory visits did not prompt mandatory reports through the reporting system.[23] However, this study did not directly ascertain the overlap between hospitalizations and reportable events and the overlap between reportable events and outpatient encounters. It is possible that cases of heat illness, whether diagnosed during an inpatient or outpatient encounters, were not documented as reportable medical events because treatment providers were not attentive to the criteria for reporting or because of ambiguity in interpreting the criteria (e.g., the heat illness did not result in a change in duty status or the core body temperature measured during/immediately after exertion or heat exposure was not available). Underreporting is especially concerning for cases of heat stroke because it may reflect insufficient attentiveness to the need for prompt recognition of cases of this dangerous illness and for timely intervention at the local level to prevent additional cases.

In spite of its limitations, this report demonstrates that heat illnesses continue to be a significant and persistent threat to both the health of U.S. military members and the effectiveness of military operations. Of all military members, the youngest and most inexperienced Marine Corps and Army members (particularly those training at installations in the southeastern U.S.) are at highest risk of heat illnesses, including heat stroke, exertional hyponatremia, and exertional rhabdomyolysis (see the other articles in this issue of the *MSMR*).

Commanders, small unit leaders, training cadre, and supporting medical personnel—particularly at recruit training centers and installations with large combat troop populations—must ensure that the military members whom they supervise and support are informed regarding the risks, preventive countermeasures (e.g., water consumption), early signs and symptoms, and first-responder actions related to heat illnesses.[16–22,28–30] Leaders should be aware of the dangers of insufficient hydration on the one hand and excessive water intake on the other; they must have detailed knowledge of, and rigidly enforce countermeasures against, all types of heat illnesses.

Policies, guidance, and other information related to heat illness prevention and sun safety among U.S. military members are available online through the Army Public Health Center website at https://phc.amedd.army.mil/topics/discond/hipss/Pages/default.aspx.

REFERENCES

1. Atha WF. Heat-related illness. *Emerg Med Clin North Am*. 2013;31(4):1097–1108.
2. Simon HB. Hyperthermia. *N Engl J Med*. 1993;329(7):483–487.
3. O'Connor FG, Sawka MN, Deuster P. Disorders due to heat and cold. In: Goldman L, Schafer AI, eds. *Goldman-Cecil Medicine.* 25th ed. Philadelphia, PA: Elsevier Saunders; 2016:692–693.
4. Armed Forces Health Surveillance Branch, Defense Health Agency. In collaboration with U.S. Air Force School of Aerospace Medicine, Army Public Health Center, and Navy and Marine Corps Public Health Center. Armed Forces Reportable Medical Events. Guidelines and Case Definitions, January 2020. Accessed 18 March 2021. https://health.mil/Reference-Center/Publications/2020/01/01/Armed-Forces-Reportable-Medical-Events-Guidelines
5. Leon LR, Bouchama A. Heat stroke. *Compr Physiol*. 2015;5(2):611–647.
6. Epstein Y. Heat intolerance: predisposing factor or residual injury? *Med Sci Sports Exerc*. 1990;22(1):29–35.
7. O'Connor FG, Casa DJ, Bergeron MF, et al. American College of Sports Medicine roundtable on exertional heat stroke—return to duty/return to play: conference proceedings. *Curr Sports Med Rep*. 2010;9(5):314–321.
8. Shapiro Y, Magazanik A, Udassin R, Ben-Baruch G, Shvartz E, Shoenfeld Y. Heat intolerance in former heatstroke patients. *Ann Intern Med*. 1979;90(6):913–916.
9. Dematte JE, O'Mara K, Buescher J, et al. Near-fatal heat stroke during the 1995 heat wave in Chicago. *Ann Intern Med.* 1998;129(3):173–181.
10. Wallace RF, Kriebel D, Punnett L, Wegman DH, Amoroso PJ. Prior heat illness hospitalization and risk of early death. *Environ Res.* 2007;104(2):290–295.
11. Carter R 3rd, Cheuvront SN, Williams JO, et al. Epidemiology of hospitalizations and deaths from heat illness in soldiers. *Med Sci Sports Exerc.* 2005;37(8):1338–1344.
12. Hancock PA, Ross JM, Szalma JL. A meta-analysis of performance response under thermal stressors. *Hum Factors*. 2007;49(5):851–877.
13. Caldwell JN, Engelen L, van der Henst C, Patterson MJ, Taylor NA. The interaction of body armor, low-intensity exercise, and hot-humid conditions on physiological strain and cognitive function. *Mil Med*. 2011;176(5):488–493.
14. Maynard SL, Kao R, Craig DG. Impact of personal protective equipment on clinical output and perceived exertion. *J R Army Med Corps.* 2016;162(3):180–183.
15. Sawka MN, Cheuvront SN, Kenefick RW. High skin temperature and hypohydration impair aerobic performance. *Exp Physiol*. 2012;97(3):327–332.
16. Goldman RF. Introduction to heat-related problems in military operations. In: Lounsbury DE, Bellamy RF, Zajtchuk R, eds. *Textbook of Military Medicine: Medical Aspects of Harsh Environments, Volume 1*. Falls Church, VA: Office of the Surgeon General; 2001:3–49.
17. Sonna LA. Practical medical aspects of military operations in the heat. In: Lounsbury DE, Bellamy RF, Zajtchuk R, eds. *Textbook of Military Medicine: Medical Aspects of Harsh Environments, Volume 1*. Falls Church, VA: Office of the Surgeon General; 2001:293–309.
18. Headquarters, Department of the Army and Air Force. Technical Bulletin, Medical 507, Air Force Pamphlet 48-152. Heat Stress Control and Heat Casualty Management. 7 March 2003.
19. Headquarters, United States Marine Corps, Department of the Navy. Marine Corps Order 6200.1E. Marine Corps Heat Injury Prevention Program. Washington DC: Department of the Navy; 6 June 2002.
20. Navy Environmental Health Center. Technical Manual NEHC-TM-OEM 6260.6A. Prevention and Treatment of Heat and Cold Stress Injuries. Published June 2007.
21. Webber BJ, Casa DJ, Beutler AI, Nye NS, Trueblood WE, O'Connor FG. Preventing exertional death in military trainees: recommendations and treatment algorithms from a multidisciplinary working group. *Mil Med*. 2016;181(4):311–318.
22. Lee JK, Kenefick RW, Cheuvront SN. Novel cooling strategies for military training and operations. *J Strength Cond Res*. 2015;29(suppl 11):S77–S81.
23. Armed Forces Health Surveillance Branch. Update: Heat illness, active component, U.S. Armed Forces, 2018. *MSMR*. 2019;26(4):15–20.
24. Dahl K, Licker R, Abatzoglou JT, Declet-Barreto J. Increased frequency of and population exposure to extreme heat index days in the United States during the 21st century. *Environ Res Commun*. 2019;1:075002.
25. Parsons IT, Stacey MJ, Woods DR. Heat adaptation in military personnel: mitigating risk, maximizing performance. *Front Physiol.* 2019;10:1485.
26. Kenny GP, Notley SR, Flouris AD, Grundstein A. Climate change and heat exposure: impact on health in occupational and general populations. In: Adams W, Jardine J, eds. *Exertional Heat Illness: A Clinical and Evidence-Based Guide*. Cham, Switzerland: Springer Nature; 2020:225–261.
27. Armed Forces Health Surveillance Branch. Surveillance case definition: Heat illness. Accessed on 18 March 2021. https://health.mil/Reference-Center/Publications/2019/10/01/Heat-Injuries
28. Headquarters, Department of the Army Training and Doctrine Command. Memorandum. TRADOC Heat Illness Prevention Program 2018. 8 January 2018.
29. Kazman JB, O'Connor FG, Nelson DA, Deuster PA. Exertional heat illness in the military: risk mitigation. In: Hosokawa Y, ed. *Human Health and Physical Activity During Heat Exposure*. Cham, Switzerland: SpringerBriefs in Medical Earth Sciences; 2018:59–71.
30. Nye NS, O'Connor FG. Exertional heat illness considerations in the military. In: Adams W, Jardine J, eds. *Exertional Heat Illness: A Clinical and Evidence-Based Guide*. Cham, Switzerland: Springer Nature; 2020:181–210.

Update: Exertional Rhabdomyolysis, Active Component, U.S. Armed Forces, 2016–2020

Among active component service members in 2020, there were 501 incident cases of exertional rhabdomyolysis, for an unadjusted incidence rate of 37.8 cases per 100,000 person-years (p-yrs). Subgroup-specific rates in 2020 were highest among males, those less than 20 years old, non-Hispanic Black service members, Marine Corps or Army members, and those in combat-specific occupations. During 2016–2020, crude rates of exertional rhabdomyolysis reached a peak of 42.9 per 100,000 p-yrs in 2018 after which the rate decreased to a low of 37.8 per 100,000 p-yrs in 2020. Most cases of exertional rhabdomyolysis were diagnosed at installations that support basic combat/recruit training or major ground combat units of the Army or the Marine Corps. Medical care providers should consider exertional rhabdomyolysis in the differential diagnosis when service members (particularly recruits) present with muscular pain or swelling, limited range of motion, or the excretion of darkened urine after strenuous physical activity, especially in hot, humid weather.

WHAT ARE THE NEW FINDINGS?

The 501 incident cases of exertional rhabdomyolysis in 2020 represented an unadjusted annual incidence rate of 37.8 cases per 100,000 p-ys among active component service members, the lowest of the 5-year surveillance period of 2016–2020. Among demographic and service sub-groups, rates were higher among males, those under 20 years old, non-Hispanic Black service members, and recruit trainees.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

Exertional rhabdomyolysis is a serious illness associated with physically demanding activities, particularly in hot weather. Prevention of this condition is linked to the prevention of the other heat-related illnesses. Such illnesses are a perennial threat to the health and readiness of the force and demand continuing attention to preventive measures by leaders and service members.

Rhabdomyolysis is characterized by the breakdown of skeletal muscle cells and the subsequent release of intracellular muscle contents into the circulation. The characteristic triad of rhabdomyolysis includes weakness, myalgias, and red to brown urine (due to myoglobinuria) accompanied by an elevated serum concentration of creatine kinase.[1,2] In exertional rhabdomyolysis, damage to skeletal muscle is generally caused by high-intensity, protracted, or repetitive physical activity, usually after engaging in unaccustomed strenuous exercise (especially with eccentric and/or muscle-lengthening contractions).[3] Even athletes who are used to intense training and who are being carefully monitored are at risk of this condition,[4] especially if new overexertion-inducing exercises are being introduced.[5] Illness severity ranges from elevated serum muscle enzyme levels without clinical symptoms to life-threatening disease associated with extreme enzyme elevations, electrolyte imbalances, acute kidney failure, disseminated intravascular coagulation, compartment syndrome, cardiac arrhythmia, and liver dysfunction.[1–3,6] A diagnosis of exertional rhabdomyolysis should be made when there are severe muscle symptoms (e.g., pain, stiffness, and/or weakness) and laboratory results indicating myonecrosis (usually defined as a serum creatine kinase level 5 or more times the upper limit of normal) in the context of recent exercise.[7]

Risk factors for exertional rhabdomyolysis include exertion in hot, humid conditions; younger age; male sex; a lower level of physical fitness; a prior heat illness; impaired sweating; and a lower level of education.[1,3,8–11] Acute kidney injury, due to an excessive concentration of free myoglobin in the urine accompanied by volume depletion, renal tubular obstruction, and renal ischemia, represents a serious complication of rhabdomyolysis.[6,12] Severely affected patients can also develop compartment syndrome, fever, dysrhythmias, metabolic acidosis, and altered mental status.[11]

In U.S. military members, rhabdomyolysis is a significant threat during physical exertion, particularly under heat stress.[8,10,13] Moreover, although rhabdomyolysis can affect any service member, new recruits, who are not yet accustomed to the physical exertion required of basic training, may be at particular risk.[10] Each year, the *MSMR* summarizes the numbers, rates, trends, risk factors, and locations of occurrences of exertional heat injuries, including exertional rhabdomyolysis. This report includes the data for 2016–2020. Additional information about the definition, causes, and prevention of exertional rhabdomyolysis can be found in previous issues of the *MSMR*.[13].

METHODS

The surveillance period was 1 January 2016 through 31 December 2020. 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 exertional rhabdomyolysis diagnoses 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 [MHS]) treatment facilities worldwide. In-theater diagnoses of exertional rhabdomyolysis were identified from medical records of service members deployed to Southwest Asia/Middle East and whose health care encounters were documented in the Theater Medical Data Store.

For this analysis, a case of exertional rhabdomyolysis was defined as an individual with 1) a hospitalization or outpatient medical encounter with a diagnosis in any position of either "rhabdomyolysis" (International Classification of Diseases, 9th Revision [ICD-9]: 728.88; International Classification of Diseases, 10th Revision [ICD-10]: M62.82) or "myoglobinuria" (ICD-9: 791.3; ICD-10: R82.1) plus a diagnosis in any position of 1 of the following: "volume depletion (dehydration)" (ICD-9: 276.5*; ICD-10: E86.0, E86.1, E86.9), "effects of heat and light" (ICD-9: 992.0–992.9; ICD-10: T67.0*–T67.9*), "effects of thirst (deprivation of water)" (ICD-9: 994.3; ICD-10: T73.1*), "exhaustion due to exposure" (ICD-9: 994.4; ICD-10: T73.2*), or "exhaustion due to excessive exertion (overexertion)" (ICD-9: 994.5; ICD-10: T73.3*).[13] Each individual could be considered an incident case of exertional rhabdomyolysis only once per calendar year.

To exclude cases of rhabdomyolysis that were secondary to traumatic injuries, intoxications, or adverse drug reactions, medical encounters with diagnoses in any position of "injury, poisoning, toxic effects" (ICD-9: 800.*–999.*; ICD-10: S00.*–T88.*, except the codes specific for "sprains and strains of joints and adjacent muscles" and "effects of heat, thirst, and exhaustion") were not considered indicative of exertional rhabdomyolysis.[14]

For surveillance purposes, a "recruit trainee" was defined as an active component member in an enlisted grade (E1–E4) who was assigned to 1 of the services' recruit training locations (per the individual's initial military personnel record). For this report, each service member was considered a recruit trainee for the period of time corresponding to the usual length of recruit training in his or her service. Recruit trainees were considered a separate category of enlisted service members in summaries of rhabdomyolysis cases by military grade overall.

In-theater diagnoses of exertional rhabdomyolysis were analyzed separately; however, the same case-defining criteria and incidence rules were applied to identify incident cases. Records of medical evacuations from the U.S. Central Command (CENTCOM) area of responsibility (AOR) (e.g., Iraq and Afghanistan) to a medical treatment facility outside the CENTCOM AOR also were analyzed separately. Evacuations were considered case defining if affected service members met the above criteria in a permanent military medical facility in the U.S. or Europe from 5 days before to 10 days after their evacuation dates.

It is important to note that medical data from sites that were using the new electronic health record for the Military Health System, MHS GENESIS, between July 2017 and October 2019 are not available in the DMSS. These sites include Naval Hospital Oak Harbor, Naval Hospital Bremerton, Air Force Medical Services Fairchild, and Madigan Army Medical Center. Therefore, medical encounter data for individuals seeking care at any of these facilities from July 2017 through October 2019 were not included in the current analysis.

RESULTS

In 2020, there were 501 incident cases of rhabdomyolysis likely associated with physical exertion and/or heat stress (exertional rhabdomyolysis) **(Table 1)**. The crude (unadjusted) incidence rate was 37.8 cases per 100,000 person-years (p-yrs). Subgroup-specific incidence rates of exertional rhabdomyolysis were highest among males (42.3 per 100,000 p-yrs), those less than 20 years old (75.6 per 100,000 p-yrs), non-Hispanic Black service members (56.4 per 100,000 p-yrs), Marine Corps or Army members (97.4 per 100,000 p-yrs and 50.1 per 100,000 p-yrs, respectively), and those in combat-specific occupations (78.0 per 100,000 p-yrs) **(Table 1)**. Of note, the incidence rate among recruit trainees was more than 5 times the rates among other enlisted members and officers, even though cases among this group accounted for only 10.2% of all cases in 2020.

During the surveillance period, crude rates of exertional rhabdomyolysis reached a peak of 42.9 per 100,000 p-yrs in 2018 after which the rate decreased to a low of 37.8 per 100,000 p-yrs in 2020 **(Figure 1)**. The annual incidence rates of exertional rhabdomyolysis were highest among non-Hispanic Blacks in every year except 2018, when the highest rate occurred among Asian/Pacific Islanders **(data not shown)**. Overall and annual rates of incident exertional rhabdomyolysis were highest among service members in the Marine Corps, intermediate among those in the Army, and lowest among those in the Air Force and Navy **(Table 1, Figure 2)**. Among Marine Corps and Army members, annual rates increased between 2016 and 2018 (15.9% and 6.7% increases, respectively), dropped in 2019, and then increased slightly in 2020 **(Figure 2)**. In contrast, annual rates among Air Force and Navy members were relatively stable between 2016 and 2019 and then decreased to their lowest points in 2020. During 2016–2020, three-quarters (75.6%) of the cases occurred during the 6 months of May through October **(Figure 3)**.

Rhabdomyolysis by location

During the 5-year surveillance period, the medical treatment facilities at 13 installations diagnosed at least 50 cases each; when combined, these installations diagnosed more than half (57.5%) of all cases **(Table 2)**. Of these 13 installations, 4 provide support to recruit/basic combat training centers (Marine Corps Recruit Depot [MCRD] Parris Island/Beaufort, SC; Fort Benning, GA; Joint Base San Antonio-Lackland, TX; and Fort Leonard Wood, MO). In addition, 6 installations support large combat troop populations (Fort Bragg, NC; Marine Corps Base [MCB] Camp Lejeune/Cherry Point, NC; MCB Camp Pendleton, CA; Fort Hood, TX; Fort Shafter, HI; and Fort Campbell, KY). During 2016–2020, the most cases overall were diagnosed at MCRD Parris Island/Beaufort, SC (n=283), and Fort Bragg, NC (n=256), which together accounted for about one-fifth (20.7%) of all cases **(Table 2)**.

TABLE 1. Incident cases[a] and incidence rates[b] of exertional rhabdomyolysis, active component, U.S. Armed Forces, 2020

	Hospitalizations		Ambulatory visits		Total	
	No.	Rate[b]	No.	Rate[b]	No.	Rate[b]
Total	162	12.2	339	25.5	501	37.8
Sex						
Male	151	13.7	314	28.6	465	42.3
Female	11	4.8	25	11.0	36	15.8
Age group (years)						
<20	32	17.3	108	58.3	140	75.6
20–24	54	15.8	104	30.5	158	46.3
25–29	45	14.6	74	24.1	119	38.7
30–34	12	5.7	34	16.3	46	22.0
35–39	10	6.4	12	7.6	22	14.0
40+	9	7.1	7	5.5	16	12.6
Race/ethnicity group						
Non-Hispanic White	93	12.7	167	22.8	260	35.5
Non-Hispanic Black	41	19.1	80	37.3	121	56.4
Hispanic	17	7.5	54	23.8	71	31.2
Asian/Pacific Islander	6	10.4	22	38.0	28	48.3
Other/unknown	5	5.2	16	16.7	21	22.0
Service						
Army	85	17.8	154	32.3	239	50.1
Navy	21	6.2	17	5.0	38	11.3
Air Force	18	5.5	28	8.5	46	14.0
Marine Corps	38	20.8	140	76.6	178	97.4
Military status						
Recruit	10	38.8	41	158.9	51	197.7
Enlisted	123	11.5	261	24.5	384	36.0
Officer	29	12.4	37	15.8	66	28.2
Military occupation						
Combat-specific[c]	47	25.8	95	52.2	142	78.0
Motor transport	8	20.0	16	40.0	24	59.9
Pilot/air crew	3	6.5	2	4.3	5	10.8
Repair/engineering	22	5.5	49	12.4	71	17.9
Communications/intelligence	25	8.7	43	15.0	68	23.7
Health care	13	11.4	20	17.5	33	28.9
Other/unknown	44	16.8	114	43.7	158	60.5
Home of record[d]						
Midwest	30	13.1	65	28.4	95	41.5
Northeast	22	13.3	49	29.6	71	42.9
South	74	12.9	149	25.9	223	38.8
West	32	10.1	71	22.4	103	32.5
Other/unknown	4	9.6	5	12.0	9	21.5

[a]One case per person per year.
[b]Rate per 100,000 person-years.
[c]Infantry/artillery/combat engineering/armor.
[d]As self-reported at time of entry into service.
No., number.

Rhabdomyolysis in Iraq and Afghanistan

There were 7 incident cases of exertional rhabdomyolysis diagnosed and treated in Iraq/Afghanistan **(data not shown)** during the 5-year surveillance period. Characteristics of affected servicemembers in Iraq/Afghanistan were generally similar to those who were affected overall. One active component service member was medically evacuated from Iraq/Afghanistan for exertional rhabdomyolysis during the surveillance period; this medical evacuation occurred in November 2020 **(data not shown)**.

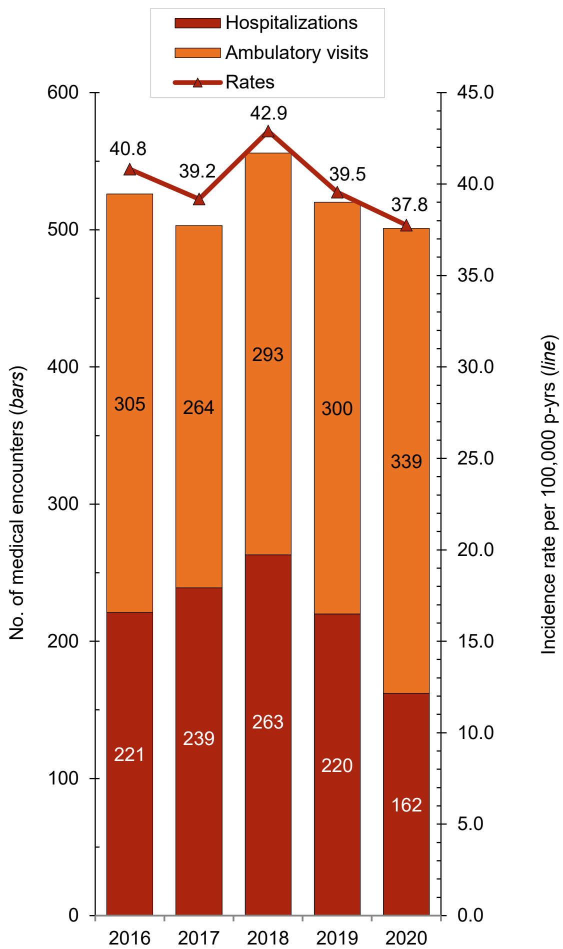
EDITORIAL COMMENT

This report documents that the crude rates of exertional rhabdomyolysis reached a peak of 42.9 per 100,000 p-yrs in 2018 after which the rates decreased to a low of 37.8 per 100,000 p-yrs in 2020 (12.0% decrease). Exertional rhabdomyolysis occured most frequently from early spring through early fall at installations that support basic combat/recruit training or major Army or Marine Corps combat units.

The risks of heat injuries, including exertional rhabdomyolysis, are elevated among individuals who suddenly increase overall levels of physical activity, recruits who are not physically fit when they begin training, and recruits from relatively cool and dry climates who may not be acclimated to the high heat and humidity at training camps in the summer.[1,2,10] Soldiers and Marines in combat units often conduct rigorous unit physical training, personal fitness training, and field training exercises regardless of weather conditions. Thus, it is not surprising that recruit camps and installations with large ground combat units account for most of the cases of exertional rhabdomyolysis.

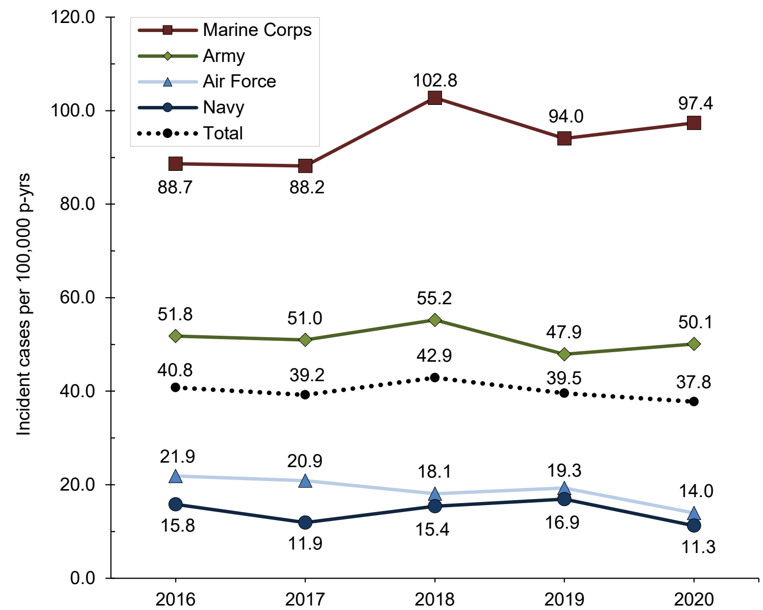
The annual incidence rates among non-Hispanic Black service members were higher than the rates among members of other race/ethnicity groups in 3 of the 4 previous years, with the exception of 2018. This observation has been attributed, at least in part, to an increased risk of exertional rhabdomyolysis among individuals with sickle cell trait (SCT)[15–18] and is supported by studies among U.S. service members.[10,19,20] The rhabdomyolysis-related deaths of 2 SCT-positive service members (an Air Force

FIGURE 1. Incident cases and incidence rate of exertional rhabdomyolysis, by source of report and year of diagnosis, active component, U.S. Armed Forces, 2016–2020



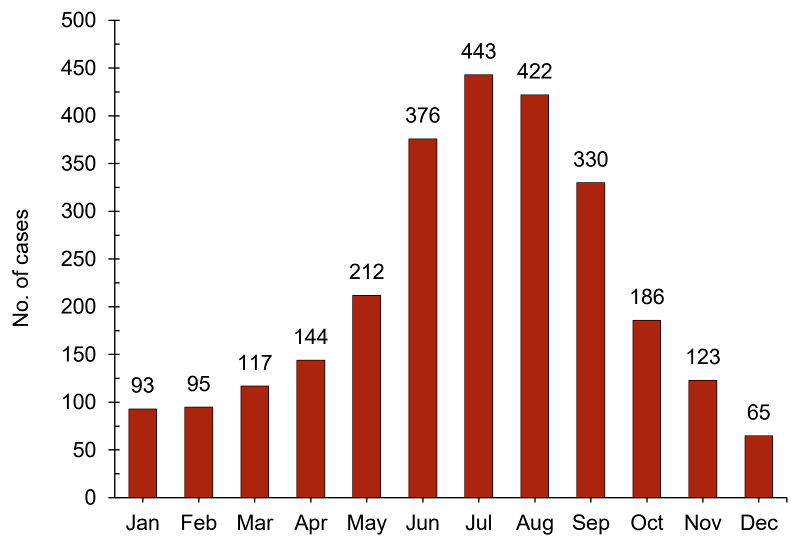
No., number; p-yrs, person-years.

FIGURE 2. Annual incidence rates of exertional rhabdomyolysis, by service, active component, U.S. Armed Forces, 2016–2020



P-yrs, person-years.

FIGURE 3. Cumulative numbers of exertional rhabdomyolysis cases, by month of diagnosis, active component, U.S. Armed Forces, 2016–2020



No., number.

member and a Navy recruit) after physical training in 2019 highlight this elevated risk.[21,22] However, although it is well established that sickle cell trait is positively associated with exertional rhabdomyolysis, its association with disease progression and severity is unclear and warrants further study.[19,20] Currently, the Army, Navy, Air Force, and Marine Corps conduct laboratory screening for SCT for all accessions. In addition, some service-specific SCT-related precautions are in place prior to mandatory physical fitness testing (e.g., questions about SCT status on fitness questionnaires; wearing colored belts, arm bands, or tags).

The findings of this report should be interpreted with consideration of its limitations. A diagnosis of "rhabdomyolysis" alone does not indicate the cause. Ascertainment of the probable causes of cases of exertional rhabdomyolysis was attempted by using a combination of ICD-9/ICD-10 diagnostic codes related to rhabdomyolysis with additional codes indicative of the effects of exertion, heat, or dehydration. Furthermore, other ICD-9/ICD-10 codes were used to exclude cases of rhabdomyolysis that may have been secondary to trauma, intoxication, or adverse drug reactions.

The measures that are effective at preventing exertional heat injuries in general apply to the prevention of exertional rhabdomyolysis. In the military training setting, the risk of exertional rhabdomyolysis can be reduced by emphasizing graded, individual preconditioning before starting a more strenuous exercise program and by adhering to recommended work/rest and hydration schedules, especially in hot weather. The physical activities of

TABLE 2. Incident cases of exertional rhabdomyolysis, by installation (with at least 30 cases during the period), active component, U.S. Armed Forces, 2016–2020

Location of diagnosis	No.	% total
MCRD Parris Island/ Beaufort, SC	283	10.9
Fort Bragg, NC	256	9.8
Fort Benning, GA	148	5.7
MCB Camp Lejeune/ Cherry Point, NC	141	5.4
MCB Camp Pendleton, CA	129	5.0
Fort Hood, TX	78	3.0
Fort Leonard Wood, MO	77	3.0
Fort Shafter, HI	74	2.8
JBSA-Lackland, TX	70	2.7
Fort Carson, CO	66	2.5
NMC San Diego, CA	66	2.5
Fort Campbell, KY	59	2.3
Fort Gordon, GA	51	2.0
Fort Belvoir, VA	44	1.7
Okinawa, Japan	47	1.8
Fort Polk, LA	45	1.7
Fort Belvoir, VA	44	1.7
Twentynine Palms, CA	38	1.5
Fort Bliss, TX	38	1.5
Fort Jackson, SC	36	1.4
NMC Portsmouth, VA	34	1.3
Other/unknown locations	782	30.0
Total	2,606	100.0

No., number; MCRD, Marine Corps Recruit Depot; MCB, Marine Corps Base; JBSA, Joint Base San Antonio; NMC Naval Medical Center.

overweight and/or previously sedentary new recruits should be closely monitored. Strenuous activities during relatively cool mornings following days of high heat stress should be particularly closely monitored; in the past, such situations have been associated with increased risk of exertional heat injuries (including rhabdomyolysis).[8]

Management after treatment for exertional rhabdomyolysis, including the decision to return to physical activity and duty, is a persistent challenge among athletes and military members.[10,,11,23] It is recommended that those who have had a clinically confirmed exertional rhabdomyolysis event be further evaluated and risk stratified for recurrence before return to activity/duty.[7,11,23,24] Low-risk patients may gradually return to normal activity levels, while those deemed high risk for recurrence will require further evaluative testing (e.g., genetic testing for myopathic disorders).[23,24]

Commanders and supervisors at all levels should ensure that guidelines to prevent heat injuries are consistently implemented, be vigilant for early signs of exertional heat injuries, and intervene aggressively when dangerous conditions, activities, or suspicious illnesses are detected. Finally, medical care providers should consider exertional rhabdomyolysis in the differential diagnosis when service members (particularly recruits) present with muscular pain or swelling, limited range of motion, or the excretion of darkened urine (possibly due to myoglobinuria) after strenuous physical activity, especially in hot, humid weather.

REFERENCES

1. Zutt R, van der Kooi AJ, Linthorst GE, Wanders RJ, de Visser M. Rhabdomyolysis: review of the literature. *Neuromuscul Disord*. 2014;24(8):651–659.
2. Beyond muscle destruction: a systematic review of rhabdomyolysis for clinical practice. Chavez L, Leon M, Einav S, Varon J. *Crit Care*. 2016;20:135
3. Rawson ES, Clarkson PM, Tarnopolsky MA. Perspectives on exertional rhabdomyolysis. *Sports Med*. 2017;47(suppl 1):33–49.
4. McKewon S. Two Nebraska football players hospitalized, treated after offseason workout. *Omaha World-Herald*. 20 January 2019. Accessed 29 March 2021.https://www.omaha.com/huskers/football/two-nebraska-football-players-hospitalized-treated-after-offseason-workout/article_d5929674-53a7-5d90-803e-6b4e9205ee60.html
5. Raleigh MF, Barrett JP, Jones BD, Beutler AI, Deuster PA, O'Connor FG. A cluster of exertional rhabdomyolysis cases in a ROTC program engaged in an extreme exercise program. *Mil Med*. 2018;183(suppl 1):516–521.
6. Bosch X, Poch E, Grau JM. Rhabdomyolysis and acute kidney injury. *N Engl J Med*. 2009;361(1):62–72.
7. O'Connor FG, Deuster P, Leggit J, et al. Clinical Practice Guideline for the Management of Exertional Rhabdomyolysis in Warfighters 2020. Bethesda, Maryland: Uniformed Services University. 2020.
8. Hill OT, Wahi MM, Carter R, Kay AB, McKinnon CJ, Wallace RF. Rhabdomyolysis in the U.S. active duty Army, 2004–2006. *Med Sci Sports Exerc*. 2012;44(3):442–449.
9. Lee G. Exercise-induced rhabdomyolysis. *R I Med J*. 2014;97(11):22–24.
10. Hill OT, Scofield DE, Usedom J, et al. Risk factors for rhabdomyolysis in the U.S. Army. *Mil Med*. 2017;182(7):e1836–e1841.
11. Knapik JJ, O'Connor FG. Exertional rhabdomyolysis: epidemiology, diagnosis, treatment, and prevention. *J Spec Oper Med*. 2016;15(3):65–71.
12. Holt S, Moore K. Pathogenesis of renal failure in rhabdomyolysis: the role of myoglobin. *Exp Nephrol*. 2000;8(2):72–76.
13. Armed Forces Health Surveillance Branch. Update: Exertional rhabdomyolysis among active component members, U.S. Armed Forces, 2014–2018. *MSMR*. 2019;26(4):21–26.
14. Armed Forces Health Surveillance Branch. Surveillance case definition. Exertional rhabdomyolysis. Accessed 29 March 2021. https://www.health.mil/Reference-Center/Publications/2017/03/01/Rhabdomyolysis-Exertional
15. Gardner JW, Kark JA. Fatal rhabdomyolysis presenting as mild heat illness in military training. *Mil Med*. 1994;159(2):160–163.
16. Makaryus JN, Catanzaro JN, Katona KC. Exertional rhabdomyolysis and renal failure in patients with sickle cell trait: is it time to change our approach? *Hematology*. 2007;12(4):349–352.
17. Ferster K, Eichner ER. Exertional sickling deaths in Army recruits with sickle cell trait. *Mil Med*. 2012;177(1):56–59.
18. Naik RP, Smith-Whitley K, Hassell KL, et al. Clinical outcomes associated with sickle cell trait: a systematic review. *Ann Intern Med*. 2018;169(9):619–627.
19. Nelson DA, Deuster PA, Carter R, Hill OT, Wolcott VL, Kurina LM. Sickle cell trait, rhabdomyolysis, and mortality among U.S. Army soldiers. *N Engl J Med*. 2016;375(5):435–442.
20. Webber BJ, Nye NS, Covey CJ, et al. Exertional Rhabdomyolysis and Sickle Cell Trait Status in the U.S. Air Force, January 2009–December 2018. *MSMR*. 2021;28(1):15–19.
21. Air Combat Command. U.S. Air Force Ground Accident Investigation Board Report. 20th Component Maintenance Squadron 20th Fighter Wing, Shaw Air Force Base, South Carolina. Fitness assessment fatality; 24 May 2019.
22. Mabeus C. Autopsy reports reveal why two recruits died at boot camp. *NavyTimes*. 8 November 2019. Accessed 7 April 2021. https://www.navytimes.com/news/your-navy/2019/11/08/autopsy-reports-reveal-why-two-recruits-died-at-boot-camp/
23. O'Connor FG, Brennan FH Jr, Campbell W, Heled Y, Deuster P. Return to physical activity after exertional rhabdomyolysis. *Curr Sports Med Rep*. 2008;7(6):328–331.
24. Atias D, Druyan A, Heled Y. Recurrent exertional rhabdomyolysis: coincidence, syndrome, or acquired myopathy? *Curr Sports Med Rep*. 2013;12(6):365–369.

Update: Exertional Hyponatremia, Active Component, U.S. Armed Forces, 2005–2020

From 2005 through 2020, there were 1,643 incident diagnoses of exertional hyponatremia among active component service members, for a crude overall incidence rate of 7.6 cases per 100,000 person-years (p-yrs). Compared to their respective counterparts, females, those less than 20 years old, and recruit trainees had higher overall incidence rates of exertional hyponatremia diagnoses. The overall incidence rate during the 16-year period was highest in the Marine Corps, intermediate in the Army and Air Force, and lowest in the Navy. Overall rates during the surveillance period were highest among Asian/Pacific Islander and non-Hispanic White service members and lowest among non-Hispanic Black service members. Between 2005 and 2020, crude annual incidence rates of exertional hyponatremia peaked in 2010 (12.7 per 100,000 p-yrs) and then decreased to a low of 5.3 cases per 100,000 p-yrs in 2013. The crude annual rates fluctuated between 2014 and 2020, reaching the 2 highest rates in 2015 (8.6 per 100,000 p-yrs) and in 2020 (8.0 per 100,000 p-yrs). Service members and their supervisors must be knowledgeable of the dangers of excessive water consumption and the prescribed limits for water intake during prolonged physical activity (e.g., field training exercises, personal fitness training, and recreational activities) in hot, humid weather.

WHAT ARE THE NEW FINDINGS?

In 2020, there were 106 incident cases of exertional hyponatremia (8.0 cases per 100,000 p-yrs) among active component service members. Rates were higher in females, officers, Asian/Pacific Islanders and non-Hispanic Whites, and Marines. Although rates among recruit trainees have usually been higher than among officers and other enlisted personnel (14 of the last 16 years), that was not true in 2020, when there were only 2 cases among recruit trainees.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

Exertional hyponatremia continues to pose a health risk to U.S. military members and can significantly impair performance and reduce combat effectiveness. Military members (particularly recruit trainees and females) and their supervisors must be vigilant for early signs of heat-related illnesses, intervene immediately and appropriately (but not excessively) in such cases, and heed the recommended guidance on fluid intake.

Exertional (or exercise-associated) hyponatremia refers to a low serum, plasma, or blood sodium concentration (below 135 mEq/L) that develops during or up to 24 hours following prolonged physical activity.[1] Acute hyponatremia creates an osmotic imbalance between fluids outside and inside of cells. This osmotic gradient causes water to flow from outside to inside the cells of various organs, including the lungs (which can cause pulmonary edema) and brain (which can cause cerebral edema), producing serious and sometimes fatal clinical effects.[1,2] Swelling of the brain increases intracranial pressure, which can decrease cerebral blood flow and disrupt brain function, potentially causing hypotonic encephalopathy, seizures, or coma. Rapid and definitive treatment is needed to relieve increasing intracranial pressure and prevent brain stem herniation, which can result in respiratory arrest.[2–4]

Serum sodium concentration is determined mainly by the total content of exchangeable body sodium and potassium relative to total body water. Thus, exertional hyponatremia can result from loss of sodium and/or potassium, a relative excess of body water, or a combination of both.[5,6] However, overconsumption of fluids and the resultant excess of total body water are the primary driving factors in the development of exertional hyponatremia.[1,7,8] Other important factors include the persistent secretion of antidiuretic hormone (arginine vasopressin), excessive sodium losses in sweat, and inadequate sodium intake during prolonged physical exertion, particularly during heat stress.[2–4,9] The importance of sodium losses through sweat in the development of exertional hyponatremia is influenced by the fitness level of the individual. Less fit individuals generally have a higher sweat sodium concentration, a higher rate of sweat production, and an earlier onset of sweating during exercise.[10–12]

This report uses a surveillance case definition for exertional hyponatremia to estimate the frequencies, rates, trends, geographic locations, and demographic and military characteristics of exertional hyponatremia cases among U.S. military members from 2005 through 2020.[13]

METHODS

The surveillance period was 1 January 2005 through 31 December 2020. The surveillance population included all individuals who served in an active component of the U.S. Army, Navy, Air Force, or Marine Corps at any time during the surveillance period. All data used to determine incident exertional hyponatremia diagnoses were derived from records routinely maintained in the Defense Medical Surveillance System (DMSS). These records document both ambulatory encounters and hospitalizations of active component service members of the U.S. Armed Forces in fixed military and civilian (if reimbursed through the Military Health System (MHS)) treatment facilities worldwide. In-theater diagnoses of hyponatremia were identified from medical records of service members deployed to Southwest Asia/Middle East and whose health care encounters were documented in the Theater Medical Data Store (TMDS). TMDS records became available in the DMSS beginning in 2008.

For this analysis, a case of exertional hyponatremia was defined as 1) a hospitalization or ambulatory visit with a primary (first-listed) diagnosis of "hypo-osmolality and/or hyponatremia" (International Classification of Diseases (ICD-9): 276.1; ICD-10: E87.1) and no other illness or injury-specific diagnoses (ICD-9: 001–999) in any diagnostic position or 2) both a diagnosis of "hypo-osmolality and/or hyponatremia" (ICD-9: 276.1; ICD-10: E87.1) and at least 1 of the following within the first 3 diagnostic positions (dx1–dx3): "fluid overload" (ICD-9: 276.9; ICD-10: E87.70, E87.79), "alteration of consciousness" (ICD-9: 780.0*; ICD-10: R40.*), "convulsions" (ICD-9: 780.39; ICD-10: R56.9), "altered mental status" (ICD-9: 780.97; ICD-10: R41.82), "effects of heat/light" (ICD-9: 992.0–992.9; ICD-10: T67.0*–T67.9*), or "rhabdomyolysis" (ICD-9: 728.88; ICD-10: M62.82).[13]

Medical encounters were not considered case-defining events if the associated records included the following diagnoses in any diagnostic position: alcohol/illicit drug abuse; psychosis, depression, or other major mental disorders; endocrine (e.g., pituitary or adrenal) disorders; kidney diseases; intestinal infectious diseases; cancers; major traumatic injuries; or complications of medical care. Each individual could be considered an incident case of exertional hyponatremia only once per calendar year.

For surveillance purposes, a "recruit trainee" was defined as an active component member in an enlisted grade (E1–E4) who was assigned to 1 of the services' recruit training locations (per the individual's initial military personnel record). For this report, each service member was considered a recruit trainee for the period corresponding to the usual length of recruit training in his/her service. Recruit trainees were considered a separate category of enlisted service members in summaries of exertional hyponatremia by military grade overall.

In-theater diagnoses of exertional hyponatremia were analyzed separately using the same case-defining criteria and incidence rules that were applied to identify incident cases at fixed treatment facilities. Records of medical evacuations from the U.S. Central Command (CENTCOM) area of responsibility (AOR) (e.g., Iraq and Afghanistan) to a medical treatment facility outside the CENTCOM AOR were analyzed separately. Evacuations were considered case defining if the affected service members met the above criteria in a permanent military medical facility in the U.S. or Europe from 5 days before to 10 days after their evacuation dates.

It is important to note that medical data from sites that were using the new electronic health record for the Military Health System, MHS GENESIS, between July 2017 and October 2019 are not available in the DMSS. These sites include Naval Hospital Oak Harbor, Naval Hospital Bremerton, Air Force Medical Services Fairchild, and Madigan Army Medical Center. Therefore, medical encounter data for individuals seeking care at any of these facilities from July 2017 through October 2019 were not included in the current analysis.

RESULTS

During 2005–2020, permanent medical facilities recorded 1,643 incident diagnoses of exertional hyponatremia among active component service members, for a crude overall incidence rate of 7.6 cases per 100,000 person-years (p-yrs) **(Table 1)**. In 2020, there were 106 incident diagnoses of exertional hyponatremia (incidence rate: 8.0 per 100,000 p-yrs) among active component service members. During this year, males represented 80.2% of exertional hyponatremia cases (n=85); the annual incidence rate was slightly higher among females (9.2 per 100,000 p-yrs) than males (7.7 per 100,000 p-yrs) **(Table 1)**. The highest age group-specific incidence rates in 2020 were among the oldest (40+ years old) and the youngest (less than 20 years old) service members. Although the Army had the most cases during 2020 (n=41), the highest incidence rate was among members of the Marine Corps (17.0 per 100,000 p-yrs). In 2020, the highest rate of exertional hyponatremia occurred among officers (9.4 per 100,000 p-yrs) **(Table 1)**. There were only 2 cases of exertional hyponatremia among recruit trainees resulting in a rate of 7.9 per 100,000 p-yrs. The rates among recruit trainees were higher than among other enlisted members and officers in all but 2 years of the surveillance period **(data not shown)**.

During the 16-year surveillance period, females had a slightly higher overall incidence rate of exertional hyponatremia diagnoses than males **(Table 1)**. The overall incidence rate was highest in the Marine Corps (16.1 per 100,000 p-yrs) and lowest in the Navy (4.7 per 100,000 p-yrs). Overall rates during the surveillance period were highest among Asian/Pacific Islander (9.1 per 100,000 p-yrs) and non-Hispanic White service members (8.5 per 100,000 p-yrs) and lowest among non-Hispanic Black service members (5.6 per 100,000 p-yrs). Although recruit trainees accounted for slightly less than one-tenth (9.1%) of all exertional hyponatremia cases during 2005–2020, their overall crude incidence rate was 5.2 and 3.6 times the rates among other enlisted members and officers, respectively **(Table 1)**. During the 16-year period, 86.4% (n=1,420) of all cases were diagnosed and treated without having to be hospitalized **(Figure 1)**.

Between 2005 and 2020, crude annual rates of incident exertional hyponatremia diagnoses peaked in 2010 (12.7 per 100,000 p-yrs) and then decreased to a low of 5.3 cases per 100,000 p-yrs in 2013. The crude annual rates fluctuated between 2014 and 2019, reaching a high in 2015 (8.6 per 100,000 p-yrs) before decreasing through 2017. Crude annual rates rose again in 2018, 2019, and 2020 reaching 8.0 per 100,000 p-yrs in 2020 **(Figure 1)**. During 2005–2020, annual incidence rates of exertional hyponatremia diagnoses were consistently higher in the Marine Corps compared to the other services, with the overall trend in rates primarily influenced by the trend among Marine Corps members **(Figure 2)**.

TABLE 1. Incident cases[a] and rates[b] of hyponatremia/overhydration, active component, U.S. Armed Forces, 2005–2020

	2020		Total 2005-2020	
	No.	Rate[b]	No.	Rate[b]
Total	106	8.0	1,643	7.6
Sex				
Male	85	7.7	1,374	7.5
Female	21	9.2	269	8.2
Age group (years)				
<20	10	10.0	210	14.2
20–24	34	8.0	507	7.2
25–29	19	6.2	307	6.1
30–34	15	7.2	190	5.7
35–39	15	9.6	189	7.5
40+	13	10.2	240	10.7
Race/ethnicity group				
Non-Hispanic White	75	10.2	1,099	8.5
Non-Hispanic Black	6	2.8	198	5.6
Hispanic	15	6.6	175	6.1
Asian/Pacific Islander	4	6.9	75	9.1
Other/unknown	6	6.3	96	6.4
Service				
Army	41	8.6	586	7.2
Navy	11	3.3	247	4.7
Air Force	23	7.0	324	6.2
Marine Corps	31	17.0	486	16.1
Military status				
Recruit	2	7.9	150	34.0
Enlisted	82	7.7	1,146	6.6
Officer	22	9.4	347	9.4
Military occupation				
Combat-specific[c]	23	12.6	281	9.1
Motor transport	2	5.0	33	5.1
Pilot/air crew	2	4.3	50	6.2
Repair/engineering	19	4.8	294	4.7
Communications/intelligence	17	5.9	284	6.0
Health care	11	9.6	125	6.7
Other/unknown	32	12.3	576	14.0
Home of record[d]				
Midwest	24	10.5	307	7.7
Northeast	18	10.9	243	8.7
South	34	5.9	693	7.6
West	27	8.5	332	6.8
Other/unknown	3	7.2	68	8.2

[a]One case per person per year.
[b]Rate per 100,000 person-years.
[c]Infantry/artillery/combat engineering/armor.
[d]Home of record self-reported at entry into service.

Between 2018 and 2020, annual incidence rates increased among Marine Corps and Air Force members. Rates among Army members increased between 2018 and 2019 and then leveled off in 2020. Among Navy members, rates decreased between 2018 and 2019 followed by a slight increase in 2020 **(Figure 2)**.

Exertional hyponatremia by location

During the 16-year surveillance period, exertional hyponatremia cases were diagnosed at the medical treatment facilities of more than 150 U.S. military installations and geographic locations worldwide; however, 16 U.S. installations contributed 20 or more cases each and accounted for 51.7% of the total cases **(Table 2)**. The installation with the most exertional hyponatremia cases overall was the Marine Corps Recruit Depot (MCRD) Parris Island/Beaufort, SC (n=209).

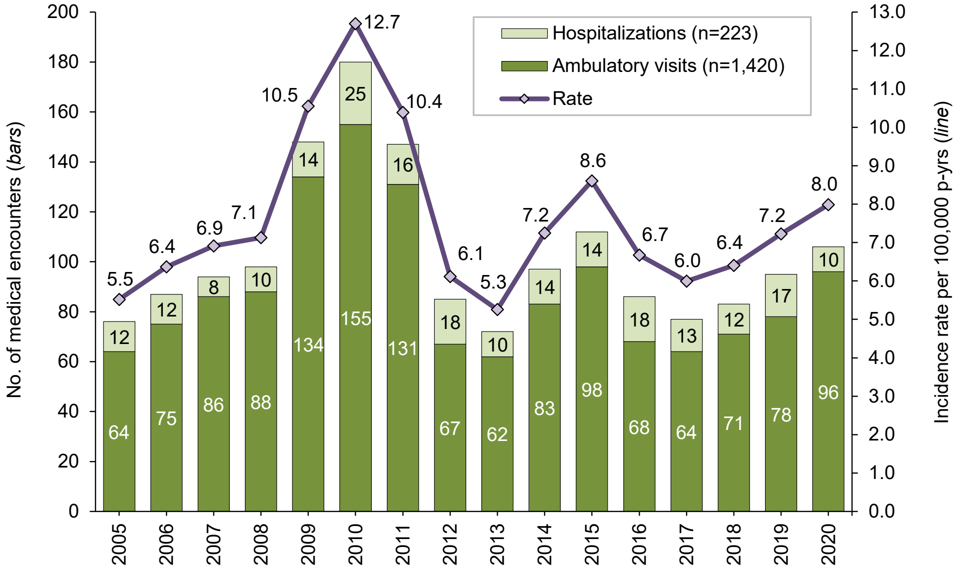
Exertional hyponatremia in Iraq and Afghanistan

From 2008 through 2020, a total of 20 cases of exertional hyponatremia were diagnosed and treated in Iraq and Afghanistan. Two new cases were diagnosed in 2020. Deployed service members who were affected by exertional hyponatremia were most frequently male (n=18), non-Hispanic White (n=16), 20–24 years old (n=9), in the Army (n=14), enlisted (n=17), and in combat-specific (n=7) or communications/intelligence (n=5) occupations **(data not shown)**. During the entire surveillance period, 7 service members were medically evacuated from Iraq or Afghanistan for exertional hyponatremia **(data not shown)**.

EDITORIAL COMMENT

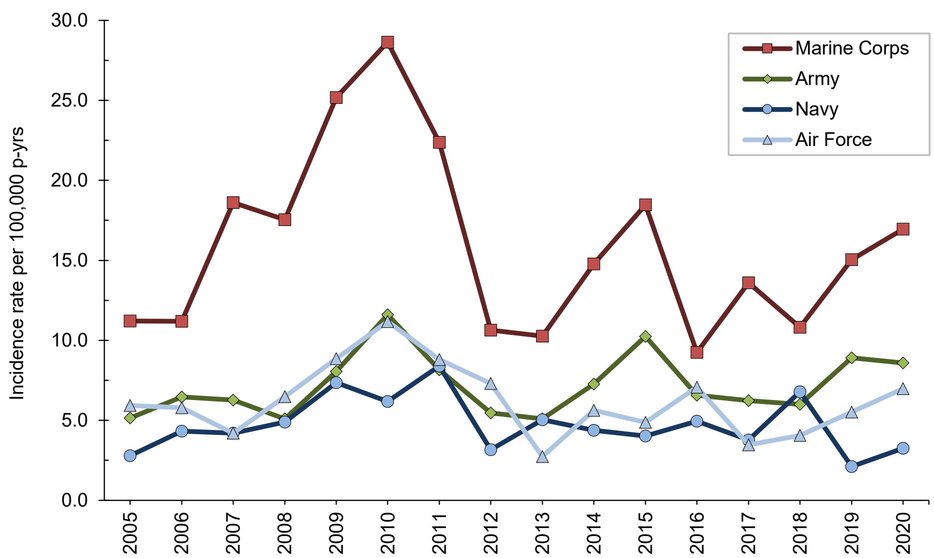
This report documents that after a period (2015–2017) of decreasing numbers and rates of exertional hyponatremia among active component U.S. military members, numbers and rates of diagnoses increased slightly but steadily during 2018 through 2020. Subgroup-specific patterns of overall incidence rates of exertional hyponatremia (e.g., sex, age, race/

FIGURE 1. Annual incident cases and rates of exertional hyponatremia, active component, U.S. Armed Forces, 2005–2020



No, number; p-yrs, person-years.

FIGURE 2. Annual incidence rates of exertional hyponatremia, by service, active component, U.S. Armed Forces, 2005–2020



P-yrs, person-years.

ethnicity, service, and military status) were generally similar to those reported in previous *MSMR* updates.[14] It is important to note that in *MSMR* analyses before April 2018, in-theater cases were included if there was a diagnosis of hypo-osmolality and/or hyponatremia in any diagnostic position. Beginning in 2018, the same case-defining criteria that were applied to inpatient and outpatient encounters were applied to the in-theater encounters. Therefore, the results of the in-theater analysis are not comparable to those presented in earlier *MSMR* updates.

Several important limitations should be considered when interpreting the results of this analysis. First, there is no diagnostic code specific for exertional hyponatremia. Thus, for surveillance purposes, cases of presumed exertional hyponatremia were ascertained from records of medical encounters that included diagnoses of hypo-osmolality and/or hyponatremia but not of other conditions (e.g., metabolic, renal, psychiatric, or iatrogenic disorders) that increase the risk of hyponatremia in the absence of physical exertion or heat stress. As such, exertional hyponatremia cases here likely include hyponatremia from both exercise- and non-exercise-related conditions. Consequently, the results of this analysis should be considered estimates of the actual incidence of symptomatic exertional hyponatremia from excessive water consumption among U.S. military members. In addition, the accuracy of estimated numbers, rates, trends, and correlates of risk depends on the completeness and accuracy of diagnoses that are documented in standardized records of relevant medical encounters. As a result, an increase in recorded diagnoses indicative of exertional hyponatremia may reflect, at least in part, increasing awareness of, concern regarding, and aggressive management of incipient cases by military supervisors and primary health care providers.

In the past, concerns about hyponatremia resulting from excessive water consumption were focused at training—particularly recruit training—installations. In this analysis, rates were relatively high among the youngest, and hence the most junior service members, and the highest numbers of cases tended to be diagnosed at medical facilities that support large recruit training centers (e.g., MCRD Parris Island/Beaufort, SC; Fort Benning, GA; and Joint Base San Antonio–Lackland, TX) and large Army and Marine Corps combat units (e.g., Fort Bragg, NC, and Marine Corps Base Camp Lejeune/Cherry Point, NC).

In response to previous historical cases of exertional hyponatremia in the U.S. military, the guidelines for fluid replacement during military training in hot weather were revised and promulgated in 1998.[15–18] The revised guidelines were designed to protect service members from not only heat injury, but also hyponatremia due to excessive water consumption by limiting fluid

TABLE 2. Incident cases of exertional hyponatremia by installation (with at least 20 cases during the period), active component, U.S. Armed Forces, 2005–2020

Location of diagnosis	No.	% total
MCRD Parris Island/ Beaufort, SC	209	12.7
Fort Benning, GA	120	7.3
JBSA-Lackland, TX	72	4.4
Fort Bragg, NC	54	3.3
MCB Camp Lejeune/ Cherry Point, NC	53	3.2
Walter Reed NMMC, MD[a]	43	2.6
MCB Camp Pendleton, CA	42	2.6
MCB Quantico, VA	41	2.5
NMC San Diego, CA	38	2.3
NMC Portsmouth, VA	34	2.1
Fort Campbell, KY	28	1.7
Fort Shafter, HI	26	1.6
Fort Hood, TX	26	1.6
Fort Jackson, SC	22	1.3
Fort Belvoir, VA	22	1.3
Fort Leonard Wood, MO	20	1.2
Other/unknown locations	793	48.3
Total	1,643	100.0

[a]Walter Reed NMMC is a consolidation of National Naval Medical Center (Bethesda, MD) and Walter Reed Army Medical Center (Washington, DC). This number represents the sum of the 2 sites before the consolidation (Nov 2011) and the number reported from the single consolidated medical center afterwards.
No., number; MCRD, Marine Corps Recruit Depot; JBSA, Joint Base San Antonio; NMMC; National Military Medical Center; MCB, Marine Corps Base; NMC, Naval Medical Center.

intake regardless of heat category or work level to no more than 1.5 quarts hourly and 12 quarts daily.[16,17] There were fewer hospitalizations of soldiers for hyponatremia due to excessive water consumption during the year after (vs. the year before) implementation of the new guidelines.[19] In 2003, the revised guidelines were included in the multiservice Technical Medical Bulletin 507, Heat Stress Control and Heat Casualty Management that provides guidance to military and civilian health care providers, allied medical personnel, and military leadership.[20] A recent study found that this military fluid intake guidance remains valid for preventing excessive dehydration as well as overhydration and can be used by military health professionals and leadership to adequately maintain a normal level of hydration in service members working in the 5 designated flag conditions (levels of heat/humidity stress) while wearing contemporary uniform configurations (including protective gear/equipment) across a range of metabolic rates.[21]

During endurance events, a “drink-to-thirst” or a programmed fluid intake plan of 400–800 mL per estimated hour of activity has been suggested to limit the risk of exertional hyponatremia, although this rate should be customized to the individual’s tolerance and experience.[4,8,17,19] In addition to these guidelines, reducing the availability of fluids may help prevent exertional hyponatremia during endurance events.[22,23] Carrying a maximum fluid load of 1 quart of fluid per estimated hour of activity and encouraging a “drink-to-thirst” approach to hydration may help prevent both severe exertional hyponatremia and dehydration during military training exercises and recreational hikes that exceed 2–3 hours.[4,8,22,23,24] Although rare, exercise-related hyponatremia and exertional heat stroke can present simultaneously with symptoms that may be hard to differentiate.[25] Encouraging a “drink-to-thirst” approach while incorporating prevention strategies for heat stroke may help mitigate such rare cases.

Females had relatively high rates of hyponatremia during the entire surveillance period; females may be at greater risk because of lower fluid requirements and longer periods of exposure to risk during some training exercises (e.g., land navigation courses or load-bearing marches).[9] The finding that the overall incidence of females experiencing exertional hyponatremia was greater than that of males in this analysis is similar to results found among samples of marathon runners in the general population. However, a large study of marathon runners suggested that the apparent sex difference did not remain after adjustment for body mass index and racing times.[26–28]

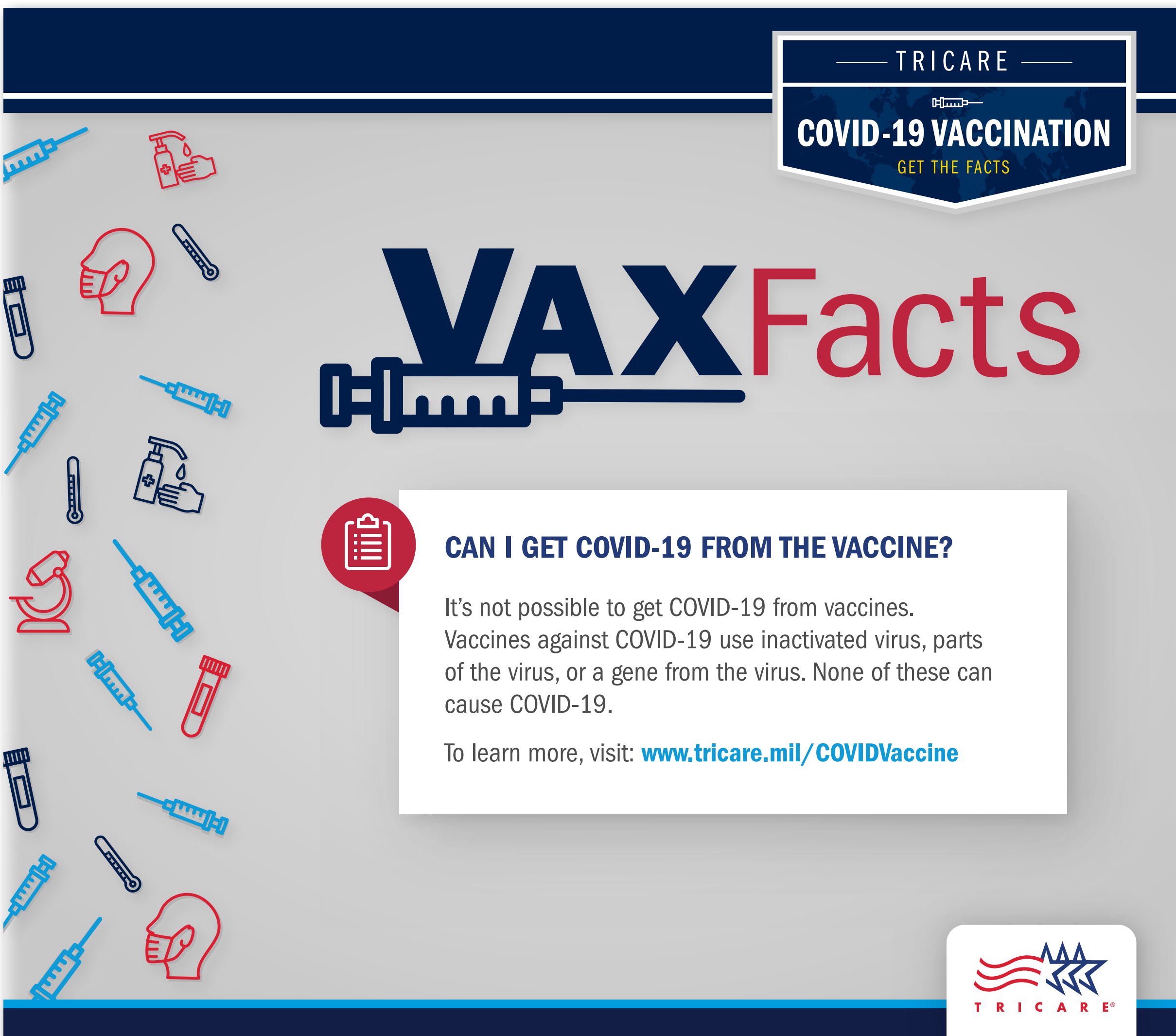
In many circumstances (e.g., recruit training and Ranger School), military trainees rigorously adhere to standardized training schedules regardless of weather conditions. In hot and humid weather, commanders, supervisors, instructors, and medical support staff must be aware of and enforce guidelines for work–rest cycles and water consumption. The finding in this report that most cases of hyponatremia were treated in outpatient settings suggests that monitoring by supervisors and medical staff identified most cases during the early and less severe manifestations of hyponatremia.

In general, service members and their supervisors must be knowledgeable of the dangers of excessive water consumption as well as the prescribed limits for water intake during prolonged physical activity (e.g., field training exercises, personal fitness training, and recreational activities) in hot, humid weather. Military members (particularly recruit trainees and females) and their supervisors must be vigilant for early signs of heat-related illnesses and intervene immediately and appropriately (but not excessively) in such cases. Finally, the recent validation of the current fluid intake guidance highlights its importance as a resource to leadership in sustaining military readiness.

REFERENCES

1. Hew-Butler T, Rosner MH, Fowkes-Godek S, et al. Statement of the Third International Exercise-Associated Hyponatremia Consensus Development Conference, Carlsbad, California, 2015. *Clin J Sport Med*. 2015;25(4):303–320.
2. Montain SJ. Strategies to prevent hyponatremia during prolonged exercise. *Curr Sports Med Rep*. 2008;7(4):S28–S35.
3. Chorley J, Cianca J, Divine J. Risk factors for exercise-associated hyponatremia in non-elite marathon runners. *Clin J Sport Med*. 2007;17(6):471–477.
4. Hew-Butler T, Loi V, Pani A, Rosner MH. Exercise-associated hyponatremia: 2017 update. *Front Med (Lausanne)*. 2017;4:21.
5. Edelman IS, Leibman J, O’Meara MP, Birkenfeld LW. Interrelations between serum sodium concentration, serum osmolarity and total exchangeable sodium, total exchangeable potassium and total body water. *J Clin Invest*. 1958;37(9):1236–1256.
6. Nguyen MK, Kurtz I. Determinants of plasma water sodium concentration as reflected in the Edelman equation: role of osmotic and Gibbs-Donnan equilibrium. *Am J Physiol Renal Physiol*. 2004;286(5):F828–F837.
7. Noakes TD, Sharwood K, Speedy D, et al. Three independent biological mechanisms cause exercise-associated hyponatremia: evidence from 2,135 weighed competitive athletic performances. *Proc Natl Acad Sci U S A*. 2005;102(51):18550–18555.

8. Oh RC, Malave B, Chaltry JD. Collapse in the heat—from overhydration to the emergency room—three cases of exercise-associated hyponatremia associated with exertional heat illness. *Mil Med*. 2018;183(3–4):e225–e228.
9. Carter R III. Exertional heat illness and hyponatremia: an epidemiological prospective. *Curr Sports Med Rep*. 2008;7(4):S20–S27.
10. Buono MJ, Ball KD, Kolkhorst FW. Sodium ion concentration vs. sweat rate relationship in humans. *J Appl Physiol (1985)*. 2007;103(3):990–994.
11. Buono MJ, Sjoholm NT. Effect of physical training on peripheral sweat production. *J Appl Physiol (1985)*. 1988;65(2):811–814.
12. Nadel ER, Pandolf KB, Roberts MF, Stolwijk JA. Mechanisms of thermal acclimation to exercise and heat. *J Appl Physiol.* 1974;37(4):515–520.
13. Armed Forces Health Surveillance Branch. Surveillance Case Definition. Hyponatremia. March 2017. Accessed 29 March 2021. https://cms.health.mil//Reference-Center/Publications/2017/03/01/Hyponatremia-Exertional
14. Armed Forces Health Surveillance Branch. Update: Exertional hyponatremia, active component, U.S. Armed Forces, 2004–2019. *MSMR*. 2020;27(3):15–19.
15. Army Medical Surveillance Activity. Case reports: Hyponatremia associated with heat stress and excessive water consumption: Fort Benning, GA; Fort Leonard Wood, MO; Fort Jackson, SC, June–August 1997. *MSMR*. 1997;3(6):2–3,8.
16. Department of the Army, Office of the Surgeon General. Memorandum, subject: Policy guidance for fluid replacement during training, dated 29 April 1998.
17. Montain S., Latzka WA, Sawka MN. Fluid replacement recommendations for training in hot weather. *Mil Med*. 1999;164(7):502–508.
18. O'Brien KK, Montain SJ, Corr WP, Sawka MN, Knapik JJ, Craig SC. Hyponatremia associated with overhydration in U.S. Army trainees. *Mil Med*. 2001;166(5):405–410.
19. Army Medical Surveillance Activity. Surveillance trends: Hyponatremia associated with heat stress and excessive water consumption: the impact of education and a new Army fluid replacement policy. *MSMR*. 1999;5(2):2–3,8–9.
20. Headquarters, Departments of the Army and Air Force (DoTAaA). Heat stress control and heat casualty management. Technical Bulletin Medical 507. Air Force Pamphlet, 48–152(I). 2003.
21. Luippold AJ, Charkoudian N, Kenefick RW, et al. Update: Efficacy of military fluid intake guidelines. *Mil Med*. 2018;183(9/10):e338–e342.
22. Hew-Butler T, Verbalis JG, Noakes TD. Updated fluid recommendation: Position statement from the International Marathon Medical Directors Association (IMMDA). *Clin J Sport Med.* 2006;16(4):283–292.
23. Thomas DT, Erdman KA, Burke LM. American College of Sports Medicine Joint Position Statement.Nutrition and athletic performance. *Med Sci Sport Exerc*. 2016;48(3):543–568.
24. Nolte HW, Nolte K, Hew-Butler T. Ad libitum water consumption prevents exercise-associated hyponatremia and protects against dehydrations in soldiers performing a 40-km route-march. *Mil Med Res*. 2019;6(1):1.
25. Oh RC, Galer M, Bursey MM. Found in the field—a soldier with heat stroke, exercise-associated hyponatremia, and kidney injury. *Curr Sports Med Rep*. 2018;17(4):123–125.
26. Almond CS, Shin AY, Fortescue EB, et al. Hyponatremia among runners in the Boston Marathon. *N Engl J Med*. 2005;352(15):1550–1556.
27. Ayus JC, Varon J, Arieff AI. Hyponatremia, cerebral edema, and noncardiogenic pulmonary edema in marathon runners. *Ann Intern Med*. 2000;132(9):711–714.
28. Hew TD, Chorley JN, Cianca JC, Divine JG. The incidence, risk factors, and clinical manifestations of hyponatremia in marathon runners. *Clin J Sport Med*. 2003;13(1):41–47.



Skin and Soft Tissue Infections, Active Component, U.S. Armed Forces, January 2016–September 2020

Shauna Stahlman, PhD, MPH; Valerie F. Williams, MA, MS; Gi-Taik Oh, MS; David R. Tribble, MD, DrPH; Eugene V. Millar, PhD

During 1 January 2016–30 September 2020, there were 210,914 incident cases of skin and soft tissue infections (SSTIs) among active component U.S. military members, corresponding to a crude overall incidence rate of 352.8 per 10,000 person-years (p-yrs). An additional 4,250 cases occurred in theaters of operations (251.0 per 10,000 p-yrs). Of the total incident SSTI diagnoses, 64.5% were classified as cellulitis/abscess, 30.0% were "other SSTIs" (e.g., folliculitis, impetigo), 5.3% were carbuncles/furuncles, and 0.2% were erysipelas. Crude annual incidence rates declined by 21.9% over the surveillance period. In general, higher rates of SSTIs were associated with younger age, recruit/trainee status, and junior enlisted rank. A total of 174,893 service members were treated for SSTIs, which accounted for 307,160 medical encounters and 14,819 hospital bed days. SSTIs in the military are associated with significant operational and health care burden. Strategies for the prevention, early diagnosis, and definitive treatment of SSTIs are warranted, particularly in initial military training and operational settings associated with increased risk of infection.

WHAT ARE THE NEW FINDINGS?

During the surveillance period, 210,914 incident cases of SSTIs affected 174,893 service members, resulting in 307,160 health care encounters and 14,819 hospital bed days. Those most commonly affected were the youngest service members, recruits/trainees, and junior enlisted personnel. The annual incidence rates have fallen in recent years, but the burden of disease is still significant.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

Although most SSTIs can be treated and cured with antibiotics, the health care burden presented by these relatively common conditions detracts from the availability of service members for readiness training and for operational duties.

Skin and soft tissue infections (SSTIs) result from microbial breaches of skin and its supporting structure. SSTIs have diverse clinical manifestations, but most frequently present as abscess (a tender mass containing cells, microbes and pus) or cellulitis (an area of redness and swelling involving deeper skin tissue). Less frequent clinical outcomes such as impetigo and folliculitis present as pustules or vesicles forming on skin surfaces or in hair follicles. When an initial occurrence of folliculitis penetrates deeper into skin tissue, furuncles and carbuncles ("boils") may develop and lead to tender, swollen pustules. Among otherwise healthy persons, SSTIs are generally mild and resolve after a short course of antibiotics and/or drainage.

SSTIs are common in both military and nonmilitary populations. In the military, rates of SSTIs are highest among recruits/trainees due to an increased prevalence of SSTI risk factors (e.g., crowding, infrequent hand washing/bathing, skin abrasions and trauma, and environmental contamination) in the military training environment. These factors favor the acquisition and transmission of *Staphylococcus* spp and *Streptococcus* spp, the major causative agents of SSTIs, and can result in outbreaks of disease in military trainees.[1-3]

SSTIs in military personnel are rarely associated with severe clinical outcomes. However, they are a major cause of infectious disease morbidity and impose a significant operational and health care burden on the Military Health System (MHS). The epidemiology of SSTIs in the MHS has been described previously.[4,5] From 2013 through 2016, the overall incidence of SSTI among active component U.S. military members was 558.2 per 10,000 person-years (p-yrs), approximately 20% higher than that of a similarly aged, non-military population in the U.S.[6] Notably, annual incidence rates over the 4-year period declined by 46.6%, mirroring trends of declining[7,8] or stabilizing[9] rates of SSTIs reported from U.S. civilian hospitals.

This report summarizes the frequencies, rates, and trends of incident diagnoses of SSTIs, overall and by type, among members of the active component of the U.S. Armed Forces from 1 January 2016 through 30 September 2020. In particular, installation-specific SSTI rates for each service's recruit/trainee population, the military group at highest risk for infection, are reported.

METHODS

The surveillance period was 1 January 2016 to 30 September 2020. The surveillance population included all members of the U.S. Army, Navy, Air Force, or Marine Corps who served in the active component at any time during the surveillance period. The data used in this analysis were derived from the Defense Medical Surveillance System (DMSS), which maintains electronic records of all actively serving U.S. military members' hospitalizations and ambulatory visits in U.S. military and civilian (contracted/purchased care through the MHS) medical facilities worldwide.

Diagnoses recorded in the combat theater of operations were derived from records documented in the Theater Medical Data Store (TMDS). TMDS records were only included if they occurred during an operational deployment.

For surveillance purposes, cases of SSTI were identified from records of hospitalizations, ambulatory visits, and in-theater medical encounters that included diagnostic codes (ICD-9 and ICD-10) specific for SSTI **(Table 1)**. Incident cases of SSTI were defined by hospitalization records with case-defining diagnostic codes in the primary or secondary diagnostic position or by ambulatory or in-theater visit records with case-defining diagnostic codes in the first diagnostic position. An individual could account for multiple incident cases (i.e., recurrent SSTI) if there were more than 30 days between the dates of consecutive incident case-defining encounters. Rates of SSTIs diagnosed in inpatient or outpatient settings were calculated using non-deployed person time. SSTIs occurring during deployments were analyzed separately from inpatient and outpatient cases using the same 30-day incidence rule, and rates of SSTIs occurring during deployments were calculated using deployed person time.

Because SSTI can progress in clinical severity, case-defining diagnoses from hospitalization records were prioritized over those from outpatient records in characterizing incident cases. Thus, if a service member had two or more case-defining encounters for SSTI that occurred within 30 days of each other, an inpatient diagnosis was prioritized over an outpatient diagnosis. In addition, case-defining diagnoses were prioritized by their presumed severity as follows: cellulitis/abscess, erysipelas, carbuncle/furuncle, and "other" (e.g., folliculitis, impetigo, pyoderma, pyogenic granuloma).

The burden of SSTIs including numbers of individuals affected, total numbers of medical encounters, and hospital bed days, was assessed by quantifying the number of inpatient or outpatient medical encounters between 2016 and 2019 with a diagnosis of SSTI in the primary diagnostic position; 2020 was omitted because data were not complete for the entire calendar year at the time of analysis. Medical evacuations for SSTI were assessed by identifying cases that were diagnosed from 5 days prior to 10 days after reported dates of medical evacuations from within to outside of the U.S. Central Command (CENTCOM). Recruit/trainees were defined as such by identifying cases during the relevant basic training periods (e.g., 8 weeks for Navy basic training) at service-specific training locations.

RESULTS

During 1 January 2016 to 30 September 2020, there were 210,914 incident cases of SSTI among active component U.S. military members, corresponding to a crude overall incidence of 352.8 cases per 10,000 person-years (p-yrs) **(Table 2)**. Crude annual incidence rates ranged from 291.2 in the first 3 quarters of 2020 to 373.4 per 10,000 p-yrs in 2017. There was a 21.9% decline in the annual rates of SSTI over the surveillance period. The vast majority of total cases (97.7%) were treated in outpatient facilities (overall rate: 344.7 per 10,000 p-yrs) **(Table 3)**. By contrast, the crude overall SSTI rate in inpatient facilities was 8.1 per 10,000 p-yrs.

Of all incident diagnoses, 30.0% were classified as "other SSTI" (e.g., folliculitis, impetigo, pyoderma); 64.5% were cellulitis/abscess; 5.3% were carbuncles/furuncles; and 0.2% were erysipelas **(Table 3, data not shown)**. Among hospitalized cases, cellulitis/abscess was the most frequent diagnosis (n=4,631; 7.7 per 10,000 p-yrs).

For all SSTIs, overall incidence rates were higher among females than males **(Table 3)**. Compared to Hispanic, Asian/Pacific Islander, and those of other/unknown race/ethnicities, non-Hispanic Black service members had higher rates of carbuncles/furuncles and "other SSTI". In contrast, non-Hispanic White service members had higher rates of cellulitis/abscess and erysipelas.

Overall rates of cellulitis/abscess, carbuncles/furuncles, and "other SSTIs" were highest among service members in the youngest (<20 years) age group. Across the services, rates of cellulitis/abscess were highest among Marine Corps and Army members. Overall rates of carbuncles/furuncles were higher among Army members; rates of erysipelas were slightly higher among Air Force and Marine Corps members; and rates of "other SSTIs" were highest among Marine Corps members **(Table 3)**.

For all SSTIs, overall rates were higher among recruits compared to non-recruits. Rates of cellulitis/abscess, carbuncle/furuncle, and "other SSTIs" were higher in the junior enlisted ranks compared to officers and senior enlisted. The rate of cellulitis/abscess was highest among service members in "other/unknown" occupations (including recruits/trainees), as compared with those in combat-specific, armor/motor transport, pilot/air crew, repair/engineering, communications/intelligence, or health care occupations. The rate of carbuncles/furuncles was slightly higher among those in health care occupations. Overall rates of "other SSTIs" were highest among those in "other/unknown" and health care occupations, respectively **(Table 3)**.

Overall and by year, cellulitis/abscess was the most frequent diagnosis for SSTI-associated hospitalizations **(Table 2)**. However, annual rates of cellulitis/abscess associated hospitalizations decreased from 2016 (8.9 per 10,000 p-yrs) to the first 3 quarters of 2020 (5.4 per 10,000 p-yrs). During the surveillance period, hospitalization rates for "other SSTIs" also decreased from 0.4 to 0.2 per 10,000 p-yrs **(Table 2, Figure 1)**. Hospitalization rates for all other skin infection types remained relatively low and stable throughout the period.

Overall and by year, cellulitis/abscess was the most frequent classification among infections treated in outpatient settings **(Table 2, Figure 2)**. Crude annual rates of outpatient diagnoses of "other SSTIs", carbuncles/furuncles, and cellulitis/abscess decreased during the surveillance period (% change in annual rates from 2016 through 2020: 17.8%, 37.4%, and 21.6%, respectively). Crude annual rates of outpatient-treated erysipelas were low and stable throughout the surveillance period.

Body site

Of the incident cases of cellulitis/abscess, the lower extremity was most frequently affected (33.6% of cases; n=45,732) body site, followed by the upper extremity (28.3%; n=38,449), the

TABLE 1. ICD-9/ICD-10 diagnostic codes for skin infections

	Cellulitis/abscess	Carbuncle/furuncle	Erysipelas	Other infections of skin and subcutaneous tissue[a]
All ICD-9[b]	681**-682*	680*	035	684, 686.0, 686.00, 686.09, 686.8, 686.9, 704.8
All ICD-10[b]	L02.01, L02.11, L02.21*, L02.31, L02.41*, L02.51*, L02.61*, L02.81*, L02.91, L03.*	L02.02, L02.03, L02.12, L02.13, L02.22*, L02.23*, L02.32, L02.33, L02.42*, L02.43*, L02.52*, L02.53*, L02.62*, L02.63*, L02.82*, L02.83*, L02.92, L02.93	A46	L01.*, L08.0, L08.81, L08.82, L08.89, L08.9, L73.8, L73.9
Upper extremity				
Arm	ICD-9: 682.3 ICD-10: L03111, L03112, L03113, L03114, L03121, L03122, L03123, L03124, L02411, L02412, L02413, L02414	ICD-9: 680.3 ICD-10: L02.421, L02.422, L02.423, L02.424, L02.431, L02.432, L02.433, L02.434	---	---
Hand	ICD-9: 682.4 ICD-10: L02.51*	ICD-9: 680.4 ICD-10: L0252*, L0253*	---	---
Finger	ICD-9: 681.0* ICD-10: L03.01*, L03.02*	---	---	---
Unspecified digit	ICD-9: 681.9	---	---	---
Lower extremity				
Leg	ICD-9: 682.6 ICD-10: L03.115, L03.116, L03.125, L03.126, L02.415, L02.416	ICD-9: 680.6 ICD-10: L02.425, L02.426, L02.435, L02.436	---	---
Foot	ICD-9: 682.7 ICD-10: L02.61*	ICD-9: 680.7 ICD-10: L02.62*, L02.63*	---	---
Toe	ICD-9: 681.1* ICD-10: L03.03*, L03.04*	---	---	---
Head/face/neck				
Neck	ICD-9: 682.1 ICD-10: L03.22*, L02.11	ICD-9: 680.1 ICD-10: L02.12, L02.13	---	---
Face	ICD-9: 682.0 ICD-10: L03.21*, L02.01	ICD-9: 680.0 ICD-10: L02.02, L02.03	---	---
Head/scalp	ICD-9: 682.8 ICD-10: L03.811, L03.891, L02.811	ICD-9: 680.8 ICD-10: L02.821, L02.831	---	---
Trunk				
Buttock	ICD-9: 682.5 ICD-10: L03.317, L03.327, L02.31	ICD-9: 680.5 ICD-10: L02.32, L02.33	---	---
Trunk	ICD-9: 682.2 ICD-10: L02.21*, L03.311, L03.312, L03.313, L03.314, L03.315, L03.316, L03.319, L03.321, L03.322, L03.323, L03.324, L03.325, L03.326, L03.329	ICD-9: 680.2 ICD-10: L02.22*, L02.23*	---	---
Other/ unspecified	ICD-9: 682.9 ICD-10: L03.119, L03.129, L03.818, L03.898, L03.9*, L02.419, L02.818, L02.91	ICD-9: 680.9 ICD-10: L02.429, L02.439, L02.828, L02.838, L02.92, L02.93		

[a]Impetigo, pyoderma, pyogenic granuloma skin/subcutaneous, folliculitis, other specified/unspecified skin infections
[b]An asterisk (*) indicates that any subsequent digit/character is included.

TABLE 2. Incident cases and incidence rates[a] of skin and soft tissue infection, by encounter type, active component, U.S. Armed Forces, 1 January 2016–30 September 2020

	2016		2017		2018		2019		2020[b]		Total 2016–2020[b]	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total												
Total inpatient/ outpatient only	46,660	372.7	46,163	373.4	44,494	356.8	45,382	356.4	28,215	291.2	210,914	352.8
Total TMDS[b]	1,175	375.8	1,150	281.7	804	186.7	756	213.6	365	194.2	4,250	251.0
Cellulitis/abscess												
Inpatient	1,109	8.9	1,042	8.4	961	7.7	999	7.8	520	5.4	4,631	7.7
Outpatient	29,099	232.4	28,911	233.8	27,510	220.6	28,272	222.0	17,658	182.3	131,450	219.9
TMDS[b]	400	127.9	499	122.2	419	97.3	437	123.5	235	125.0	1,990	117.5
Carbuncle/furuncle												
Inpatient	6	0.0	4	0.0	7	0.1	1	0.0	2	0.0	20	0.0
Outpatient	2,863	22.9	2,550	20.6	2,204	17.7	2,149	16.9	1,386	14.3	11,152	18.7
TMDS[b]	53	17.0	73	17.9	55	12.8	53	15.0	17	9.0	251	14.8
Erysipelas												
Inpatient	3	0.0	6	0.0	5	0.0	8	0.1	1	0.0	23	0.0
Outpatient	66	0.5	76	0.6	65	0.5	69	0.5	55	0.6	331	0.6
TMDS[b]	3	1.0	0	0.0	3	0.7	1	0.3	0	0.0	7	0.4
Other SSTIs												
Inpatient	48	0.4	49	0.4	41	0.3	33	0.3	24	0.2	195	0.3
Outpatient	13,466	107.6	13,525	109.4	13,701	109.9	13,851	108.8	8,569	88.4	63,112	105.6
TMDS[b]	719	229.9	578	141.6	327	75.9	265	74.9	113	60.1	2,002	118.2

[a]Rates for inpatient/outpatient cases used non-deployed person-time and rates for (deploy-matched) TMDS cases used deployed person-time.
[b]TMDS cases were analyzed separately from inpatient/outpatient cases. TMDS cases and rates were only assessed through 30 September 2020 because deployment data were only available through 20 September 2020.
SSTIs, skin and soft tissue infections.

trunk (14.2%; n=19,368), other/unspecified region (12.4%; n=16,846), and the head/face/neck (11.5%; n=15,686) **(data not shown)**. Cases affecting the upper extremity were more commonly in the arm (16.4%; n=22,259) and finger (11.1%; n=15,042), followed by the hand (0.8%; n=1,148). Cellulitis/abscess cases affecting the lower extremity were more commonly in the leg (22.6%; n=30,814) and toe (10.3%; n=14,056), followed by the foot (0.6%; n=862). A total of 6,892 cases (5.1%) occurred in the buttock. In addition, 10,800 cases (7.9%) were in the face, 2,996 (2.2%) were in the neck, and 1,890 (1.4%) were in the head or scalp.

Of the incident cases of carbuncle/furuncle, the trunk was the most frequently affected region (28.0% of cases; n=3,130), followed by other/unspecified regions (23.1%; n=2,586), the head/face/neck (22.5%; n=2,516), upper extremity (15.1%; n=1,692), and lower extremity (11.2%; n=1,248) **(data not shown)**. Cases in the upper extremity were more commonly in the arm (14.2%; n=1,584), and cases in the lower extremity were more commonly in the leg (10.4%; n=1,160). A total of 1,217 cases (10.9%) occurred on the face, 877 on the buttock (7.8%), 687 on the neck (6.1%), and 612 (5.5%) on the head or scalp.

Time in service

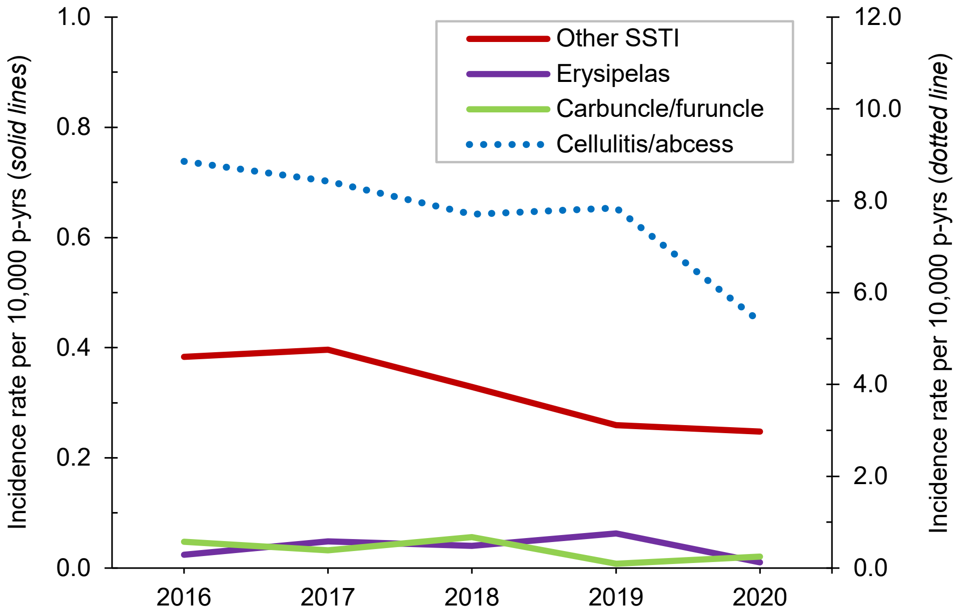
Among individuals who entered military service during the surveillance period, peaks of SSTI-related medical encounters occurred during the first 3 months of military service; typically, this is the period of initial military training, and military trainees are known to be at increased risk of SSTI. In all service branches, cellulitis/abscess was the most frequently diagnosed

TABLE 3. Incidence counts and incidence rates of skin infections by type and demographic/military characteristics, active component, U.S. Armed Forces, 1 January 2016–30 September 2020

	Cellulitis/abscess		Carbuncle/furuncle		Erysipelas		Other SSTI		Total	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
Total	136,081	227.7	11,172	18.7	354	0.6	63,307	105.9	210,914	352.8
Clinical setting										
Inpatient	4,631	7.7	20	0.0	23	0.0	195	0.3	4,869	8.1
Outpatient	131,450	219.9	11,152	18.7	331	0.6	63,112	105.6	206,045	344.7
Sex										
Male	110,908	222.4	8,695	17.4	288	0.6	51,599	103.5	171,490	343.9
Female	25,173	254.1	2,477	25.0	66	0.7	11,708	118.2	39,424	397.9
Race/ethnicity group										
Non-Hispanic White	81,902	243.7	5,797	17.2	248	0.7	35,394	105.3	123,341	366.9
Non-Hispanic Black	20,914	215.9	2,667	27.5	30	0.3	11,681	120.6	35,292	364.4
Hispanic	19,926	209.8	1,610	17.0	43	0.5	10,058	105.9	31,637	333.1
Asian/Pacific Islander	4,573	183.2	387	15.5	12	0.5	1,967	78.8	6,939	278.0
Other/unknown	8,766	195.6	711	15.9	21	0.5	4,207	93.9	13,705	305.8
Age group (years)										
<20	16,958	380.5	1,105	24.8	26	0.6	7,911	177.5	26,000	583.3
20–29	74,027	225.1	5,813	17.7	176	0.5	33,711	102.5	113,727	345.8
30–39	32,767	198.3	3,126	18.9	105	0.6	15,248	92.3	51,246	310.2
40–49	10,883	206.8	1,015	19.3	41	0.8	5,650	107.3	17,589	334.2
50+	1,446	225.4	113	17.6	6	0.9	787	122.7	2,352	366.6
Service										
Army	53,962	252.6	4,886	22.9	125	0.6	22,768	106.6	81,741	382.6
Navy	27,882	182.5	2,195	14.4	60	0.4	12,815	83.9	42,952	281.1
Air Force	30,548	208.5	2,810	19.2	107	0.7	16,483	112.5	49,948	341.0
Marine Corps	23,689	279.3	1,281	15.1	62	0.7	11,241	132.5	36,273	427.6
Status										
Recruit	11,311	879.0	576	44.8	13	1.0	4,858	377.5	16,758	1,302.4
Non-Recruit	124,770	213.3	10,596	18.1	341	0.6	58,449	99.9	194,156	332.0
Rank										
Junior enlisted	69,704	270.7	5,196	20.2	152	0.6	31,943	124.0	106,995	415.5
Senior enlisted	46,972	200.6	4,373	18.7	127	0.5	21,334	91.1	72,806	310.9
Junior officer	12,133	183.1	983	14.8	40	0.6	5,973	90.1	19,129	288.7
Senior officer	7,272	182.8	620	15.6	35	0.9	4,057	102.0	11,984	301.3
Occupation										
Combat-specific[a]	19,679	243.9	1,253	15.5	52	0.6	7,703	95.5	28,687	355.6
Armor/motor transport	4,204	239.2	310	17.6	8	0.5	1,912	108.8	6,434	366.1
Pilot/air crew	3,435	161.5	279	13.1	14	0.7	1,678	78.9	5,406	254.2
Repair/engineering	35,516	199.6	2,946	16.6	93	0.5	15,863	89.1	54,418	305.8
Communications/intelligence	28,156	219.1	2,777	21.6	81	0.6	13,698	106.6	44,712	348.0
Health care	12,842	241.3	1,204	22.6	33	0.6	6,657	125.1	20,736	389.6
Other/unknown[b]	32,249	272.0	2,403	20.3	73	0.6	15,796	133.2	50,521	426.1

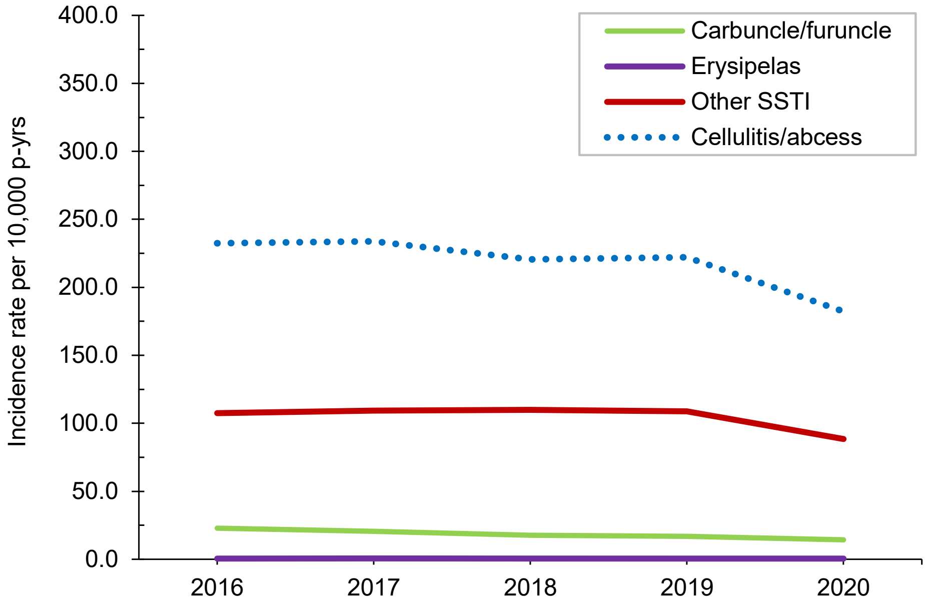
[a]Infantry, artillery, combat engineering.
[b]Includes recruits/trainees.

FIGURE 1. Annual rates of incident inpatient cases of SSTIs, by type, active component, U.S. Armed Forces, 1 January 2016–30 September 2020



SSTIs, skin and soft tissue infections; p-yrs, person-years.

FIGURE 2. Annual rates of incident outpatient cases of SSTIs, by type, active component, U.S. Armed Forces, 1 January 2016–30 September 2020



SSTIs, skin and soft tissue infections; p-yrs, person-years.

type of skin infection during this early period of service **(Figures 3a–d)**.

Burden of disease

During the surveillance period, 174,893 service members were treated for SSTI; the infections accounted for 307,160 medical encounters and 14,819 hospital bed days **(Figure 4)**. Annual numbers of medical encounters and individuals affected decreased 5.5% and 2.7%, respectively, from 2016 through 2019, which was the last complete calendar year of data at the time of the analysis.

Annual numbers of bed days decreased 8.9% between 2016 and 2019 **(Figure 4)**. Cellulitis/abscess accounted for more than two-thirds (69.1%) of all SSTI-associated medical encounters, 68.2% of individuals affected, and 95.8% of hospital bed days **(Figure 4, data not shown)**.

SSTI during deployment

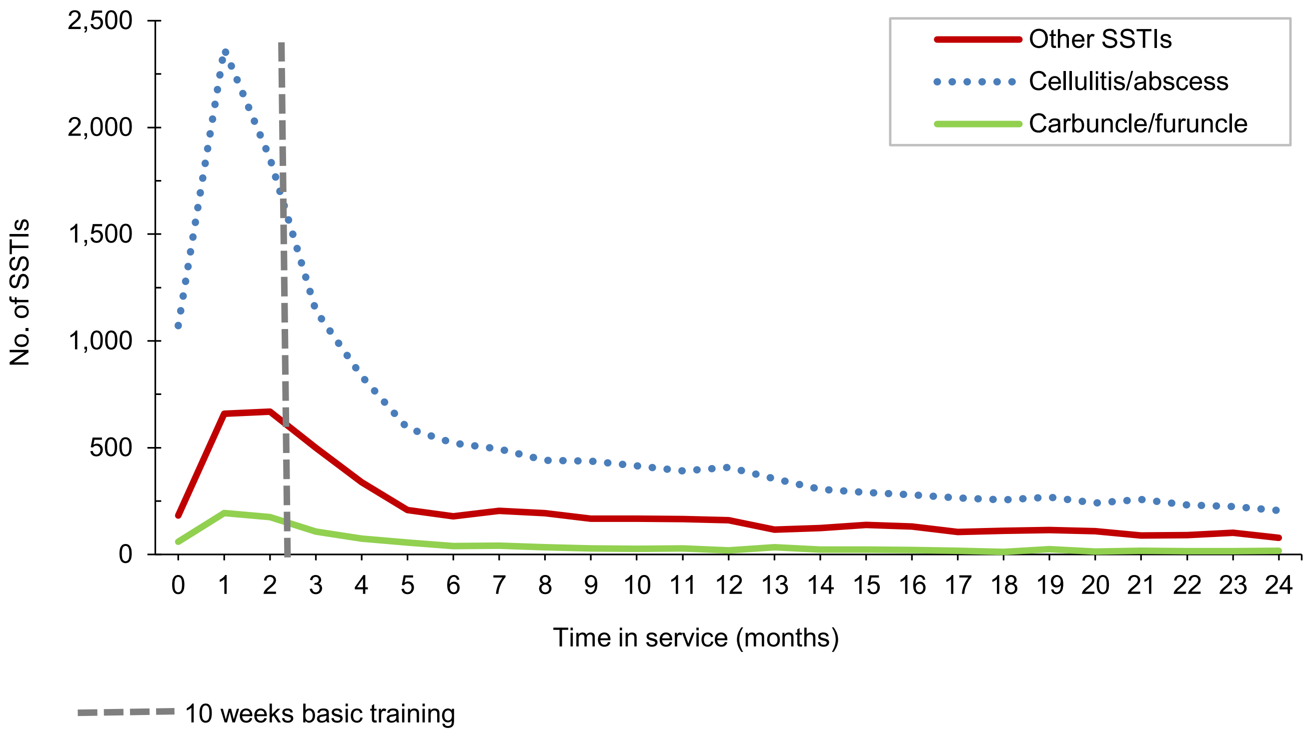
From 1 January 2016 through 30 September 2020, there were 4,250 incident cases of SSTI in theaters of operation, corresponding to an overall incidence of 251.0 per 10,000 p-yrs **(Table 2)**. "Other SSTIs" (47.1%) and cellulitis/abscess (46.8%) were the most frequent classifications. Frequencies of carbuncles/furuncles (5.9%) and erysipelas (0.2%) were low. During the surveillance period, crude overall rates of SSTI during deployment markedly decreased, from 375.8 to 194.2 per 10,000 p-yrs (33.2% decrease) **(Table 2)**. The majority of SSTIs diagnosed in theater occurred while deployed to Kuwait (25.2%; n=1,069), Qatar (21.1%; n=895), United Arab Emirates (8.6%; n=366), Jordan (7.3%; n=309), or Afghanistan (7.2%; n=305). Lastly, there were 9 SSTI-associated medical evacuations from theater. Of these, 8 were classified as cellulitis/abscess and 1 was an unspecified local infection of the skin and subcutaneous tissue **(data not shown)**.

Rates of cellulitis/abscess by service, installation, and recruit status

Among Army basic training sites, overall incidence rates of cellulitis/abscess in the recruit population were highest at Fort Benning, GA (1,032.6 per 10,000 p-yrs), Fort Jackson, SC (976.5 per 10,000 p-yrs), Fort Sill, OK (824.4 per 10,000 p-yrs), and Fort Leonard Wood, MO (752.9 per 10,000 p-yrs), respectively **(Figure 5a)**. Among nonrecruits, limited to Army installations where more than 500 cases of cellulitis/abscess were diagnosed, overall rates were highest at Fort Benning, GA (479.1 per 10,000 p-yrs) and Fort Leonard Wood, MO (393.0 per 10,000 p-yrs).

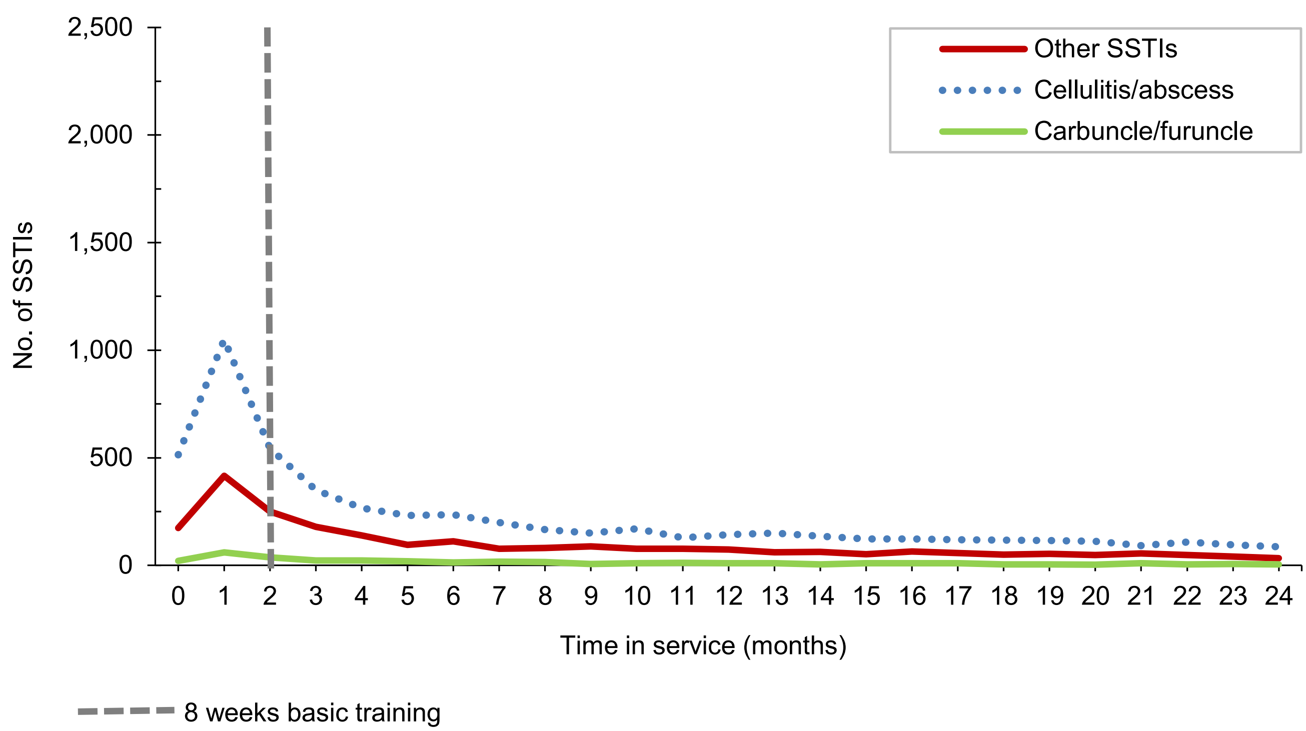
The overall incidence rate of cellulitis/abscess in the Navy recruit population at Naval Station Great Lakes, IL was 695.1 per 10,000 p-yrs **(Figure 5b)**. Among

FIGURE 3a. Number of incident SSTIs, by type and time in service (months 0–24), active component, U.S. Army, 1 January 2016–30 September 2020



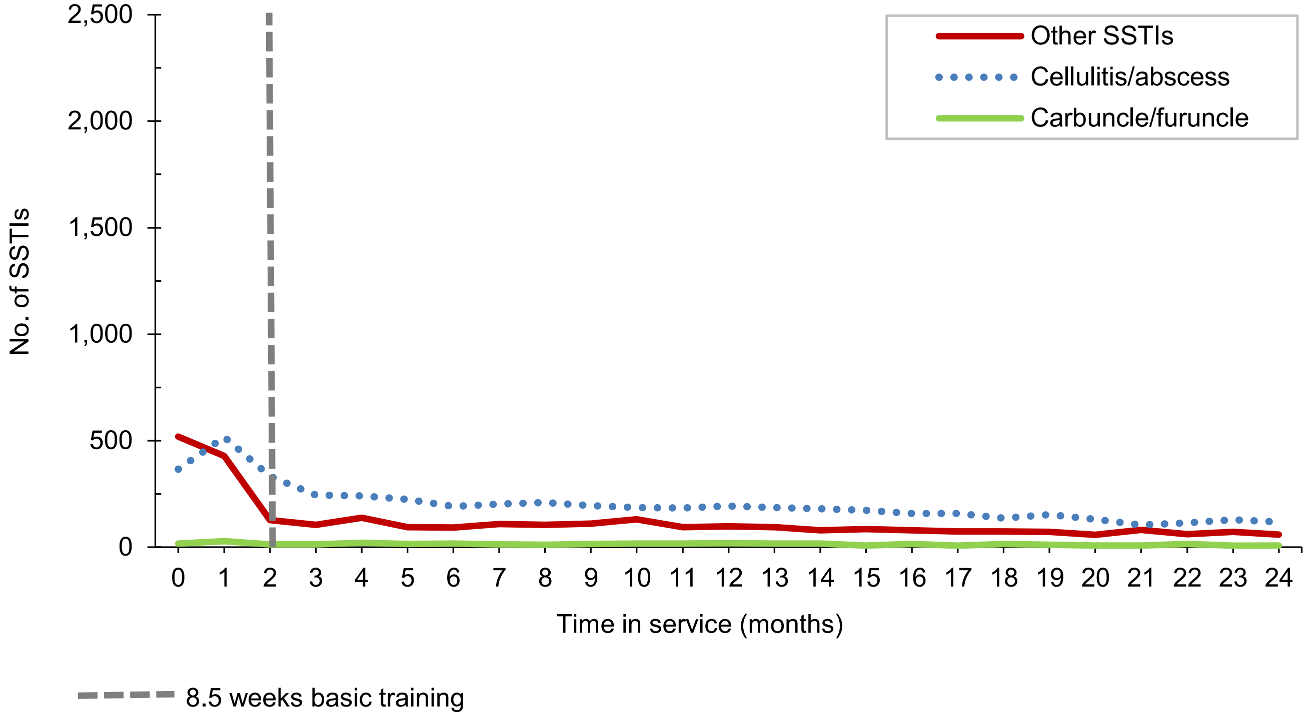
SSTIs, skin and soft tissue infections; no., number.

FIGURE 3b. Number of incident SSTIs, by type and time in service (months 0–24), active component, U.S. Navy, 1 January 2016–30 September 2020



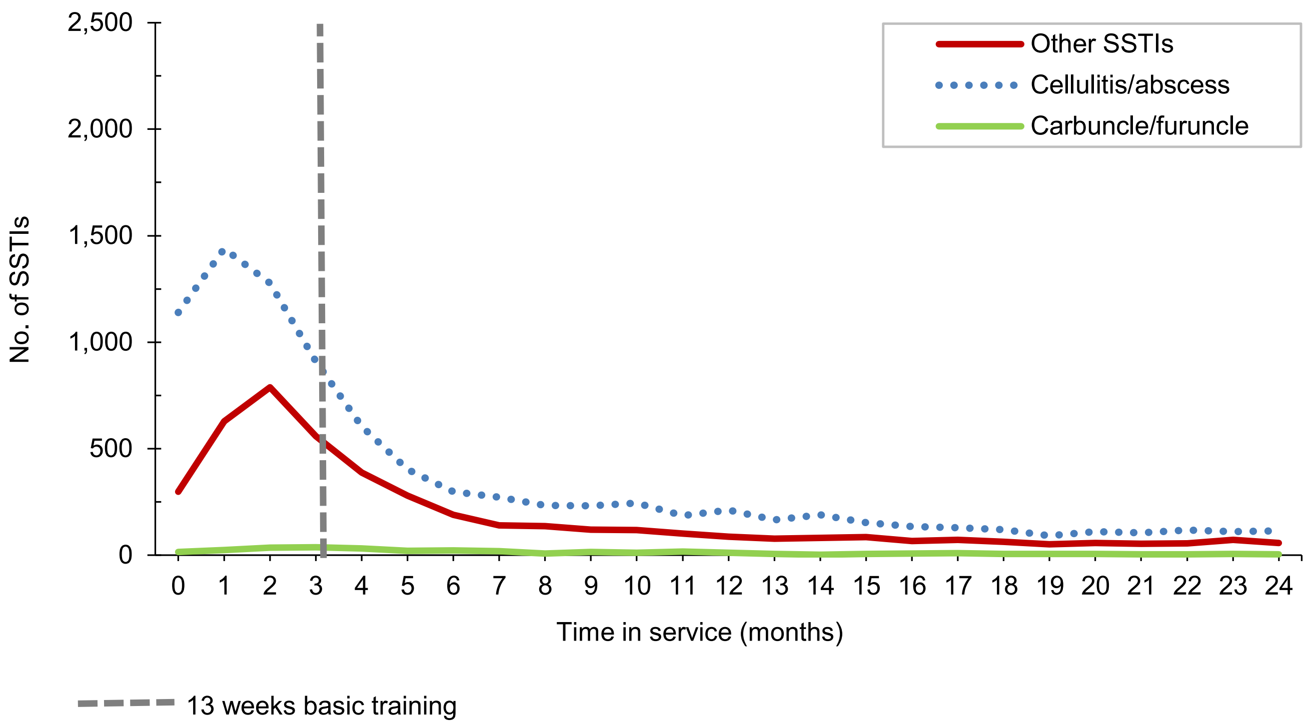
SSTIs, skin and soft tissue infections; no., number.

FIGURE 3c. Number of incident SSTIs by type and time in service (months 0–24), active component, U.S. Air Force, 1 January 2016–30 September 2020



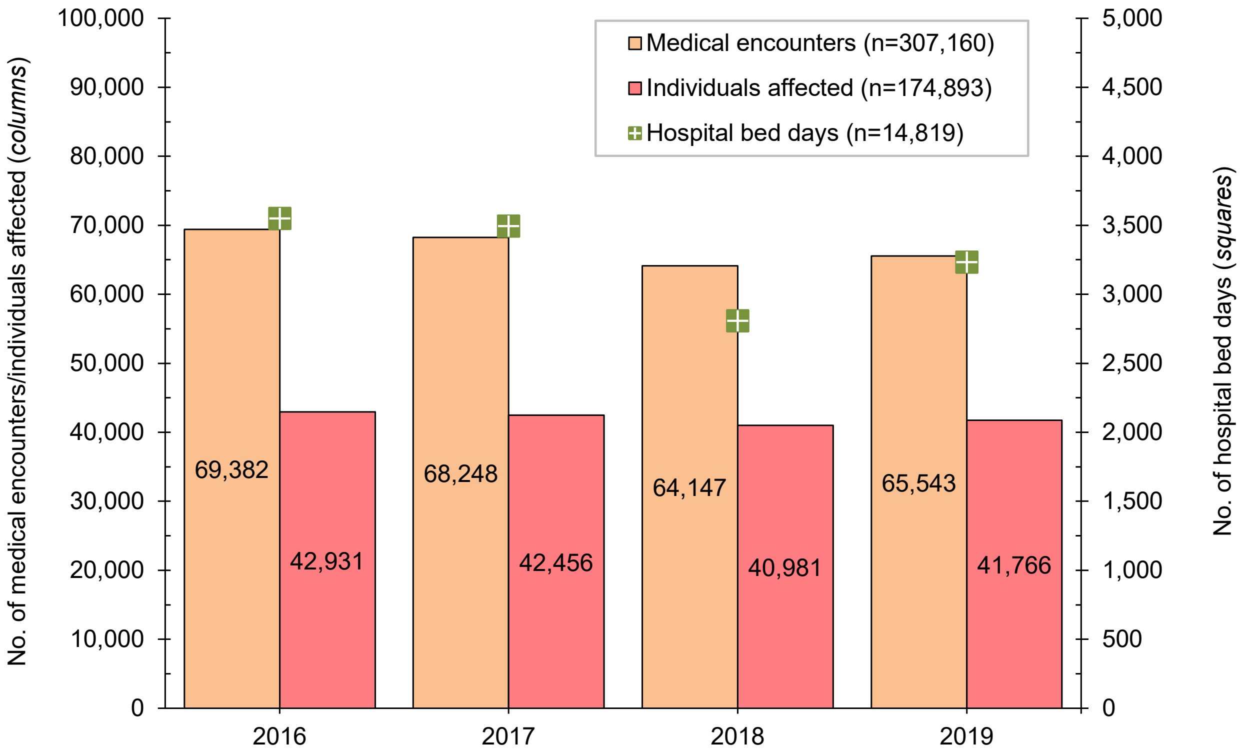
SSTIs, skin and soft tissue infections; no., number.

FIGURE 3d. Number of incident SSTIs by type and time in service (months 0–24), active component, U.S. Marine Corps, 1 January 2016–30 September 2020



SSTIs, skin and soft tissue infections; no., number.

FIGURE 4. Numbers of medical encounters, individuals affected, and hospital bed days for SSTIs, active component, U.S. Armed Forces, 2016-2019[a]



SSTIs, skin and soft tissue infections; no., number.
[a]Data for 2020 are not shown because data for the full calendar year were incomplete at the time of the analysis.

nonrecruits at Navy installations where more than 500 cases of cellulitis/abscess were diagnosed, overall rates were highest at Naval Air Station (NAS) Jacksonville, FL (250.1 per 10,000 p-yrs), NAS Pensacola, FL (241.3 per 10,000 p-yrs), and Naval Weapons Station Charleston, SC (230.0 per 10,000 p-yrs).

Among Marine Corps training centers, overall cellulitis/abscess rates in the recruit population were highest at MCRD Parris Island, (1,435.1 per 10,000 p-yrs) (**Figure 5c**), followed by MCRD San Diego (1,049.6 per 10,000 p-yrs). Among nonrecruits at Marine Corps installations where more than 200 cases were diagnosed, the rate was highest at Marine Corps Recruit Depot Parris Island, SC (583.9 per 10,000 p-yrs).

The overall cellulitis/abscess rate in the Air Force recruit population at Joint Base San Antonio-Lackland, TX was 447.8 per 10,000 p-yrs (**Figure 5d**). Among nonrecruits at Air Force installations where more than 500 cases were diagnosed, rates were highest at Dyess Air Force Base (AFB), TX (272.2 per 10,000 p-yrs), Shaw AFB, SC (254.4 per 10,000 p-yrs), and Joint Base San Antonio-Lackland, TX (239.0 per 10,000 p-yrs).

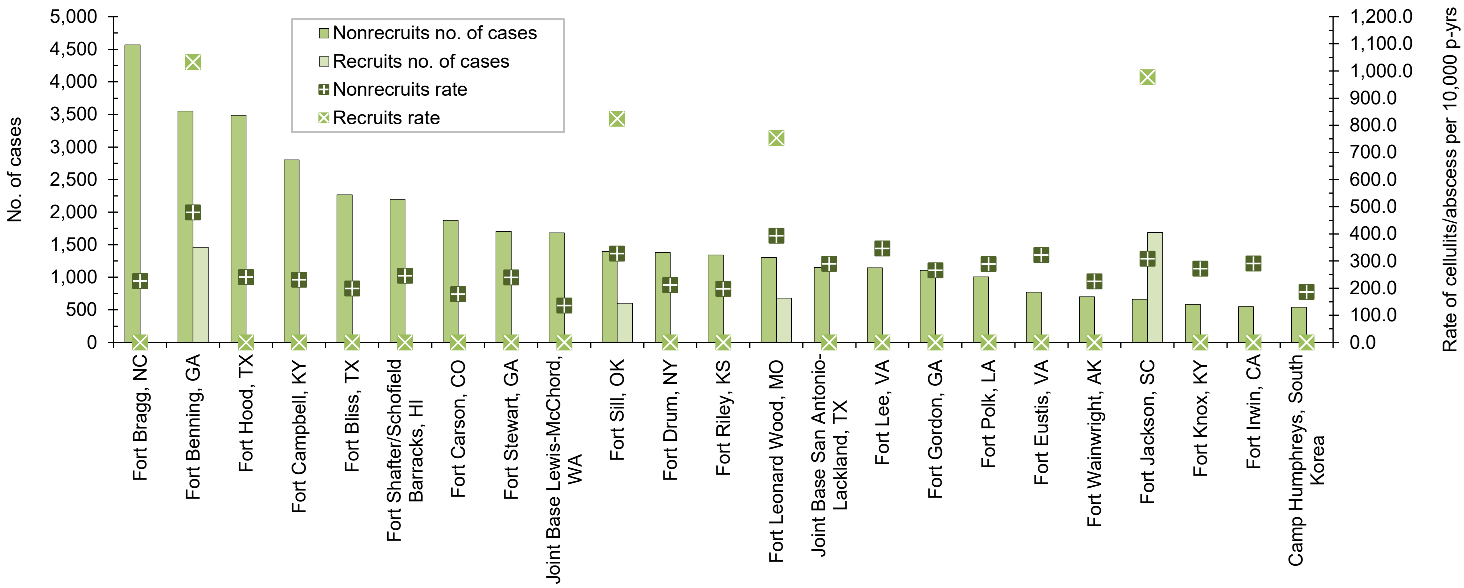
EDITORIAL COMMENT

This report found that the burden of SSTI in military populations remains high, with an overall rate of 352.8 per 10,000 p-yrs between 1 January 2016 and 30 September 2020. Although contemporaneous rates of SSTI in U.S. civilian populations have not been reported, it is known that certain military personnel are at disproportionately higher risk for SSTI when compared to their nonmilitary counterparts. These rate differences are likely due to the frequent engagement of military personnel in training- and deployment-related exercises and operations where an increased frequency of minor traumatic injuries to skin (e.g., abrasions, cuts, and scrapes) which, when compounded by limited access to good hygiene, increases their susceptibility to microbial contamination and subsequent infection.

The current analysis demonstrates that SSTI rates in the military are highest among new recruits/trainees and among those in a deployed setting.[3,10] Across all services, overall SSTI rates in recruit/trainee populations were 1.8–2.7 times higher than that of nonrecruit/nontrainee populations at the same installation. Physical conditions of military training and operational environments (i.e., crowding, infrequent hand washing/bathing, and environmental contamination) favor the transmission of microbial pathogens and thereby increase infection risk in these settings,[2] suggesting that medical countermeasures for SSTI would be most cost effective when specifically targeted to these high risk populations.

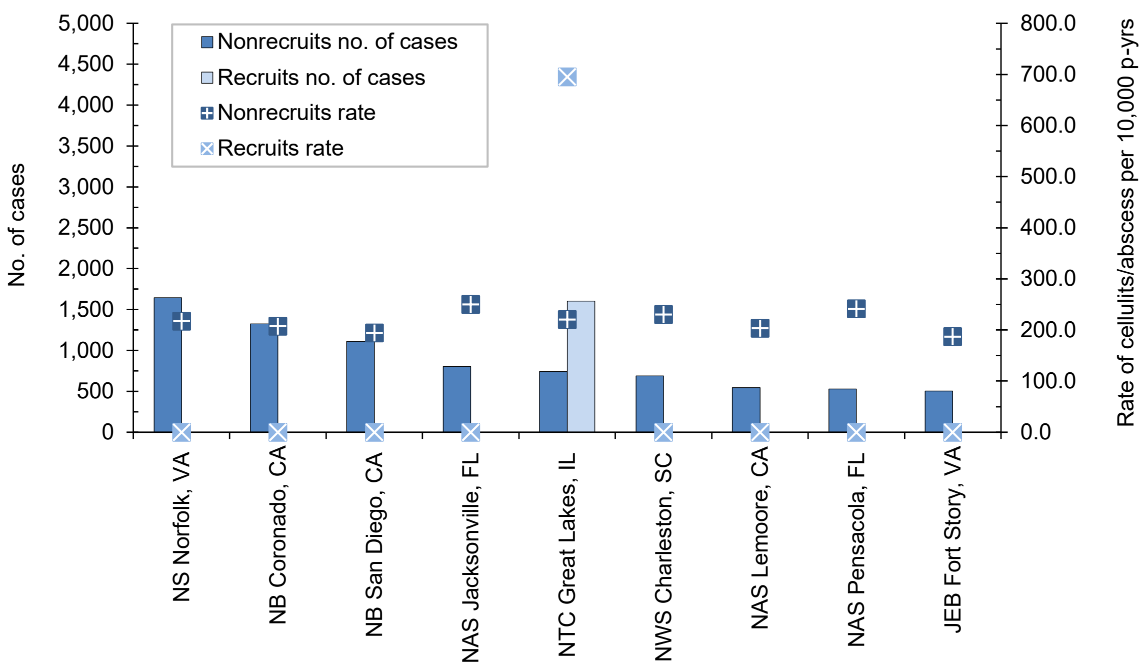
Among all initial military trainees, overall rates of cellulitis/abscess were

FIGURE 5a. Numbers of incident diagnoses and rates of cellulitis/abscess at U.S. Army installations with more than 500 cases, 1 January 2016–30 September 2020



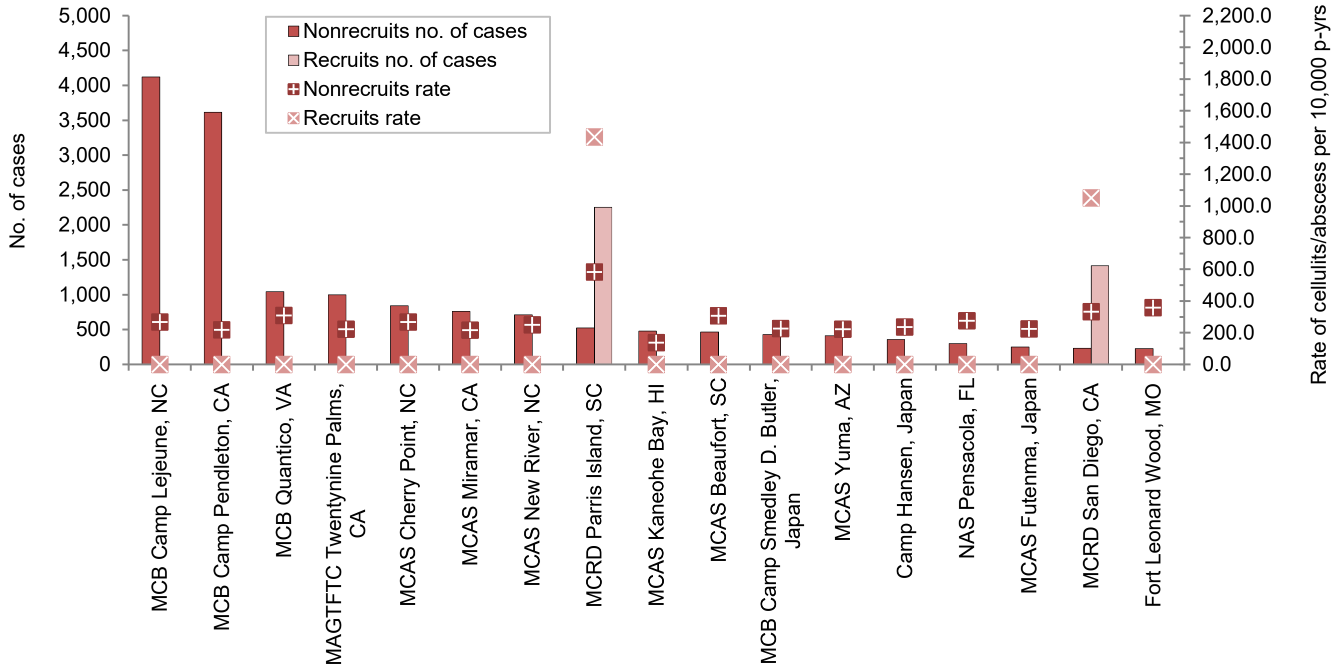
No., number; p-yrs, person-years.

FIGURE 5b. Numbers of incident diagnoses and rates of cellulitis/abscess at U.S. Navy installations with more than 500 cases among non-recruits, 1 January 2016–30 September 2020



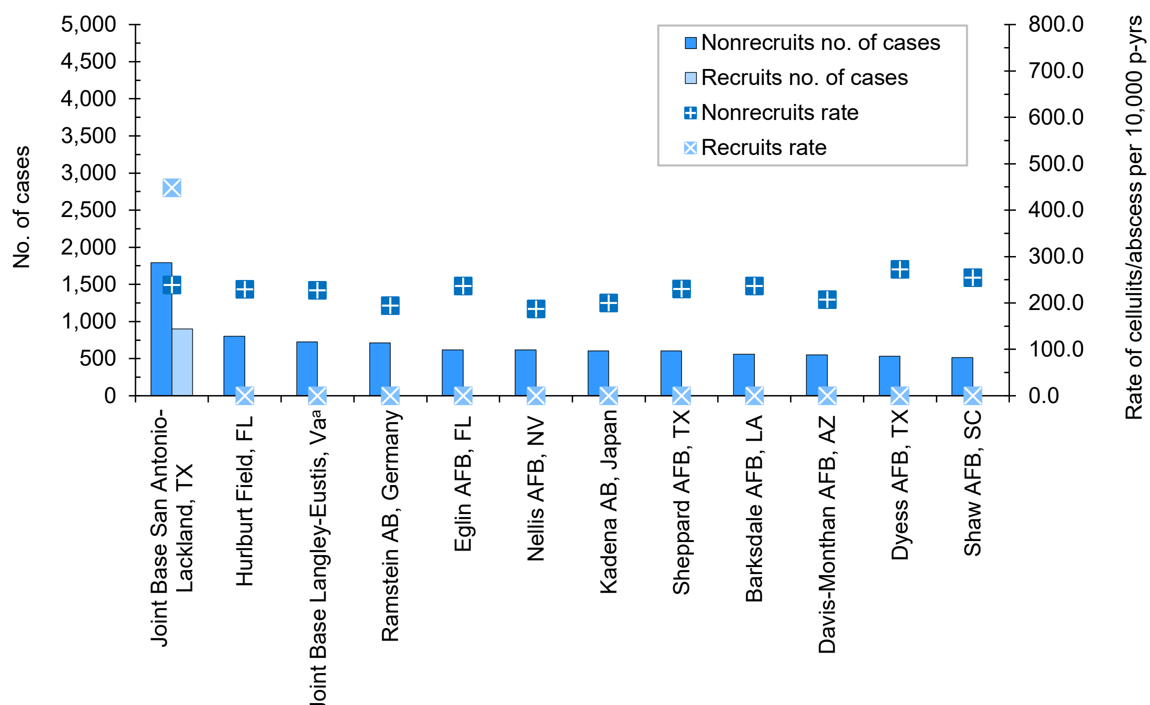
No., number; NS, Naval Station; NB, Naval Base; NAS, Naval Air Station; NTC, Naval Training Center; NWS, Naval Weapons Station; JEB, Joint Expeditionary Base; p-yrs, person-years.

FIGURE 5c. Numbers of incident cases and rates of cellulitis/abscess at U.S. Marine Corps installations with more than 200 cases among nonrecruits, 1 January 2016–30 September 2020



No., number; MCB, Marine Corps Base; MCAS, Marine Corps Air Station; MAGTFTC, Marine Corps Air Ground Combat Center and Task Force Training Command; MCRD, Marine Corps Recruit Depot; p-yrs, person-years.

FIGURE 5d. Numbers of incident cases and rates of cellulitis/abscess at U.S. Air Force installations with more than 500 cases among nonrecruits, 1 January 2016–30 September 2020



No., number; AFB, Air Force Base; AB, Air Base; p-yrs, person-years.

highest among Marine Corps members. The reasons for these service-specific differences in SSTI rates have not been explored to date and might be attributable to differences in the type, intensity, and/or duration of initial military training, each of which may affect a given recruit/trainee's risk of infection. Outbreaks of SSTI among initial military trainees have been reported in California, Texas, and Georgia.[1-3] Further evaluation of epidemiologic characteristics (e.g., specific training activities associated with increased SSTI risk), personal/environmental hygiene practices, and potential environmental reservoirs for SSTI-associated pathogens is warranted.

Annual incidence rates declined by 21.9% over the surveillance period. Moreover, the overall incidence of 352.8 per 10,000 p-yrs from 2016–2020 represents a 37% decline in incidence from the 2013–2016 surveillance period.[10] A decline or plateau in rates of SSTIs in ambulatory, emergency department, and inpatient settings has been reported from nonmilitary health care facilities in the U.S.[7-9] The reasons for the observed decrease or stabilization of SSTI rates in the U.S. civilian sector are unknown.

Limitations to this study include the use of ICD-9 and ICD-10 codes to identify skin and soft tissue infections, which depend on accurate coding in the patient record and may result in misclassification of the outcome. ICD-9 codes were included because, at the time of analysis, some TMDS records still included these codes. In addition, recruits were identified using an algorithm based on age, rank, location, and time in service. This method is only an approximation and likely resulted in some misclassification of recruit training status. Further, the COVID-19 pandemic impacted training cycles in several services in 2020 (e.g., the training cycle length for Air Force recruits was shortened to 7.5 weeks and Keesler AFB served as an alternate recruit training location). Such changes were not incorporated into the recruit-finding algorithm at the time of the analysis.

Early diagnosis and treatment of SSTI—particularly in high-risk settings such as initial military training and deployment settings—is critical to decreasing the significant health care burden and cost that these infections impose on the MHS. Personal hygiene-based strategies failed to prevent SSTIs in a U.S. Army trainee population[11] and vaccines for the leading causes of SSTI do not exist. Research, education, and training activities focused on SSTI control and prevention among high-risk military personnel should be high priorities. Specific recommendations to prevent, evaluate, diagnose, and treat methicillin-resistant *Staphylococcus aureus* (MRSA) infections in U.S. military populations are summarized at https://phc.amedd.army.mil/PHC Resource Library/CA-MRSA_FS_13-021-0914.pdf

Author affiliations: Armed Forces Health Surveillance Division, Silver Spring, MD (Dr. Stahlman, Ms. Williams, Mr. Oh); Infectious Disease Clinical Research Program, Department of Preventive Medicine and Biostatistics, Uniformed Services University of the Health Sciences, Bethesda, MD (Drs. Millar and Tribble); Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., Bethesda, MD (Dr. Millar)

Disclaimer: The views expressed in this article are those of the authors and do not necessarily reflect the official policy of the Uniformed Services University of the Health Sciences, the Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., Department of Defense or the U.S. Government.

REFERENCES

1. Campbell KM, Vaughn AF, Russell KL, et al. Risk factors for community-associated methicillin-resistant Staphylococcus aureus infections in an outbreak of disease among military trainees in San Diego, California, in 2002. *J Clin Microbiol*. 2004;42:4050–4053.
2. Millar EV, Rice GK, Elassal EM, et al. Genomic Characterization of USA300 Methicillin-Resistant Staphylococcus aureus (MRSA) to Evaluate Intraclass Transmission and Recurrence of Skin and Soft Tissue Infection (SSTI) Among High-Risk Military Trainees. *Clin Infect Dis.* 2017;65:461–468.
3. Webber BJ, Federinko SP, Tchandja JN, Cropper TL, Keller PL. Staphylococcus aureus and other skin and soft tissue infections among basic military trainees, Lackland Air Force Base, Texas, 2008–2012. *MSMR* 2013;20:12–15; discussion 5-6.
4. Armed Forces Health Surveillance Center. Bacterial skin infections, active component, U.S. Armed Forces, 2000–2012. *MSMR*. 2013;20:2–7.
5. Landrum ML, Neumann C, Cook C, et al. Epidemiology of Staphylococcus aureus blood and skin and soft tissue infections in the US military health system, 2005–2010. *JAMA*. 2012;308:50–59.
6. Ray GT, Suaya JA, Baxter R. Incidence, microbiology, and patient characteristics of skin and soft-tissue infections in a U.S. population: a retrospective population-based study. *BMC Infect Dis.* 2013;13:252.
7. Klein EY, Mojica N, Jiang W, et al. Trends in Methicillin-Resistant Staphylococcus aureus Hospitalizations in the United States, 2010-2014. *Clin Infect Dis.* 2017;65:1921–1923.
8. Morgan E, Hohmann S, Ridgway JP, Daum RS, David MZ. Decreasing Incidence of Skin and Soft-tissue Infections in 86 US Emergency Departments, 2009–2014. *Clin Infect Dis.* 2019;68:453–459.
9. Fritz SA, Shapiro DJ, Hersh AL. National Trends in Incidence of Purulent Skin and Soft Tissue Infections in Patients Presenting to Ambulatory and Emergency Department Settings, 2000–2015. *Clin Infect Dis.* 2020;70:2715–2718.
10. Stahlman S, Williams VF, Oh GT, Millar EV, Bennett JW. Skin and soft tissue infections, active component, U.S. Armed Forces, 2013–2016. *MSMR*. 2017;24:2–11.
11. Ellis MW, Schlett CD, Millar EV, et al. Hygiene strategies to prevent methicillin-resistant Staphylococcus aureus skin and soft tissue infections: a cluster-randomized controlled trial among high-risk military trainees. *Clin Infect Dis.* 2014;58:1540–1548.

TRICARE

COVID-19 VACCINATION

GET THE FACTS

DID YOU KNOW?

You have options on where to receive the COVID-19 vaccine, depending on local and DoD availability.

To find out when and how you can get the vaccine, contact your:

- Local military hospital or clinic: **www.tricare.mil/mtf**
- State health department: **www.usa.gov/state-health**
- Local retail pharmacy: **www.cdc.gov/vaccines/covid-19/retail-pharmacy-program**

Charlie Mike. Let's continue the vaccine mission together.

TRICARE®

Medical Surveillance Monthly Report (MSMR)
Armed Forces Health Surveillance Division
11800 Tech Road, Suite 220
Silver Spring, MD 20904

MEDICAL SURVEILLANCE MONTHLY REPORT (MSMR), in continuous publication since 1995, is produced by the Armed Forces Health Surveillance Division (AFHSD). AFHSD is a designated public health authority within the Defense Health Agency. The *MSMR* provides evidence-based estimates of the incidence, distribution, impact, and trends of illness and injuries among U.S. military members and associated populations. Most reports in the *MSMR* are based on summaries of medical administrative data that are routinely provided to the AFHSD and integrated into the Defense Medical Surveillance System for health surveillance purposes.

Archive: Past issues of the *MSMR* are available as downloadable PDF files at www.health.mil/MSMRArchives.

Online Subscriptions: Submit subscription requests at www.health.mil/MSMRSubscribe.

Editorial Inquiries: Call (301) 319-3240 or email dha.ncr.health-surv.mbx.msmr@mail.mil.

Instructions for Authors: Information about article submissions is provided at www.health.mil/MSMRInstructions.

Follow us:
www.facebook.com/AFHSBPAGE
http://twitter.com/AFHSBPAGE

ISSN 2158-0111 (print)
ISSN 2152-8217 (online)