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Trends of Sepsis Hospitalizations Among Female Active Component U.S. Service Members, 2011–2022

Trends in Cervical Cancer Screening Modality in the Active Component U.S. Military, 2013–2023

Infertility Among Active Component Service Women, U.S. Armed Forces, 2019–2023

Association Between Recurring Headache and Selected Women's Health Issues Among U.S. Navy and Marine Corps Women: Cross-Sectional Results of the Annual Periodic Health Assessment, 2021

Long-Acting Reversible Contraception and Unintended Pregnancy Among U.S. Active Duty Service Members, 2017–2018

Contraceptive Use Trends from the Periodic Health Assessment Among Female Active Duty U.S. Sailors and Marines, 2018–2023

Optimizing Female Warfighter Health and Performance in Environmental Extremes

Enhancing Military Women's Health and Readiness Through Targeted Research Initiatives

Mid-Season Vaccine Effectiveness Estimates for Influenza: the Department of Defense Global Respiratory Pathogen Surveillance Program, 2024-2025 Season

Reportable Medical Events at Military Health System Facilities Through Week 9, Ending February 1, 2025

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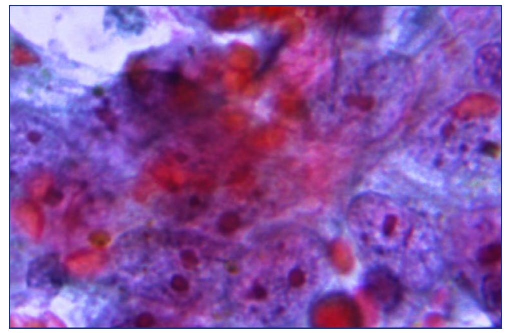
Table of Contents



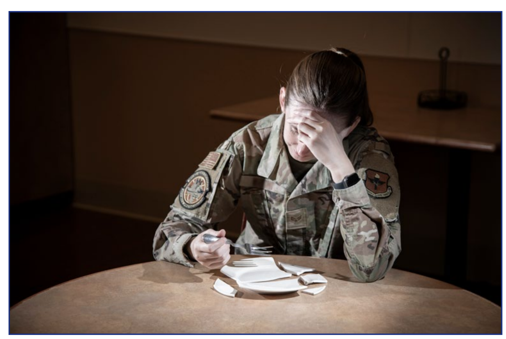


Table of Contents

Trends of Sepsis Hospitalizations Among Female Active Component U.S. Service Members, 2011–2022

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Studies of sepsis within the U.S. military population have consistently shown that rates of sepsis have increased over time. The observed higher incidence of sepsis in studies among women compared to men of the active component U.S. military population is of concern and warrants further evaluation, as it diverges from incidence typically observed in the U.S. general population. The objectives of this study were to examine cases of sepsis among active component U.S. service women between January 1, 2011 and December 31, 2022, compare them to active component men in the U.S. military, and identify factors associated with sepsis among female active component service members. In this study, female active component service members evinced higher rates (66.5 per 100,000 person-years) compared to males (36.7 per 100,000 person-years), with a rate of sepsis 1.9 times higher after adjusting for demographic and military-related factors. Rates of sepsis were higher among women with a history of co-morbidities.

What are the new findings?

Rates of sepsis hospitalizations among female active component service members have consistently been higher compared to male active component members. Female active component members had 1.9 times higher rates for hospitalization for sepsis compared to active component service men after adjusting for demographic and military-related factors.

What is the impact on readiness and force health protection?

Sepsis is a life-threatening condition that is costly to treat. Patients who survive sepsis may experience lasting impacts, such as long-term disability. Recovery from sepsis could lead to lost duty time, disability, or attrition among service members if the infection is severe. Identifying risk factors and prevention measures to reduce sepsis incidence and severity would improve force health protection.

Each year, approximately 1.7 million adults in the U.S. develops sepsis, and at least 250,000 adults who develop sepsis die.[1] It is estimated that 30-50% of hospitalization deaths are attributable to sepsis,[1,2] and this estimate increases with increased disease severity.[3] In a study of 750 million U.S. hospitalizations over a 22-year period, the rate of sepsis increased from 82.7 to 240.4 cases per 100,000 population from 1979 to 2000.[4] From 2016 to 2019 the number of inpatient stays in the U.S. increased by 20.1% to 2.1 million, and with the emergence of COVID-19, the number increased again to 2.5 million.[5] Sepsis imposes a great burden on the U.S. health care system, costing an estimated $41.5 billion per year.[6] Implementing and maintaining hospital sepsis prevention programs associated with reductions in mortality, lengths of hospital stay, and health care costs is imperative.[1,7]

Studies of sepsis among the U.S. military population have consistently shown increasing rates of sepsis over time. A 2013 study of sepsis in the active component U.S. military population from 2000 to 2012 found an overall incidence of 13.2 cases per 100,000 person-years (p-yrs) and a 570% increase between 2004 and 2012. Definitions and coding practices for sepsis changed during that period, which may have driven the large increase.[8] A follow-up study in 2021 found that overall incidence among the active component was 39.8 per 100,000 p-yrs, and annual incidence of sepsis hospitalization increased by 64% from 2011 to 2019.[9]

Both the 2013 and 2021 studies presented evidence to suggest that sepsis rates were higher among women compared to men in the U.S. military, which is the inverse of trends seen in the general U.S. population.[1,4] Neither study, however, was able to explain the reason for this difference. The 2021 study noted that, although infections specific to female service members were seen, the numbers were not large enough to account for the differences.[9] It also suggested that clinical variability in coding practices could be a factor if, for example, obstetricians were more likely than internal medicine physicians to diagnose sepsis among patients under their care.

The observed higher incidence of sepsis in previous studies among women of the active component U.S military population is a concern that needs to be further evaluated. The previous studies raised questions about a possible growing threat to women's health in the military due to sepsis. The objectives of this study were to examine cases of sepsis between 2011 and 2022 among active component U.S. service women, compare them to active component men in the U.S. military population, and identify factors associated with sepsis among female active component service members.

Methods

This retrospective analysis included active component service members (ACSMs) from the Army, Air Force, Navy, and Marine Corps of the U.S. Armed Forces from January 1, 2011 through December 31, 2022. Data to evaluate sepsis were obtained from the Defense Medical Surveillance System (DMSS), the central repository of medical data for service members. DMSS collects inpatient administrative health records for care received at military hospitals and clinics as well as private sector care purchased through TRICARE. Demographic data obtained from DMSS included sex, age category, race and ethnicity, service branch, occupation, geographic region, deployed status, and military rank; race and ethnicity were self-reported. Deployment status was determined by service member deployment at time of sepsis diagnosis or deployment within the prior 30 days. Deployments to unknown locations or bodies of water were not included.

International Classification of Diseases, 9th Revision (ICD-9) and 10th Revision (ICD-10) diagnostic codes were used to define incident cases of sepsis **(Table 1)**. Septicemia was no longer listed in ICD coding following the October 2015 change to ICD-10 codes, with specific codes including causative organisms provided instead. A case was defined as any hospitalization record with a sepsis diagnostic code in any diagnostic position. A 14-day gap in care incidence rule was applied; an individual could be included as a case more than once if more than 14 days elapsed between dates of consecutive incident case-defining encounters. Co-occurring conditions at time of sepsis hospitalization were identified by ICD-9 and ICD-10 codes from the incident sepsis encounter.

Additional encounter data for pregnancies and co-morbidities prior to sepsis diagnosis were also included **(Table 2)**. Frequencies of sepsis cases among women who were pregnant within 280 days preceding their incident sepsis encounter

TABLE 1. Frequency of Case-Defining ICD Codes for Sepsis by Sex, Active Component U.S. Service Members, 2011–2022

ICD Version	ICD Code	Description	Females		Males	
			No.	%	No.	%
ICD-9-coded encounters (2010–September 2015)	003.1	Salmonella septicemia	1	0.1	5	0.1
	022.3	Anthrax septicemia	0	0.0	0	0.0
	038*	Septicemia	447	46.6	1,767	49.0
	995.91	Sepsis	340	35.4	1,199	33.3
	995.92	Severe sepsis	80	8.3	392	10.9
	785.52	Septic shock	45	4.7	220	6.1
	998.02	Post-operative septic shock	0	0.0	6	0.2
	112.5	*Candida* sepsis	2	0.2	15	0.4
	Female-specific					
	670.2*	Puerperal sepsis	45	4.7	0	0.0
ICD-10-coded encounters (October 2015–2022)	A02.1	Salmonella sepsis	1	0.1	1	0.0
	A22.7	Anthrax sepsis	0	0.0	0	0.0
	A26.7	Erysipelothrix sepsis	0	0.0	0	0.0
	A32.7	*Listeria* sepsis	0	0.0	1	0.0
	A40*	Streptococcal sepsis	32	2.2	140	3.8
	A41*	Other sepsis	1,003	70.2	2,889	77.4
	A42.7	Actinomycotic sepsis	0	0.0	0	0.0
	A54.86	Gonococcal sepsis	4	0.3	3	0.1
	B37.7	*Candida* sepsis	2	0.1	12	0.3
	R65.2*	Severe sepsis	202	14.1	675	18.1
	T81.12	Post-procedural septic shock	1	0.1	8	0.2
	Female-specific					
	O03*	Sepsis following spontaneous abortion	52	3.6	0	0.0
	O04.87	Sepsis following induced termination of pregnancy	5	0.4	0	0.0
	O07.37	Sepsis following failed attempted termination of pregnancy	6	0.4	0	0.0
	O08.82	Sepsis following ectopic and molar pregnancy	6	0.4	0	0.0
	O85	Puerperal sepsis	97	6.8	4	0.1
	O86.04	Sepsis following obstetric procedure	18	1.3	0	0.0

*Asterisk indicates that any subsequent digit or character is included.
Abbreviations: ICD, International Classification of Diseases; No., number.

TABLE 2. Pregnancy-related and Co-Morbidity Diagnosis Codes

Diagnosis	ICD-9 Codes	ICD-10 Codes
Pregnancy and childbirth	V22.0–V22.2,V23.*,V27.*, V72.42, 630*–679*	Z33*, Z34*,Z37*, Z32.01, O*,
Immune-compromising conditions	042, 279*, 280*-289*, V42*, V58.65, 696*, 277.3*, 714.0*-714.3*, 555*, 556*, 558*	B20, D55*-D77*, D80*-D89*, Z94*, Z795*, L40*, M04*-M08*, K50*-K52*
Chronic kidney disease	583*, 585*, 586*, 590.0*, 590.1*, 590.2, 590.8*, 590.9, 591, 593.3, 593.4, 593.5, 593.7*	N03*-N16*, N18*-N19*
Any cardiovascular disease	393*-457*	I05*-I89*, Z95*
Hypertension	401*-405*, 642*	I10*-I16*, O10*-O16*
Neoplasms	140*-239*	C00*-D49*
Metabolic disease	250*, 6480*, V58.67, 240*-246*, 264*-269*, 277.7	E08*-E13*, O24*, Z794*, E00*-E07*, E50*-E64*, E88.81*
Any lung disease	490*-519*	J40*-J99*
Chronic lower respiratory disease	490*-492*	J40*-J44*
Substance use disorders	304*, 305.1*-305.9*, 305.0*, 303.0*, 303.9*, 291.0, 291.81	F10*-F16*, F18*-F19*, F17*
Alcohol use disorders	303*	F10*
Chronic liver disease	570*-573*, 070.22, 070.23, 070.32, 070.33, 070.44, 070.54, 070.59	K70*-K77*, B18*

*Asterisk indicates that any subsequent digit or character is included.
Abbreviation: ICD, International Classification of Diseases.

with a history of a listed comorbidity are described. Pregnancy-related encounters were defined using ICD-9/ICD-10 diagnosis codes **(Table 2)** in any diagnostic position during an inpatient, outpatient, or in-theater medical encounter or with a positive laboratory test result for human chorionic gonadotropin. Co-morbidities were identified based on prior associations with risk of sepsis and mortality risk from sepsis.[1,10-12] Co-morbidity encounters were defined using ICD-9/ICD-10 diagnosis codes in any diagnostic position from an inpatient, outpatient, or in-theater medical encounters. Co-morbidities were assessed for a period of 365 days preceding the incident sepsis date for sepsis cases and prior history of co-morbidity among all female ACSMs. Each co-morbidity was evaluated separately.

To further evaluate sepsis incidence among women, body mass index (BMI) data were obtained from the Military Health System Data Repository (MDR) Clinical Data Repository (CDR) Vitals and MDR GENESIS Vitals. BMI was categorized as obese (≥30) and not obese (<30). BMI records within 280 days before or after an 'O'-coded (encounters related to pregnancy) inpatient or outpatient encounter were excluded. Prior history of co-morbidities related to sepsis was defined as having at least 1 inpatient or outpatient encounter with a co-morbidity diagnosis in any diagnostic position.

Incidence rates were calculated as incident sepsis diagnoses per 100,000 p-yrs. Rates were calculated separately for female and male ACSMs. Rates among female ACSMs with a history of selected co-morbidities were calculated. Person-time contributions for each service member were determined from January 1, 2011 through December 31, 2022. Person-time was censored when a service member left the active component or at the end of the surveillance period. Incidence rate ratios (IRRs) and 95% confidence intervals (CIs) were calculated to compare sepsis rates between female and male ACSMs. An adjusted Poisson regression model (adjusted for race and ethnicity, age, service, grade, occupation) calculated adjusted IRRs comparing rates of sepsis among women and men. All analyses were conducted using SAS-Enterprise Guide (version 8.3).

Results

From January 1, 2011 through December 31, 2022, 6,588 incident cases of hospitalized sepsis occurred among 573,477 (16.8%) female and 2,841,317 (83.2%) male ACSMs. Female ACSMs accounted for 1,684 (25.6%) incident cases of hospitalized sepsis, while male ACSMs accounted for 4,904 (74.4%) incident cases of hospitalized sepsis between 2011 and 2022.

Table 1 summarizes the most commonly occurring sepsis diagnoses, stratified by sex. A case could be counted multiple times if the incident encounter featured more than 1 sepsis ICD-9/ICD-10 code. Among ICD-9-coded diagnoses, septicemia and sepsis were the most common diagnoses, accounting for 82% of sepsis-related diagnoses among both female and male sepsis cases. Puerperal sepsis was the only female-specific ICD-9 code and accounted for 4.7% of ICD-9 diagnoses. Among ICD-10-coded encounters, 77.4% of sepsis-related diagnoses among men were coded as "other sepsis" (A41*), which included sepsis due to an unspecified organism (A41.9) or *Escherichia coli*

(A41.51), and was the most common diagnosis in this category. The 'other sepsis' (A41*) code only accounted for 70.2% of sepsis diagnoses among women. Female-specific sepsis diagnoses accounted for 12.9% of ICD-10 sepsis diagnoses among women. Severe sepsis was diagnosed more frequently among men (18.1%) compared to women (14.1%).

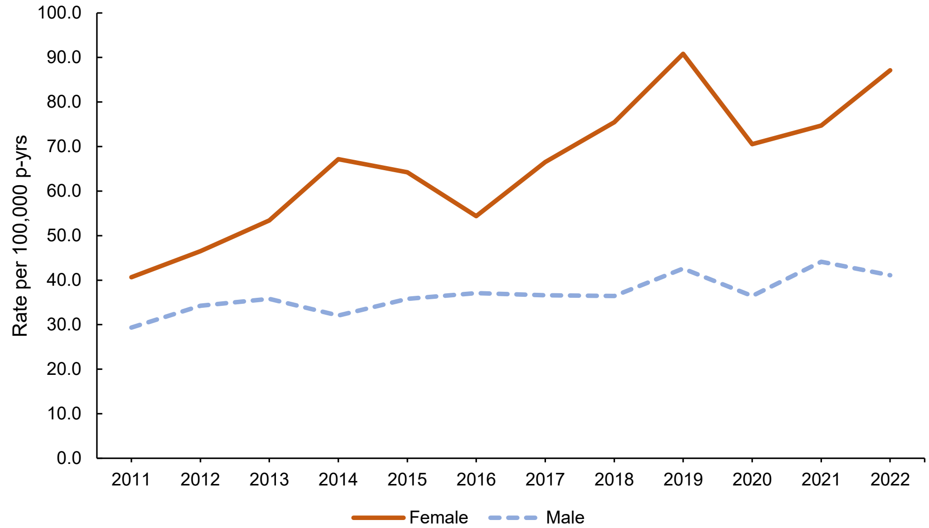
Figure 1 shows the incidence rates of sepsis per 100,000 p-yrs between 2011 and 2022, by sex. Female ACSMs consistently experienced higher rates of sepsis throughout the surveillance period. Among female ACSMs, incidence rates of sepsis peaked in 2019 (90.8 per 100,000 p-yrs) but began to trend upward again after 2020, registering 87.1 per 100,000 p-yrs in 2022. Women in nearly all demographic categories experienced higher rates of sepsis than men **(Table 3)** except in the recruit category, due to the small numbers of women. Crude rate ratios are provided that compare women to men.

Rates by age group for both sexes displayed a U-shaped pattern in which highest rates were in the under age 20 years (84.6 per 100,000 among females, 56.1 per 100,000 among males) and 45 years and older (81.6 per 100,000 among females; 72.3 per 100,000 among males) age groups in both sexes. The greatest difference between female and male sepsis cases was seen in the 20-24-year age group, in which women were 2.3 times (95% CI, 2.1, 2.6) more likely to have sepsis hospitalizations than men in the same group. Women had higher rates of sepsis compared to men in all racial and ethnic groups.

In every branch of service women also experienced higher rates of sepsis. The highest rates of sepsis for both women and men were in the Marine Corps, with female marines experiencing a rate of 87.2 per 100,000 p-yrs, while males experienced a rate of 46.1 per 100,000 p-yrs. The greatest difference in rates between the sexes was seen in the Navy, with 2.0 times (95% CI, 1.8, 2.3) the rate of sepsis hospitalization among female sailors compared to male sailors.

Among enlisted service members, rates were 1.9 times (95% CI, 1.8, 2.0) higher among women (72.4 per 100,000 p-yrs) than men. Among those in combat-specific occupations, rates were more than

FIGURE 1. Annual Rates of Sepsis Hospitalizations by Sex, Active Component, U.S. Armed Forces, 2011–2022



twice as high among women then men. Deployed service members had lower rates than those who did not recently deploy, but women had higher rates than men among both groups. Rates of sepsis among female recruits (43.0 per 100,000 p-yrs) were half that of male recruits (82.8 per 100,000 p-yrs). After accounting for the effects of age, race and ethnicity, service, grade, and occupation, the adjusted rate was nearly twice as high among female ACSMs as male ACSMs **(Table 4)**.

Further descriptions of female sepsis cases are provided in **Tables 5–7**. The most frequent co-occurring infections for sepsis cases among female ACSMs are shown in **Table 5**. Among ICD-9-coded encounters, the most common infections were pyelonephritis, pneumonia with unspecified organism, unspecified urinary tract infection (UTI), and post-operative infection. Among ICD-10-coded encounters, the most common infections were acute pyelonephritis, unspecified UTI, COVID-19, unspecified *E. coli* infection, and unspecified pneumonia.

The most common co-occurring non-infectious diagnoses under ICD-9 coding were hypopotassemia, acute kidney failure, unspecified anemia, hypo-osmolality and/or hyponatremia, and acute respiratory failure **(Table 6)**. Among ICD-10-coded diagnoses, the most common non-infectious diagnoses were hypokalemia, hypo-osmolality and hyponatremia, acute kidney failure, tubule-interstitial nephritis, and unspecified anemia.

The co-occurring diagnoses in **Tables 5** and **6** are limited to those occurring within the incident sepsis encounter. Among female ACSM sepsis cases, 1,187 cases had another health encounter that did not include a sepsis-related diagnosis, within 7 days prior to the incident sepsis hospitalization (data not shown). Seventy-seven cases were hospitalized in the 7 days preceding the incident sepsis encounter, and more than half (n=42, 55%) of those cases had primary diagnoses related to pregnancy, delivery, or postpartum care (data not shown).

Women were also assessed for co-morbid conditions in the year preceding sepsis diagnosis, defined as at least 1 diagnosis for a co-morbid condition within 365 days before the incident sepsis diagnosis **(Table 7)**. Just over two-thirds, or 67.2%, of sepsis cases had health care encounters with at least 1 co-morbidity diagnosis (n=1,131), listed in **Table 7**, within 365 days preceding incident their sepsis diagnoses. Immune-compromising conditions were the most common (n=517, 30.7%), followed by chronic kidney disease (n=325, 19.3%), cardiovascular disease (n=315, 18.7%), neoplasms (n=271, 16.1%), and obesity (n=275, 16.3%). Slightly less than one-third, or 30.8%, of women

TABLE 3. Incidence of Sepsis by Sex, Active Component U.S. Service Members, 2011–2022

Demographic Characteristics	Females		Males		Crude Rates		
	No.	Rate[a]	No.	Rate[a]	RR	95% LCL	95% UCL
Total	1,684	66.5	4,904	36.7	1.8	1.7	1.9
Age, y							
<20	158	84.6	483	56.1	1.5	1.3	1.8
20–24	630	75.7	1,360	32.3	2.3	2.1	2.6
25–29	349	55.5	932	29.6	1.9	1.7	2.1
30–34	234	58.4	695	32.4	1.8	1.6	2.1
35–39	160	59.9	635	40.2	1.5	1.3	1.8
40–44	86	64.0	427	47.7	1.3	1.1	1.7
45+	67	81.6	372	72.3	1.1	0.9	1.5
Race and ethnicity							
White, non-Hispanic	712	64.9	3,044	38.0	1.7	1.6	1.9
Black, non-Hispanic	384	60.1	658	34.5	1.7	1.5	2.0
Hispanic	330	74.9	692	35.2	2.1	1.9	2.4
Other	258	72.6	510	34.5	2.1	1.8	2.4
Service branch							
Army	531	62.1	1,824	36.1	1.7	1.6	1.9
Navy	495	67.8	1,051	33.2	2.0	1.8	2.3
Air Force	501	65.4	1,084	35.1	1.9	1.7	2.1
Marine Corps	157	87.2	945	46.1	1.9	1.6	2.2
Rank							
Enlisted	1,479	72.4	4,229	38.3	1.9	1.8	2.0
Officer	205	41.8	675	29.2	1.4	1.2	1.7
Military occupation							
Combat-related	51	83.8	823	37.4	2.2	1.7	3.0
Motor transport	56	72.1	156	40.2	1.8	1.3	2.4
Pilot/air crew	22	58.3	130	23.6	2.5	1.6	3.9
Repair/engineering	346	69.2	1,420	34.0	2.0	1.8	2.3
Communications/intelligence	572	69.1	888	33.9	2.0	1.8	2.3
Health care	299	61.9	366	40.3	1.5	1.3	1.8
Other	338	62.0	1,121	44.5	1.4	1.2	1.6
Recruit status							
Yes	24	43.0	227	82.8	0.5	0.3	0.8
No	1,660	67.0	4,677	35.7	1.9	1.8	2.0
Education level							
High school or less	1,078	74.9	3,331	37.7	2.0	1.9	2.1
Some college	266	71.2	611	39.9	1.8	1.5	2.1
Bachelor's degree or more	318	48.4	880	32.4	1.5	1.3	1.7
Other/unknown	22	34.8	82	28.7	1.2	0.8	1.9
Marital status							
Single	677	59.4	1,943	35.3	1.7	1.5	1.8
Married	812	70.8	2,720	37.0	1.9	1.8	2.1
Other	195	79.4	241	47.8	1.7	1.4	2.0
Deployment status							
Yes	16	24.2	115	21.2	1.1	0.7	1.9
No	1,668	67.6	4,789	37.4	1.8	1.7	1.9

Abbreviations: No., number; RR, rate ratio; LCL, lower confidence limit; UCL, upper confidence limit; y, years.
[a] Rate per 100,000.

had a pregnancy-related encounter within 280 days preceding an incident sepsis diagnosis.

Rates of sepsis among women with histories of hypertension, lung disease, immune-compromising conditions, alcohol abuse disorders, chronic liver disease, chronic kidney disease, neoplasms, obesity, and diabetes also were evaluated **(Figure 2)**. Rates of sepsis were consistently higher among women with a history of comorbidities, with the highest rates among women with a history of chronic kidney disease (526.3 per 100,000 p-yrs), chronic liver disease (491.2 per 100,000 p-yrs), or diabetes (204.7 per 100,000 p-yrs).

TABLE 4. Adjusted Incidence Rate Ratios of Sepsis Hospitalizations, Active Component U.S. Service Members, 2011–2022

Demographic Characteristics	Adjusted IRR[a]	95% CI
Sex		
Female	1.9	1.8–2.0
Male	Reference	
Race and ethnicity		
White, non-Hispanic	Reference	
Black, non-Hispanic	0.9	0.8–0.9
Hispanic	0.9	0.9–1.0
Other	1	0.9–1.0
Age, y		
<20	1.3	1.2–1.5
20–24	0.9	0.9–1.0
25–29	0.9	0.8–1.0
30–34	Reference	
35–39	1.2	1.1–1.4
40–44	1.5	1.4–1.7
45+	2.5	2.2–2.8
Service branch		
Army	Reference	
Navy	1.0	0.9–1.1
Air Force	1.0	0.9–1.1
Marine Corps	1.3	1.2–1.4
Grade		
Enlisted	1.7	1.6–1.9
Officer	Reference	
Military occupation		
Combat-specific	Reference	
Communications/intelligence	0.9	0.8–1.0
Health care	1.1	0.9–1.2
Motor transport	1.0	0.9–1.2
Other	1.1	1.0–1.2
Pilot/air crew	0.8	0.7–1.0
Repair/engineering	0.9	0.8–1.0

Abbreviations: IRR, Incidence rate ratio; CI, confidence interval, y, years.
[a] Adjusted for sex, age, race and ethnicity, service, grade, occupation

Discussion

Between January 1, 2011 and December 31, 2022, female ACSMs experienced higher rates of sepsis compared to male ACSMs, consistent with previous studies of the U.S. military population.[8,9] This difference in rates was true for all demographic groups analyzed except the recruit population. After adjusting for other demographic and military-related factors, female ACSMs still demonstrated higher rates than male ACSMs. While the difference in rates between sexes persists after adjustment, it cannot be ruled out that changes in 2016 in the clinical definitions of sepsis under Sepsis-3 may have had a greater impact on the rates in women than men.

Rates of sepsis were highest among the youngest and oldest age groups in both sexes. The highest rates of sepsis in active component women were seen in those of Hispanic race or ethnicity, marines, enlisted members, and service members in combat-related occupations. The highest rates of sepsis among active component men were seen in those of White, non-Hispanic race or ethnicity, marines, enlisted members, and service members in motor transport and health care occupations.

This study attempted to better understand descriptive characteristics of female ACSMs hospitalized with sepsis. Among co-occurring diagnoses with sepsis, kidney infections such as pyelonephritis and UTIs were the most frequent co-occurring conditions in incident sepsis encounters among women. Hospitalization rates for genitourinary disorders have consistently been higher among females in the active component, with a risk rate difference of 3.6 per 1,000 p-yrs reported in 2019.[13] Trends in pyelonephritis and UTIs have not been assessed in the U.S. military population more recently than 2013[14] and may warrant further study. Genitourinary diseases were also the second most frequent reason for a health encounter in the week prior to sepsis diagnosis (n=372) (data not shown).

In 2 large multi-center cohorts (Kaiser Permanente Northern California and Ann Arbor Veterans Health Administration systems) that included over 46,000 patients, 45% of sepsis patients were seen by clinicians in the week preceding hospitalization, with sharp increases just prior to admission.[15] In another study of patients in a Michigan Medicine center hospitalized

TABLE 5. Frequency Distribution of Co-Occurring Infections with Sepsis, Hospitalized Cases, Female Active Component U.S. Service Members, 2011–2022

ICD-9 Code	Description	No.	% of Diagnoses
59080	Pyelonephritis, unspecified	98	2.9
486	Pneumonia, organism unspecified	74	2.2
59010	Acute pyelonephritis without lesion of renal medullary necrosis	56	1.7
5990	UTI, site not specified	51	1.5
99859	Other post-operative infection	32	0.9
4149	Other and unspecified *E. coli*	22	0.6
64783	Other specified infectious and parasitic diseases of mother, antepartum condition or complication	20	0.6
64663	Infections of genitourinary tract In pregnancy, antepartum condition or complication	19	0.6
845	Intestinal infection due to *C. diff.*	11	0.3
340	Streptococcal sore throat	10	0.3

ICD-10 Code	Description	No.	% of Diagnoses
N10	Acute pyelonephritis	182	2.3
N390	Urinary tract infection, site not specified	123	1.6
Z20822	Contact with and (suspected) exposure to COVID-19	103	1.3
B9620	Unspecified *E. coli* as cause of diseases classified elsewhere	98	1.2
J189	Pneumonia, unspecified organism	83	1.1
B9689	Other specified bacterial agents as cause of diseases classified elsewhere	39	0.5
U071	COVID-19	38	0.5
O753	Other infection during labor	27	0.3
O411230	Chorioamnionitis, third trimester, not applicable or unspecified	26	0.3
N739	Female pelvic inflammatory disease, unspecified	25	0.3

Abbreviations: ICD-9, International Classification of Diseases, 9th Revision; No., number; ICD-10, International Classification of Diseases, 10th Revision; UTI, urinary tract infection; *E. coli*, *Escherichia coli* ; *C. diff.*, *Clostridium difficile*.

for sepsis, 10% of these patients were seen in a clinic within 1 day of admission.[16] In the present study, 70% of individuals had a health care encounter in the week prior to sepsis hospitalization. Early interactions with medical providers can lead to improved outcomes from sepsis infections if symptoms are recognized early in treatment. Sepsis severity could not be assessed in this study, but if individuals who sought care prior to their sepsis diagnoses had lower morbidity and mortality related to sepsis, this could be evidence of good practices in sepsis care and management by providers. Encouraging care-seeking behavior for kidney and UTIs among women may reduce the number of infections that progress to sepsis by providing treatment earlier in the infection. Early identification of signs of sepsis and early interventions help mitigate debilitating long-term effects from infection.

Co-morbid conditions were evaluated as potential risk factors for women. Chronic medical conditions have been shown to be associated with increased risk of sepsis and severity of sepsis due to their effects on the immune system or inflammation.[10-12] In this study, women with prior history of chronic kidney disease and chronic liver disease had rates 13 times and 8 times, respectively, higher compared to women without prior history of those 2 co-morbidities. Previous population-based studies have shown strong associations between chronic kidney disease and risk of hospital admission and death from sepsis.[11] Liver dysfunction is not only a risk factor for sepsis but is also associated with multiple organ dysfunction and death due to sepsis.[17] Additional analyses of sepsis outcomes, such as severity of illness and mortality, among women service members with co-morbidities would be needed to better quantify risk.

This study is limited due to its use of administrative health records to identify sepsis hospitalizations. While administrative health records allow for large, population-based studies, it is possible that sepsis is under-coded in administrative health records.[18] ICD coding errors are also possible in administrative health records, which may result in misclassification. Due to limitations with casualty data in DMSS, cause of death cannot be determined, and sepsis-related mortality could not be examined fully. Of note, 47 (2.9%) female ACSMs died after sepsis hospitalization, compared to 268 (5.7%) male ACSMs (data not shown).

TABLE 6. Frequency Distribution of Other Co-Occurring Diagnoses with Sepsis of Non-Infectious Conditions, Hospitalized Cases, Female Active Component U.S. Service Members, 2011–2022

ICD-9 Code	Description	No.	% of Diagnoses
2768	Hypopotassemia	63	1.9
5849	Acute kidney failure, unspecified	57	1.7
2859	Anemia, unspecified	45	1.3
2761	Hypo-osmolality and / or hyponatremia	42	1.2
51881	Acute respiratory failure	39	1.2
27651	Dehydration	34	1.0
3051	Tobacco use disorder	34	1.0
5119	Unspecified pleural effusion	31	0.9
591	Hydronephrosis	28	0.8
2762	Acidosis	24	0.7

ICD-10 Code	Description	No.	% of Diagnoses
E876	Hypokalemia	174	2.2
E871	Hypo-osmolality and hyponatremia	130	1.7
N179	Acute kidney failure, unspecified	129	1.6
N12	Tubulo-interstitial nephritis, not specified as acute or chronic	115	1.5
D649	Anemia, unspecified	111	1.4
E872	Acidosis	89	1.1
E860	Dehydration	78	1.0
J9601	Acute respiratory failure with hypoxia	75	1.0
D509	Iron deficiency anemia, unspecified	57	0.7
K5900	Constipation, unspecified	51	0.6

Abbreviations: ICD-9, International Classification of Diseases, 9th Revision; No., number; ICD-10, International Classification of Diseases, 10th Revision.

TABLE 7. Numbers and Percentages of Incident Sepsis Cases with Co-Morbidity Encounter, 365 Days Preceding Incident Diagnosis, Female Active Component U.S. Service Members, 2011–2022

Prior Co-Morbidity	No.	%
Pregnancy-related encounter	519	30.8
Immune compromising conditions	517	30.7
Chronic kidney disease	325	19.3
Any cardiovascular disease	315	18.7
Hypertension	200	11.9
Obesity	275	16.3
Neoplasms	271	16.1
Metabolic disease	223	13.2
Any lung disease	223	13.2
Chronic lower respiratory disease	43	2.6
Substance use disorders	200	11.9
Chronic liver disease	85	5.1

Abbreviation: No., number

There were no deaths among women with pregnancy-related sepsis diagnoses during the surveillance period. Additional studies may be warranted to examine mortality outcomes related to sepsis in the military population. Treatment received, such as antibiotics or intravenous fluids, could not be quantified in this study.

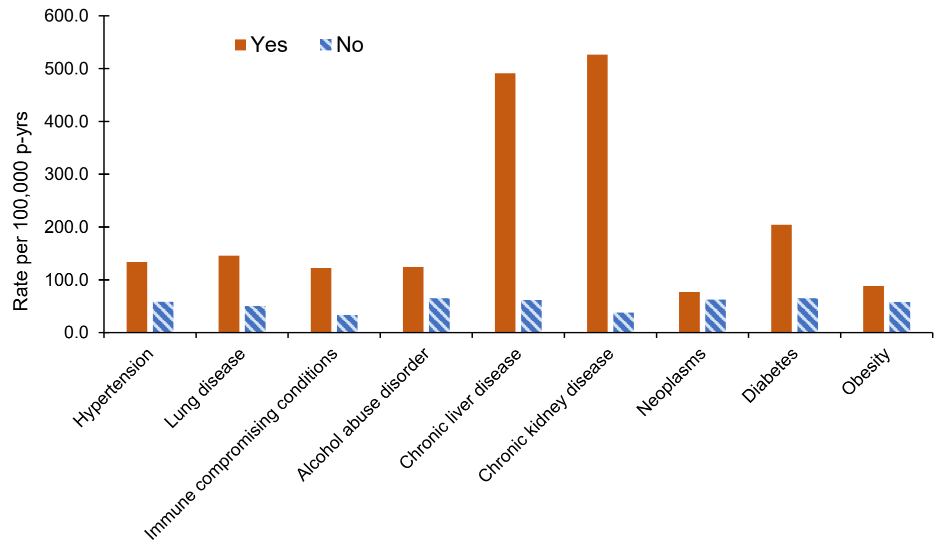
Further insights into the differing rates of sepsis among female and male ACSMs may be obtained through chart review, which could help address concerns about misclassification of cases due to possible differences in diagnosis patterns by physicians. The underlying cause of sepsis may also provide clues behind the disparities as well if there are differences by sex. For example, if female ACSMs are more likely to develop sepsis from genitourinary sources than respiratory infections, there may be opportunities to promote health education about genitourinary infections, and for increased vigilance in monitoring these types of infections. Ensuring proper treatment and adherence to treatment with antibiotics of UTIs, for instance, may also play a role in reducing the progression to sepsis. Inadequate treatment of UTIs can lead to recurrence and spread of infection.[19]

The impact of COVID-19 on the decline in sepsis hospitalizations in 2020 remains unexplained. Sepsis rates in both men and women were higher in 2021 and 2022 compared to 2020, suggesting that some aspect of the early pandemic affected sepsis rates. It cannot be determined from this study whether that decline was due to changes in health care seeking-behavior or preventive measures implemented during the pandemic that reduced the prevalence of other infections. It has been noted that severe COVID-19 infections causing organ dysfunction may not have been coded as sepsis,[20] which could explain the 2020 decline.

Sepsis has been identified as a key area of focus for the Defense Health Agency (DHA)'s Critical Care and Trauma Clinical Community, which created DHA's Sepsis Working Group in 2021.[21] The Sepsis Working Group issued a memorandum in 2025 that established a sepsis strategy in military hospitals and clinics that includes multi-disciplinary teams and a process for monitoring facility performance on sepsis-related quality measures. As efforts are made within the Military Health System to evaluate sepsis treatment and prevention strategies, this study demonstrates the importance of stratifying by sex in the study of sepsis in the military population.

Treatment and intervention strategies to prevent sepsis infections may differ by sex. Care-seeking behavior has also been shown to differ between male and female service members: Women tend to seek care at higher rates than men,[22] which may have implications for differences in sepsis severity and mortality outcomes by sex, which could not be assessed in this study. Future work on sepsis in the U.S. military should include measures of severity including sepsis-related mortality and disease severity.

FIGURE 2. Incidence Rates of Sepsis by Co-Morbidity History, Female Active Component U.S. Service Members, 2011–2022



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Disclaimer

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References

1. Rhee C, Dantes R, Epstein L, et al. CDC Prevention Epicenter Program. Incidence and trends of sepsis in US hospitals using clinical vs claims data, 2009-2014. *JAMA*. 2017;318(13):1241-1249. doi:10.1001/jama.2017.13836
2. Liu V, Escobar GJ, Greene JD, et al. Hospital deaths in patients with sepsis from 2 independent cohorts. *JAMA*. 2014;312(1):90-92. doi:10.1001/jama.2014.5804
3. Paoli CJ, Reynolds MA, Sinha M, Gitlin M, Crouser E. Epidemiology and costs of sepsis in the United States-an analysis based on timing of diagnosis and severity level. *Crit Care Med*. 2018;46(12):1889-1897. doi:10.1097/ccm.0000000000003342
4. Martin GS, Mannino DM, Eaton S, Moss M. The epidemiology of sepsis in the United States from 1979 through 2000. *NEJM*. 2003;348(16):1546-1554. doi:10.1056/nejmoa022139
5. Owens P, Miller M, Barrett M, Hensche M, Healthcare Cost and Utilization Project. Overview of Outcomes of Sepsis-Related Inpatient Stays, 2016–2021. Statistical Brief 306. Agency for Healthcare Research and Quality, U.S. Dept. of Health and Human Services. 2024. Accessed Apr. 29, 2025. https://hcup-us.ahrq.gov/reports/statbriefs/sb306-overview-sepsis-2016-2021.pdf
6. McDermott KW, Roemer M, Healthcare Cost and Utilization Project. Most Frequent Principal Diagnoses for Inpatient Stays in U.S. Hospitals, 2018. Statistical Brief 277. Agency for Healthcare Research and Quality, U.S. Dept. of Health and Human Services. 2006. Accessed Apr. 29, 2025. https://hcup-us.ahrq.gov/reports/statbriefs/sb277-Top-Reasons-Hospital-Stays-2018.pdf
7. Afshar M, Arain E, Ye C, et al. Patient outcomes and cost-effectiveness of a sepsis care quality improvement program in a health system. *Crit Care Med*. 2019;47:1371-1379. doi.org/10.1097/ccm.0000000000003919
8. Armed Forces Health Surveillance Center. Septicemia diagnosed during hospitalizations, active component service members, U.S. Armed Forces, 2000-2012. *MSMR*. 2013;20(8):10-16. Accessed Apr. 29, 2025. https://www.health.mil/reference-center/reports/2013/01/01/medical-surveillance-monthly-report-volume-20-number-8
9. Snitchler CL, Patel DM, Stahlman SL, et al. Sepsis hospitalizations among active component service members, U.S. Armed Forces, 2011-2020. *MSMR*. 2021;28(11):2-8. Accessed Apr. 29, 2025. https://www.health.mil/news/articles/2021/11/01/sepsis-hosp-msmr
10. Fay K, Sapiano MRP, Gokhale R, et al. Assess-

ment of health care exposures and outcomes in adult patients with sepsis and septic shock. *JAMA Netw Open*. 2020;3(7):e206004. doi:10.1001/jamanetworkopen.2020.6004
11. Liyanarachi KV, Mohus RM, Rogne T, et al. Chronic kidney disease and risk of bloodstream infections and sepsis: a 17-year follow-up of the population-based Trøndelag Health Study in Norway. *Infection*. 2024;52(5):1983-1993. doi:10.1007/s15010-024-02265-2
12. Wang HE, Shapiro NI, Griffin R, et al. Chronic medical conditions and risk of sepsis. *PLoS One*. 2012;7(10):e48307. doi:10.1371/journal.pone.0048307
13. Armed Forces Health Surveillance Branch. Hospitalizations, active component, U.S. Armed Forces, 2019. *MSMR*. 2020;27(5):10-17. Accessed Apr. 29, 2025. https://www.health.mil/news/articles/2020/05/01/hospitalizations-active-component-msmr-2020
14. Armed Forces Health Surveillance Branch. Urinary tract infections, active component, U.S. Armed Forces, 2000-2013. *MSMR*. 2014;21(2):7-12. Accessed Apr. 29, 2025. https://www.health.mil/reference-center/reports/2014/01/01/medical-surveillance-monthly-report-volume-21-number-2
15. Liu VX, Escobar GJ, Chaudhary R, Prescott HC. Healthcare utilization and infection in the week prior to sepsis hospitalization. *Crit Care Med*. 2018;46(4):513-516. doi:10.1097/ccm.0000000000002960
16. Miller HC, Liu VX, Prescott HC. The characteristics and outcomes of clinic visits immediately preceding sepsis hospitalization. *Am J Crit Care*. 2021;30(2): 135-139. doi:10.4037/ajcc2021456
17. Yan J, Li S, Li S. The role of the liver in sepsis. *Int Rev Immunol*. 2014;33(6):498-510. doi:10.3109/08830185.2014.889129
18. Jolley RJ, Sawka KJ, Yergens DW, et al. Validity of administrative data in recording sepsis: a systematic review. *Crit Care*. 2015;19(1):139. doi:10.1186/s13054-015-0847-3
19. Sabih A, Leslie SW. Complicated urinary tract infections. *StatPearls*. Updated Dec. 7, 2024. Accessed Apr. 29, 2025. https://www.ncbi.nlm.nih.gov/books/nbk436013
20. Shappell C, Rhee C, Klompas M. Update on sepsis epidemiology in the era of COVID-19. *Semin Respir Crit Care Med*. 2023;44(1):173-184. doi:10.1055/s-0042-1759880
21. U.S. Government Accountability Office. Defense Health Care: Information on Sepsis Incidence and Management. GAO-25-107357. 2025. Accessed Apr. 24, 2025. https://www.gao.gov/assets/gao-25-107357.pdf
22. Armed Forces Health Surveillance Division. Absolute and relative morbidity burdens attributable to various illnesses and injuries among active component members of the U.S. Armed Forces, 2023. *MSMR*. 2024;31(6):2-10. Accessed Apr. 29, 2025. https://www.health.mil/news/articles/2024/06/01/msmr-health-care-burden-active-component

Trends in Cervical Cancer Screening Modality in the Active Component U.S. Military, 2013–2023

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Cervical cancer screening recommendations have evolved in the past 20 years. Several recent studies have reported on practice pattern changes in the U.S. in response to these guideline changes, but practice patterns have not yet been evaluated in the Military Health System (MHS). Data for active component service women were queried from the Defense Medical Surveillance System for relevant inpatient and outpatient encounter codes within the MHS between January 1, 2013 and December 31, 2023 to identify instances of cervical cancer screening and classify each by modality: cytology alone, HPV alone, and co-testing. Trends in the use of each were evaluated within age categories: younger than age 21 years, ages 21–29 years, ages 30–64 years. A total of 378,952 screening events were captured from 2013 through 2023. MHS practice patterns demonstrated a response to national guideline changes, including increased co-testing and evidence of increasing primary HPV screening among women aged 30–64 years. Cervical cancer screening in women younger than age 21 years markedly decreased following recommendations against screening in this age group. The overall trends in the MHS are similar to those reported in the U.S. general population.

What are the new findings?

Trends in use of each screening modality—cytology, primary HPV, and co-testing—for active component service women are shifting in response to changing national guidelines. There is emerging evidence of increasing primary HPV screening in women ages 30–64 years, especially after 2021.

What is the impact on readiness and force health protection?

Newer cervical cancer screening modalities that incorporate HPV testing, including the possibility of patient self-collected samples, allow for prolonged screening intervals and use in challenging health care settings. Full implementation will likely require significant investment in patient and provider education as well as laboratory processes, with several key questions that remain unanswered.

The U.S. has made noteworthy gains in reducing the incidence of cervical cancer, from 9.7 per 100,000 (age-adjusted) in 1999 to 7.4 per 100,000 in 2013.[1] New screening technology, namely human papillomavirus (HPV) testing, increased understanding of the pathophysiology of HPV-driven carcinoma, and the introduction of primary prevention through HPV vaccines, continue to drive changes in cervical cancer screening methods and recommendations.[2] National 2012 guidelines from both the U.S. Preventive Services Task Force (USPSTF) and the American Cancer Society (ACS) included testing for HPV concurrently with cytology ('co-test') for women aged 30-65 years, which allowed safe prolongation of screening intervals from 3 years to 5 years.[3,4] Primary HPV screening, in which high-risk HPV (hrHPV) is tested first and cytology is performed as a reflex only if HPV is positive, was introduced for 30-65-year olds in 2018 by the USPSTF and expanded to 25-65-year olds by the ACS in 2020.[2,5] ACS guidelines notably recommended primary HPV as the preferred screening modality, with cytology and co-test acceptable if primary HPV is not available, a stance that has since been put forward for comment by the USPSTF in their draft 2024 cervical cancer screening guidelines.[2,6] The first patient self-collected vaginal swabs for primary HPV screening were also approved in 2024 by the U.S. Food and Drug Administration, and large multi-site trials are currently underway to evaluate these swabs outside of clinical settings as true 'at home' screening tests for cervical cancer.[7,8]

Implementation of new national cervical cancer screening guidelines is a massive undertaking, particularly when those guidelines require new testing modalities. Laboratories often must acquire and validate new equipment, workflows, and testing menus.[2,9-11] Providers must understand, agree with, and offer the new screening modalities to their patients, who then must accept their providers' recommendations.[9,10] This large expenditure of both human and financial resources may not be immediately feasible.[2] Several studies have examined how quickly the updated screening guidelines are implemented, by analyzing trends in use of cervical cancer screening modalities over time, including Qin et al.'s 2021 study of nearly 10 million commercially insured women from 2013 through 2019.[10,11] Qin et al. found that trends in co-test and cytology screening of 30-65-year olds aligned well with new guidelines but observed minimal uptake of primary HPV screening and some discrepancies in screening modalities of 21-29-year olds.[11]

To our knowledge, these trends have not yet been investigated in the Military Health System (MHS). The MHS experiences the same resource management challenges as the rest of U.S. health care. It must also overcome unique challenges posed by its patient population, some of whom undertake long assignments to remote and austere locations without infrastructure or medical providers necessary to support cytology screenings.[12] Applying the same methods of Qin et al. to the MHS, this report aims to reveal trends in cervical cancer screening modalities (primary HPV vs. cytology alone vs. co-test) in active component service members (ACSMs) as a response to changing national guidelines and compare trends to those of the U.S. population previously reported.

Methods

The Defense Medical Surveillance System (DMSS) was queried for inpatient and outpatient encounters within the MHS between January 1, 2013 and December 31, 2023 that included International Classification of Diseases (ICD), 10th and 9th revisions, Current Procedural Terminology (CPT), and Healthcare Common Procedure Coding System (HCPCS) codes listed in Appendix 2 of Qin et al. Inpatient encounters were included in the query to apply surveillance exclusion criteria (see below), in addition to avoiding unwitting omission of the rare inpatient screening events that met surveillance inclusion criteria. The surveillance period was chosen to capture changes following the 2012 addition of co-testing to national guidelines and include the most current available data.

The surveillance population included all female ACSMs in the Air Force (including Space Force after 2022), Army, Marine Corps, and Navy younger than 65 years, on continuous active component status for the entirety of the calendar year, with routine cervical cancer screening. To identify tests performed for routine cervical cancer screening, as opposed to diagnosis or follow-up to treatment, exclusions were made using ICD-10 / ICD-9 / CPT / HCPCS codes, mirroring those of Qin et al., with the sole addition of CPT code 57530 (trachelectomy). Service women were excluded from analysis if they had documented history of cervical dysplasia or procedure for diagnosis or treatment of dysplasia, such as loop electrosurgical excision and cervical conization, or congenital or acquired absence of uterine cervix.

To maintain comparability with reported U.S. national trends, the modality definitions of Qin et al. were also utilized. Cervical cancer screening was classified as 'co-test' if DMSS documentation included both cervical cytology within the calendar year and hrHPV testing within 3 days preceding or 30 days after cytology. Screening was classified as 'cytology alone' if cervical cytology was performed within the calendar year but no hrHPV was documented within the guidelines of 'co-testing'. Finally, screening was classified as 'HPV alone' if at least 1 hrHPV test was documented in the calendar year but no cervical cytology was performed. The screening test categories were mutually exclusive, with individuals counted only once per year, with prioritization for co-testing, followed by cytology alone and HPV alone. Individuals were further classified by demographics and age as recorded on the date of cervical cancer screening. Descriptive statistics were used to evaluate trends in use of each cervical screening modality over the duration of the surveillance period by age category, reported as a percentage of women within the surveillance population screened by each modality each year. Overall screening compliance (i.e., percentage of women 'up to date' at any given time) was not considered as an outcome.

Results

After exclusions, the surveillance population averaged 147,476 women in service each year, ranging from 123,828 in 2013 to 168,444 in 2021 **(Tables 1 and 2)**.

TABLE 1. Study Population Demographics, Annual Average, 2013–2023

	Average	
	No.	%
Age, y		
<21	15,094	10.2
21–24	46,487	31.5
25–29	41,308	28.0
30–39	34,740	23.6
40–49	8,584	5.8
50–64	1,264	0.9
Service branch		
Army	48,563	32.9
Navy	44,949	30.5
Air Force, Space Force	43,038	29.2
Marine Corps	10,927	7.4
Race and ethnicity		
White, non-Hispanic	62,909	42.7
Black, non-Hispanic	35,587	24.1
Hispanic	27,779	18.8
Other	18,497	12.5
Unknown	2,705	1.8
Rank, grade		
Junior enlisted (E1–E4)	67,480	45.8
Senior enlisted (E5–E9)	51,289	34.8
Warrant officer (W)	862	0.6
Junior officer (O1–O3)	19,564	13.3
Senior officer (O4–O10)	8,281	5.6

Abbreviations: y, years; E, enlisted; W, warrant officer; O, officer.

TABLE 2. Testing Modality, Year of Surveillance and Age Group, Absolute Number and Relative Percent, 2013–2023

Year		2013		2014		2015		2016		2017		2018	
Population total		123,828		127,446		130,187		133,938		137,796		147,760	
Age group, y	Screening modality	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<21	Total, age group	12,130		13,080		12,865		13,858		14,965		16,882	
	Co-test	6	0.1	4	0.0	3	0.0	6	0.0	9	0.1	7	0.0
	Cyto	371	3.1	307	2.4	214	1.7	210	1.5	201	1.3	206	1.2
	HPV	15	0.1	9	0.1	7	0.1	20	0.1	32	0.2	24	0.1
21–29	Total, age group	70,384		74,123		77,701		80,714		83,350		89,381	
	Co-test	115	0.2	112	0.2	216	0.3	468	0.6	692	0.8	1,056	1.2
	Cyto	19,659	27.9	20,268	27.3	21,553	27.7	23,280	28.8	23,458	28.1	24,333	27.2
	HPV	74	0.1	52	0.1	96	0.1	94	0.1	158	0.2	123	0.1
30–64	Total, age group	41,314		40,243		39,621		39,366		39,481		41,497	
	Co-test	808	2.0	1,015	2.5	1,195	3.0	1,628	4.1	2,014	5.1	2,364	5.7
	Cyto	9,542	23.1	9,417	23.4	8,725	22.0	7,934	20.2	7,007	17.7	6,685	16.1
	HPV	114	0.3	118	0.3	140	0.4	154	0.4	190	0.5	210	0.5

Year		2019		2020		2021		2022		2023	
Population total		155,605		164,708		168,444		166,864		165,661	
Age group, y	Screening modality	No.	%	No.	%	No.	%	No.	%	No.	%
<21	Total, age group	17,782		18,550		17,245		14,726		13,946	
	Co-test	9	0.1	4	0.0	10	0.1	4	0.0	7	0.1
	Cyto	160	0.9	150	0.8	164	1.0	120	0.8	73	0.5
	HPV	10	0.1	7	0.0	5	0.0	9	0.1	7	0.1
21–29	Total, age group	93,884		98,650		101,170		99,844		96,543	
	Co-test	1,283	1.4	1,437	1.5	1,067	1.1	1,221	1.2	1,458	1.5
	Cyto	26,399	28.1	24,195	24.5	26,811	26.5	23,042	23.1	20,489	21.2
	HPV	161	0.2	192	0.2	227	0.2	339	0.3	464	0.5
30–64	Total, age group	43,939		47,508		50,029		52,294		55,172	
	Co-test	2,920	6.6	2,708	5.7	3,241	6.5	3,460	6.6	3,999	7.2
	Cyto	6,988	15.9	6,459	13.6	7,581	15.2	6,525	12.5	5,762	10.4
	HPV	281	0.6	351	0.7	439	0.9	784	1.5	1,212	2.2

Abbreviations: y, years; Cyto, cytology; HPV, human papillomavirus.

Distributions of age, race and ethnicity, branch of military service, and military rank within the surveillance population were consistent throughout the surveillance period. The largest proportions of the population were 21-29 years of age (59.5%), non-Hispanic White (42.7%), and enlisted (45.8%). Service distribution was nearly equal among the Army, Air Force, and Navy, with a much smaller proportion of Marine Corps members.

A total of 378,952 cervical cancer screenings were captured during the surveillance period, classified according to the methods described. An average of 34,450 screenings occurred each calendar year, ranging from 30,704 in 2013 to 39,545 in 2021 **(Table 2)**. Cervical cancer screening in individuals younger than age 21 years declined steadily during the surveillance period, from 3.2% in 2013 to 0.6% in 2023 **(Figure 1)**. The majority (83.1–95.9%) of screenings in the younger than age 21 group were classified as cytology. Among 21-29 year olds, use of cytology alone remained steady throughout most of the surveillance period (27.9% in 2013, 28.1% in 2019) but decreased after 2019, to 21.2% in 2023 **(Figure 2)**. Co-test and HPV alone in the 21-29-year age group increased during the surveillance period, but use of both remained low: In 2019, 1.5% of women ages 21-29 were screened by co-test, 0.5% were screened by HPV alone **(Figure 2)**. Similar, but more pronounced, trends were observed in the 30-64-year age group **(Figure 3)**. Use of cytology alone decreased by more than 50% (23.1% in 2013 to 10.4% in 2023) among 30-64 year olds, while co-test more than tripled over the surveillance period (2.0% to 7.2%). HPV alone also increased in this age group, with the most marked increase occurring after 2021 (0.3% in 2013, 0.9% in 2021, 2.2% in 2023) **(Table 2, Figure 3)**.

FIGURE 1. Percentage of Women Younger than Age 21 Years with Screening for Cervical Cancer, Any Modality, 2013–2023

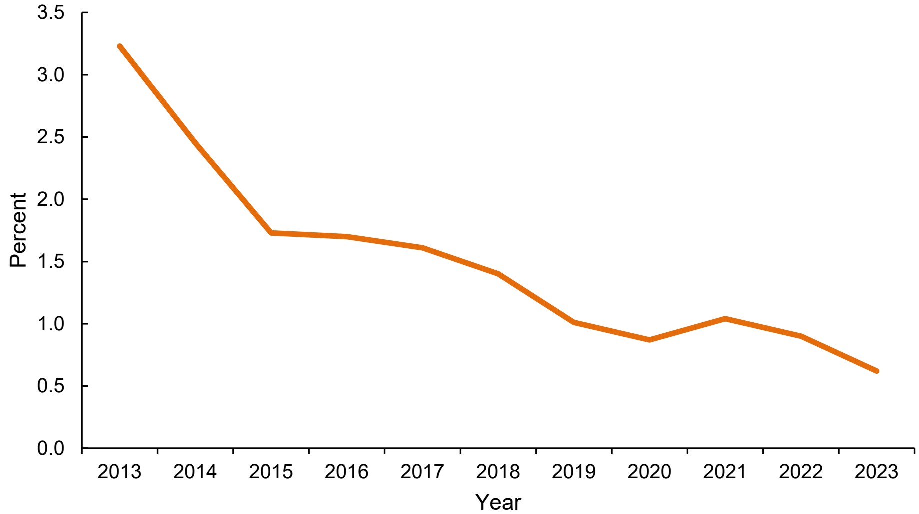
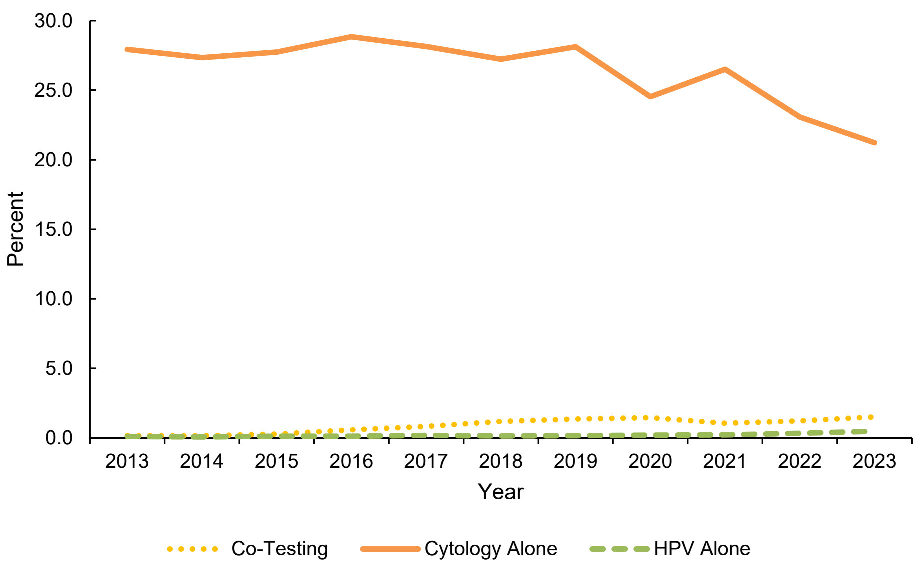


FIGURE 2. Percentage Use of Each Screening Modality for Cervical Cancer, Women Ages 21-29 Years, 2013–2023



Abbreviation: HPV, human papillomavirus.

Discussion

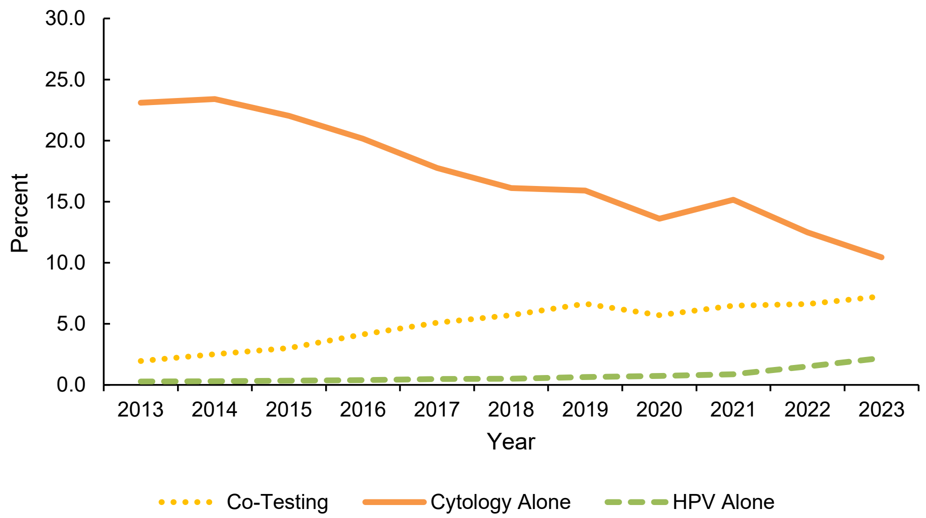
Understanding how practice patterns within the MHS change in response to guideline shifts is important because it reflects a myriad of factors influencing those changes such as provider education, patient and provider preference, and testing infrastructure, which may then inform how well the MHS is positioned to respond to future changes in screening guidelines.

These results show that trends in the MHS are overall as expected in response to national guideline changes, and similar to trends in the U.S. reported by Qin et al. in 2021. Cervical cancer screening guidelines have recommended against screening women younger than age 21 years since 2012.[4] Screening in this age group declined precipitously in the MHS, to 1.0% in 2019, well below the 9.0% reported in 2019 among women ages 18-20 years in the U.S. population.[11] Similarly, screening modalities in women ages 30-64 years shifted in both the MHS and U.S. populations in response to the 2012 guideline updates, increasingly favoring co-testing as opposed to cytology alone. Interestingly, while use of cytology alone in 30-64 year old ACSMs declined throughout the surveillance period, it remained the more common modality over co-testing. In contrast, Qin et al. reported that co-testing overtook cytology alone between 2014 and 2015.[11] Whether this represents a difference in testing characteristics, including rates of squamous atypia or length of time between reporting of cytology and hrHPV results, or a true preference for cytology and reflex HPV over co-testing within the MHS, is unclear.

Qin et al., among others, have reported a decline in use of cytology for cervical cancer screening in individuals 21-29 years of age. Potential explanations have included genuinely decreased screening among recipients of the HPV vaccine who are now entering the screening pool, as well as an artificial decline in apparent use as a result of extended screening intervals from annually to every 3 years.[11] Among ACSMs, cervical cancer screening is required as part of individual medical readiness regardless of HPV vaccination status, making this an unlikely explanation for the decrease in cytology after 2020. The 2019 management guidelines of the American Society for Colposcopy and Cervical Pathology differ between patients younger than age 25 years and those aged 25-29 years with atypical squamous cells of undetermined significance (ASCUS) on cytology screening, with preference to HPV testing for further risk stratification in those aged 25-29 years.[13] Data on the results of cervical cancer screening were not included in this analysis, and it is conceivable that a rise in ASCUS results among those 25-29 years of age caused an artificial decline in cytology percentages as ASCUS cytology results triggered reflex HPV and subsequent misclassification as 'co-test'.

This study has several limitations. As mentioned, the definitions of screening modality (co-test vs. cytology alone vs. HPV) were chosen to correlate with Qin et al., for comparison to national trends. There is likely misclassification among modalities, however, including abnormal cytology

FIGURE 3. Percentage Use of Each Screening Modality for Cervical Cancer, Women Ages 30-64 Years, 2013–2023



Abbreviation: HPV, human papillomavirus.

with reflex HPV misclassified as co-test, positive primary HPV with reflex cytology misclassified as co-test or cytology (depending on timing of cytology result), and co-test misclassified as cytology (if HPV is coded significantly before cytology result). Pathology data were not available at the time of this analysis, which precluded use of laboratory-generated data to validate or quantify degree of possible misclassification by medical encounter data. The surveillance period of this study overlaps with the COVID-19 pandemic, which may have affected screening rates during the pandemic years but would have unlikely influenced testing modality. Finally, the analysis was intended only for women undergoing routine screening, but women with a history of dysplasia may have been mistakenly included if that history was not documented within the electronic health record.

Future work should aim to confirm the trends reported here with validation by laboratory data. The performance characteristics of primary HPV screening in the ACSM population should be evaluated, including its cost effectiveness and negative predictive value in a population with a potentially higher rate of HPV infection.[12] Paradigm shifts in large-scale screening programs are gradual, and continued surveillance should be considered for further evaluation and guidance of the process as practice patterns and guidelines continue to evolve.

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References

1. U.S. Cancer Statistics Data Visualizations Tool. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Cancer Institute. https://www.cdc.gov/cancer/dataviz
2. Fontham ETH, Wolf AMD, Church TR, et al. Cervical cancer screening for individuals at average risk: 2020 guideline update from the American Cancer Society. *CA Cancer J Clin*. Sep 2020;70(5):321-346. doi:10.3322/caac.21628
3. Saslow D, Solomon D, Lawson HW, et al. American Cancer Society, American Society for Colposcopy and Cervical Pathology, and American Society for Clinical Pathology screening guidelines for the prevention and early detection of cervical cancer. *CA Cancer J Clin*. 2012;62(3):147-72. doi:10.3322/caac.21139
4. Moyer VA, U.S. Preventive Services Task Force. Screening for cervical cancer: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2012;156(12):880-891, w312. doi:10.7326/0003-4819-156-12-201206190-00424
5. U.S. Preventive Services Task Force, Curry SJ, Krist AH, et al. Screening for cervical cancer: US Preventive Services Task Force recommendation statement. *JAMA*. 2018;320(7):674-686. doi:10.1001/jama.2018.10897
6. U.S. Preventive Services Task Force. Draft Recommendation: Cervical Cancer: Screening. https://www.uspreventiveservicestaskforce.org/uspstf/draft-recommendation/cervical-cancer-screening-adults-adolescents
7. FDA Roundup May 17, 2024. 2024. https://www.fda.gov/news-events/press-announcements/fda-roundup-may-17-2024
8. NCI Launches Network to Study Self-Collection for HPV Testing to Prevent Cervical Cancer. Jan. 25, 2024. https://prevention.cancer.gov/news-and-events/blog/nci-launches-network-study-self-collection-hpv-testing-prevent-cervical-cancer
9. Marcus JZ, Cason P, Downs LS, Einstein MH, Flowers L. The ASCCP Cervical Cancer Screening Task Force endorsement and opinion on the American Cancer Society updated cervical cancer screening guidelines. *J Low Genit Tract Dis*. 2021;25(3):187-191. doi:10.1097/lgt.0000000000000614
10. Ehman KM, Jenkins GD, Grimm JA, et al. Primary human papillomavirus test uptake and cervical cancer screening trends in the midwest, United States. *J Prim Care Community Health*. 2024;15:21501319241251934. doi:10.1177/21501319241251934
11. Qin J, Shahangian S, Saraiya M, et al. Trends in the use of cervical cancer screening tests in a large medical claims database, United States, 2013-2019. *Gynecol Oncol*. 2021;163(2):378-384. doi:10.1016/j.ygyno.2021.08.023
12. Seay J, Matsuno R, Buechel J, Tannenbaum K, Wells N. HPV-related cancers: a growing threat to U.S. military health and readiness. *Mil Med*. 2022;187(5-6):149-154. doi:10.1093/milmed/usab443
13. Perkins RB, Guido RS, Castle PE, et al. 2019 ASCCP risk-based management consensus guidelines for abnormal cervical cancer screening tests and cancer precursors. *J Low Genit Tract Dis*. 2020;24(2):102-131. doi:10.1097/lgt.0000000000000525

Update

Infertility Among Active Component Service Women, U.S. Armed Forces, 2019–2023

This report presents the incidence and prevalence of diagnosed female infertility among active component U.S. service women. During 2019–2023, 8,154 active component women of childbearing potential were diagnosed with incident infertility, resulting in an overall incidence of 77.5 cases per 10,000 person-years (p-yrs). Incidence rates were highest among women in their 30s, non-Hispanic Black individuals, those in health care and pilot or air crew occupations, Army soldiers, and those who were married. From 2019 through 2023, the incidence rate of diagnosed female infertility decreased from 89.2 per 10,000 p-yrs to 69.5 per 10,000 p-yrs despite a concurrent increase in the rate of fertility testing. During the surveillance period, the average annual prevalence of diagnosed female infertility was 1.6%. Of the service women diagnosed with infertility for the first time during the surveillance period, 2,005 (24.6%) delivered live births within 2 years following their incident infertility diagnoses.

What are the new findings?

The incidence rate of diagnosed infertility among service women decreased by 22.1% during the surveillance period, coincident with an increase of 74.0% in the rate of fertility testing from 2019 through 2023.

What is the impact on readiness and force health protection?

The incidence rates of diagnosed infertility in the U.S. military reveal that there are subgroups of active component service members at higher risk. Further assessment of potential risk factors, such as health behaviors, physical as well as mental health conditions, along with occupational exposures, may be warranted. A rapid increase in annual fertility testing rates among active component service women also indicates a need for more comprehensive guidance to infertility service access and use.

For the purposes of public health data collection, the definition of infertility refers to the inability of couples to conceive a pregnancy after 1 year or more of unprotected sex.[1] Female infertility is commonly classified into several major etiological categories, including infertility associated with ovulatory dysfunction, tubal disease, uterine and cervical factors, and other or unspecified causes.[2] Ovulation disorders are estimated to account for one-third of infertility cases, most often caused by polycystic ovary syndrome (PCOS).[3,4] Other causes of infertility include hypothalamic-pituitary hormone imbalances, endometriosis, and primary ovarian insufficiency (i.e., premature menopause).[5]

Advanced maternal age may also contribute to infertility, due to declining egg quality and diminished ovarian reserves.[6] Approximately 20% of women in the U.S. now have their first child after age 35 years.[5] Data reported by the Department of Defense Birth and Infant Health Registry also indicate a trend toward delayed childbearing in military women. From 2003 to 2014, the percentages of active component women who delivered live births sharply increased among those aged 30-34 (12.5–21.7%) and 35-39 (5.4–8.5%) years.[7]

Many modifiable lifestyle factors, such as age when starting a family, nutrition, weight, and psychological stress, can have substantial effects on fertility.[8] Approximately half of military service women choose to postpone pregnancy or starting a family while in service.[9] Occupational and environmental hazards such as radiation, repetitive motions, and injury require more research within military populations for associations with infertility.[10] The increasing numbers and durations of wartime deployments have been associated with increasing rates of menstrual disorders and infertility in active component service women.[11]

MSMR has reported the incidence and prevalence of diagnosed female infertility among active component service women in the U.S. Armed Forces since 2000.[12] Annual rates of fertility testing have also been assessed since 2019.[13] From 2013 to 2018, the incidence of diagnosed female infertility decreased from 85.1 per 10,000 p-yrs to 63.6 per 10,000 p-yrs, despite a concurrent increase in the rate of fertility testing.[13]

This report continues prior *MSMR* surveillance reporting to provide more recent estimates of the incidence and prevalence of infertility diagnoses, descriptions of specific types of diagnosed infertility, and measures of concurrent rates of fertility testing services among active component service women in the U.S. Armed Forces from 2019 through 2023.

Methods

The surveillance population consisted of all active component service women of childbearing potential who served in the Army, Navy, Air Force, or Marine Corps at any time from January 1, 2019 through December 31, 2023. Women of childbearing potential were defined as women ages 17-49 years without any history of hysterectomy or permanent sterilization. History of hysterectomy or permanent sterilization was defined by a qualifying diagnostic or procedural code for hysterectomy or permanent sterilization in any position of an inpatient or outpatient record. These diagnostic and procedural codes have been previously described.[14,15] All data used for these analyses were abstracted from records routinely maintained in the Defense Medical Surveillance System (DMSS) for health surveillance purposes.

An incident case of infertility was defined by at least 2 outpatient medical encounters with an infertility diagnosis (International Classification of Diseases, 9th Revision [ICD-9] code 628.*, International Classification of Diseases, 10th Revision [ICD-10] code N97.*) in the first or second diagnostic position or by an inpatient encounter with an infertility diagnosis in the first diagnostic position. An individual could be counted as a case of infertility only once. The incident date was the date of the first qualifying medical encounter. The type of infertility—either anovulation, tubal origin, uterine origin, other, or unspecified—was assigned from the specific diagnostic codes of the inpatient or outpatient encounter record during military service; however, if an individual had multiple types of infertility, the specific type diagnosed in the earliest incident was utilized **(Table 1)**.

For incidence calculations, person-time denominators were censored at the time of the first hysterectomy or permanent sterilization diagnosis, or when the service member turned 50 years of age, or at the time of the first infertility diagnosis, whichever occurred first. The incidence rate was calculated per 10,000 person-years (p-yrs).

To be counted as a prevalent case of infertility, the woman of childbearing potential had to 1) be in active component military service during the calendar year of interest, 2) qualify as an incident case of infertility in the year of interest or any year prior (including before 2013), and 3) have an inpatient or outpatient encounter for any infertility type in any diagnostic position during the year of interest. The denominator for prevalence calculations was the total number of women of childbearing potential in active component service during that year. Prevalence rates were calculated per 10,000 persons.

The burden of medical encounters for infertility was analyzed by calculating the total number of inpatient and outpatient encounters with a primary diagnosis of infertility among all active component service women (including both prevalent and incident cases of infertility). The total numbers of individuals affected and the total number of hospital bed days for infertility were also calculated according to standard *MSMR* burden methodology.[16]

The rate of fertility testing among all active component women, not just women of childbearing potential, was also measured for the surveillance period. Fertility testing was defined by the presence of an inpatient or outpatient encounter with a diagnosis of fertility testing (ICD-9: V26.21; ICD-10: Z31.41) in any diagnostic position. One test per person per day was counted. The denominator was person-time for all female active component service members during the surveillance period.

Finally, incident infertility cases were followed for up to 2 years to measure subsequent live birth deliveries. Live birth deliveries were defined by having a hospitalization with a live birth delivery-related diagnosis code—ICD-9, V27* (excluding V271, V274, V277) and ICD-10, Z37* (excluding Z371, Z374, Z377)—in any diagnostic position.

Results

Incidence

During the surveillance period, 8,154 active component women of childbearing potential were diagnosed with infertility for the first time, corresponding to a crude overall incidence rate of 77.5 per 10,000 p-yrs **(Table 2)**. Infertility of 'unspecified' origin accounted for the most common diagnosis (29.0 per 10,000 p-yrs), followed by 'other specified' origin (26.2 per 10,000 p-yrs), and anovulation (13.7 per 10,000 p-yrs). Infertility of tubal origin (6.6 per 10,000 p-yrs) and uterine origin (2.0 per 10,000 p-yrs) represented less common diagnoses for active component women. While the annual incidence of diagnosed infertility (of any origin) decreased by 22.1% during the surveillance period, infertility of unspecified and uterine origin did not follow an overall decline;

TABLE 1. ICD-9/ICD-10 Codes for Female Infertility

ICD-9	ICD-10	Description
628.0	N97.0	Infertility associated with anovulation
628.2	N97.1	Infertility of tubal origin (block, occlusion, stenosis of fallopian tubes)
628.3	N97.2	Infertility of uterine origin (congenital anomaly of uterus, non-implantation)
628.1, 628.4, 628.8	N97.8	Infertility of other specified origin (pituitary-hypothalamic, cervical or vaginal, age-related, etc.)
628.9	N97.9	Infertility of unspecified origin

Abbreviations: ICD, International Classification of Diseases.

these 2 infertility types followed the general downward trend in 2019 and 2020, thereafter increasing through 2023 **(Figure 1)**.

Overall rates of incident infertility diagnoses increased with age, peaking for women ages 35-39 years (159.2 per 10,000 p-yrs) **(Table 2)**. While incident infertility diagnoses for women under age 40 years followed a general decline for the overall surveillance period, rates of incident infertility for those aged 40-44 years remained relatively stable. Among women ages 45-49 years, the incident infertility rate declined to 7.5 per 10,000 p-yrs in 2022, thereafter increasing to 18.4 per 10,000 p-yrs in 2024 **(Figure 2)**. For this oldest age group (40-49 years), infertility due to 'other specified' origin accounted for the highest rate of diagnosis (34.1 per 10,000 p-yrs), whereas 'other specified' and unspecified origins accounted for approximately equal rates (55.0 and 54.7 per 10,000 p-yrs, respectively) for women aged 30-39 years, and unspecified infertility accounted for the highest rate of diagnosis (20.1 per 10,000 p-yrs) in women 20-29 years of age **(Figure 3)**.

Overall incidence rates of infertility diagnoses of any type were highest among non-Hispanic Black service women (89.3 per 10,000 p-yrs) compared to women in other race and ethnicity groups **(Table 2)**; this finding is consistent for each type of infertility diagnosis, with the exception of anovulation **(Figure 4)**. Active component service women of other or unknown racial and ethnic groups accounted for the highest rates of infertility due to anovulation (16.9 per 10,000 p-yrs), followed by non-Hispanic White (14.2 per 10,000 p-yrs) and Hispanic (12.7 per 10,000 p-yrs) service women.

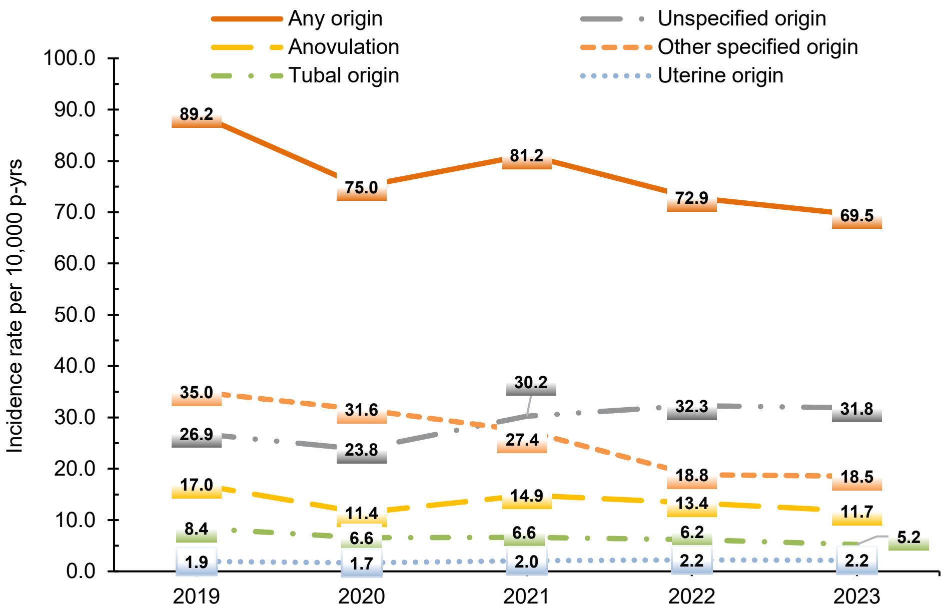
Overall rates of incident infertility diagnoses were highest among service women in the Army (92.0 per 10,000 p-yrs) and lowest in the Marine Corps (45.3 per 10,000 p-yrs), although it should be noted that these findings present rates that were unadjusted for age **(Table 2)**. Senior enlisted women had higher incidence rates than junior enlisted personnel, and senior officers had higher rates than junior officers. Compared to other occupations, service women in health care occupations had the highest incidence of diagnosed

TABLE 2. Incidence of Infertility by Type, Demographic and Military Characteristics, Active Component Service Women of Childbearing Potential, U.S. Armed Forces, 2019–2023

	No.	Rate [a]
Total	8,154	77.5
Type of infertility		
Anovulation	1,437	13.7
Tubal origin [b]	694	6.6
Uterine origin [c]	211	2.0
Other specified origin	2,761	26.2
Unspecified origin	3,051	29.0
Age, y		
<20	61	6.9
20–24	1,533	40.8
25–29	2,276	83.2
30–34	2,347	143.0
35–39	1,535	159.2
40–44	382	96.7
45–49	20	14.7
Race and ethnicity		
White, non-Hispanic	3,314	75.5
Black, non-Hispanic	2,162	89.3
Hispanic	1,499	68.0
Other/unknown	1,179	78.3
Service branch		
Army	2,959	92.0
Navy	2,365	75.1
Air Force	2,296	74.6
Marine Corps	354	45.3
Coast Guard	169	60.9
Space Force	11	68.5
Rank		
Junior enlisted (E1–E4)	2,492	50.1
Senior enlisted (E5–E9)	3,311	92.3
Junior officer (O1–O3, W01–W03)	1,554	106.4
Senior officer (O4–O10, W04–W05)	797	160.0
Military occupation		
Combat-specific [d]	200	60.5
Motor transport	221	62.1
Pilot/air crew	167	96.6
Repair/engineering	1,333	63.4
Communications/intelligence	2,645	81.2
Health care	2,016	113.4
Other/unknown	1,572	62.4
Marital status		
Married	5,973	136.0
Unmarried	1,456	28.2
Other	725	74.8

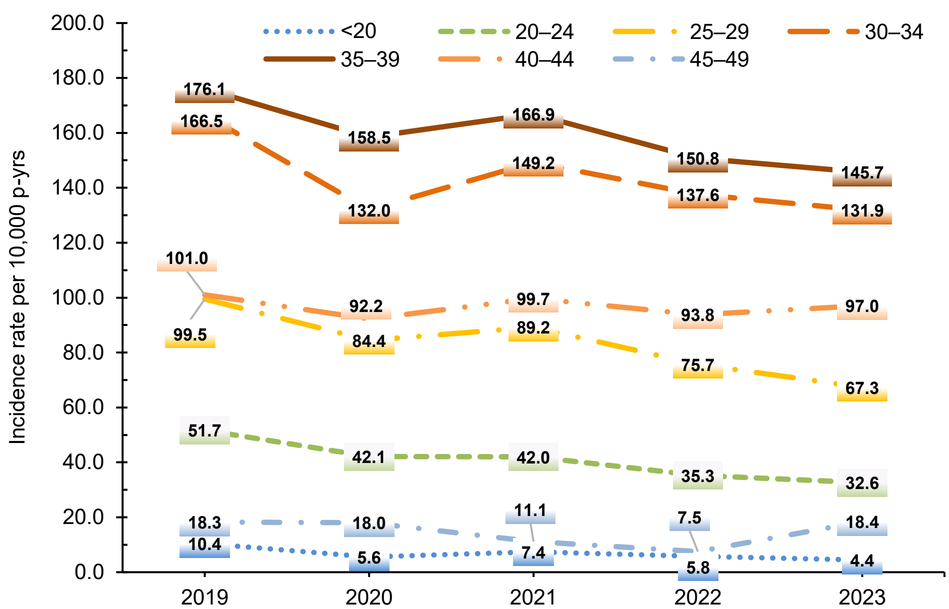
Abbreviations: No., number; y, years.
[a] Rates per 10,000 person-years.
[b] Block, occlusion, or stenosis of fallopian tubes.
[c] Structural abnormality of uterus or non-implantation; includes fibroids.
[d] Includes infantry/artillery/combat engineering/armor.

FIGURE 1. Annual Incidence Rates of Female Infertility Diagnoses, Active Component Service Women of Childbearing Potential, 2019–2023



Abbreviations: P-yrs, person-years.

FIGURE 2. Annual Incidence Rates of Female Infertility Diagnoses by Age Group, Active Component Service Women of Childbearing Potential, 2019–2023



Abbreviations: P-yrs, person-years.

infertility (113.4 per 10,000 p-yrs), and were followed by pilots and air crew (96.6 per 10,000 p-yrs). The rate of incident infertility diagnoses among married service women was nearly 5 times the rate of unmarried service women.

Prevalence

In 2023, the prevalence of diagnosed female infertility of any type was 152.7 per 10,000 persons, translating to 1.5% of the female active component population that year. This figure decreased by approximately 11% during the surveillance period, down from 171.5 per 10,000 persons (or 1.7%) in 2019. Two types of infertility increased during the surveillance period: Prevalence of infertility of uterine origin increased by 30.0% (from 4.0 to 5.2 per 10,000 persons) and infertility of unspecified origin rose by 26.8% (from 37.8 to 47.9 per 10,000 persons) from 2019 through 2023 **(Figure 5)**.

Burden

There were 66,918 total medical encounters and 31 hospital bed days recorded for female infertility during the surveillance period (data not shown). Annual numbers of medical encounters during which infertility was reported as a primary (first-listed) diagnoses and numbers of individuals affected by infertility remained relatively stable during the period, declining from 13,935 medical encounters in 2019 to 12,925 medical encounters in 2023 **(Figure 6)**.

Fertility testing

During the surveillance period, annual rates for female fertility testing increased 74.0%, from 87.2 per 10,000 p-yrs in 2019 to 151.7 per 10,000 p-yrs in 2023 **(Figure 7)**.

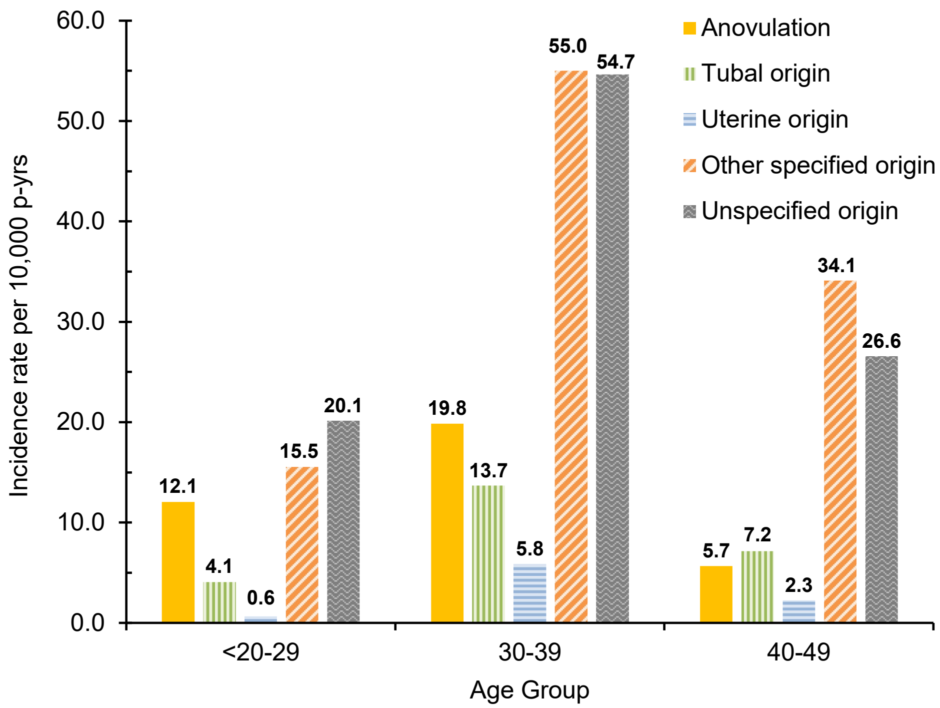
Live births after infertility diagnosis

Of the 8,154 service women diagnosed with infertility for the first time during the surveillance period, 666 (8.2%) were hospitalized for a live birth within 1 year following incident their infertility diagnoses (data not shown). In total, 2,005 (24.6%) women were hospitalized for a live birth within 2 years after an incident infertility diagnosis.

Discussion

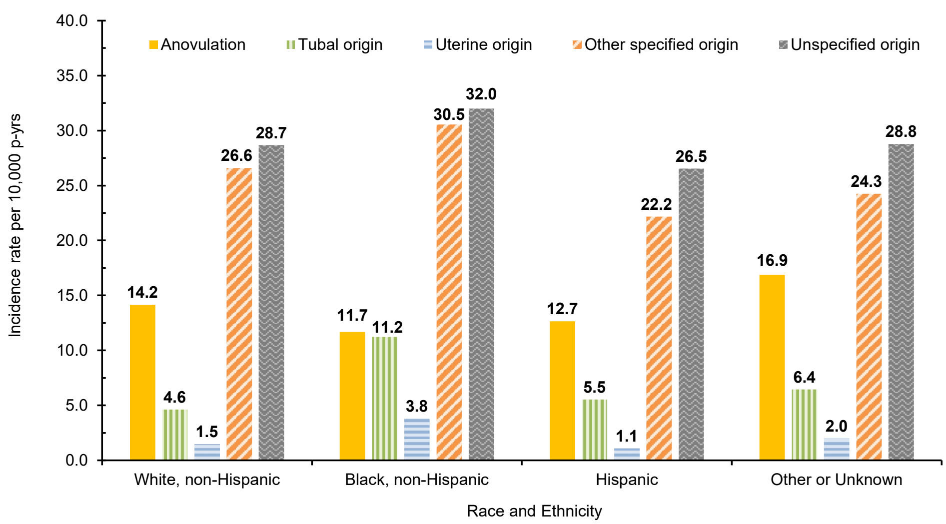
The crude overall incidence rate of diagnosed infertility among active component service women during the 2019–2023 surveillance period (77.5 per 10,000 p-yrs) remained slightly below the 2013–2018 incidence rate (79.3 per 10,000 p-yrs) previously reported, despite increased fertility

FIGURE 3. Incidence Rates of Female Infertility Diagnoses by Type and Age Group, Active Component Service Women of Childbearing Potential, 2019–2023



Abbreviations: P-yrs, person-years.

FIGURE 4. Incidence of Infertility by Type and Race and Ethnicity, Active Component Service Women of Childbearing Potential, U.S. Armed Forces, 2019–2023



Abbreviations: P-yrs, person-years.

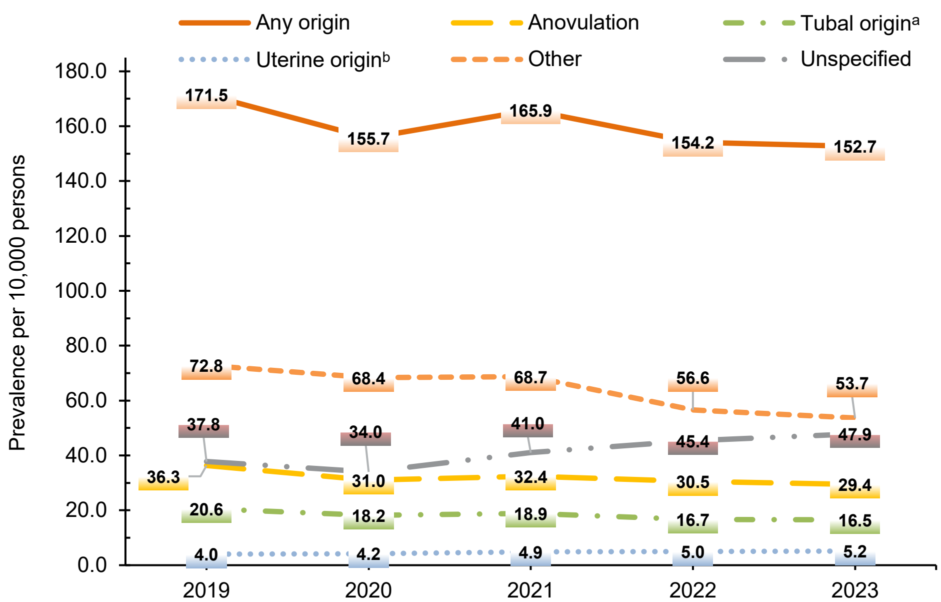
testing.[13] Over 70% of incident infertility cases were diagnosed as 'other specified' or unspecified origin, limiting descriptions of the types of causes of infertility. While annual incidence rates of diagnosed infertility (of any origin) decreased by 22.1% during the surveillance period, the rate of unspecified infertility increased by nearly 34% from 2020 through 2023. This increasing trend in unspecified diagnoses, coupled with a sustained proportion of cases diagnosed as 'other' origin, may warrant further study to better elucidate the specific types of causes of infertility; however, current ICD-10-CM coding does not provide a greater level of detail beyond the unspecified and 'other' diagnoses.

The demographic results reported herein are broadly similar to prior surveillance reports focused on active component service women, with the highest rates of female infertility diagnosed among Army soldiers, women of non-Hispanic Black race or ethnicity, and individuals aged 30-39 years. Between 2000 and 2012, active component service women ages 30-34 years accounted for the highest rates of diagnosed infertility, but the highest rates shifted to women ages 35-39 years from 2013 to 2018. This finding has persisted through this surveillance period, 2019–2023, in which women ages 35-39 years accounted for the highest rates of diagnosed infertility, followed closely by women aged 30-34 years. The comparison of age-stratified rates for infertility of uterine origin are also notable for women in their 30s. While the overall incidence rate of women diagnosed with infertility of uterine origin remained minimal during the surveillance period, the age-stratified rate (5.8 per 10,000 p-yrs) for women aged 30-39 years from 2019 to 2023 is elevated beyond the comparable age-specific rate reported for 2013–2018, at 2.9 per 10,000 p-yrs.[13]

Notably, fertility testing for active component service women increased by 74.0%, exceeding the increasing trend (30.0%) described in the prior surveillance period.[13] The current report also approximates that one-quarter (24.6%) of women had live births within 2 years following their incident infertility diagnoses, increasing from one-fifth (20.7%), previously reported for 2013–2018.[13]

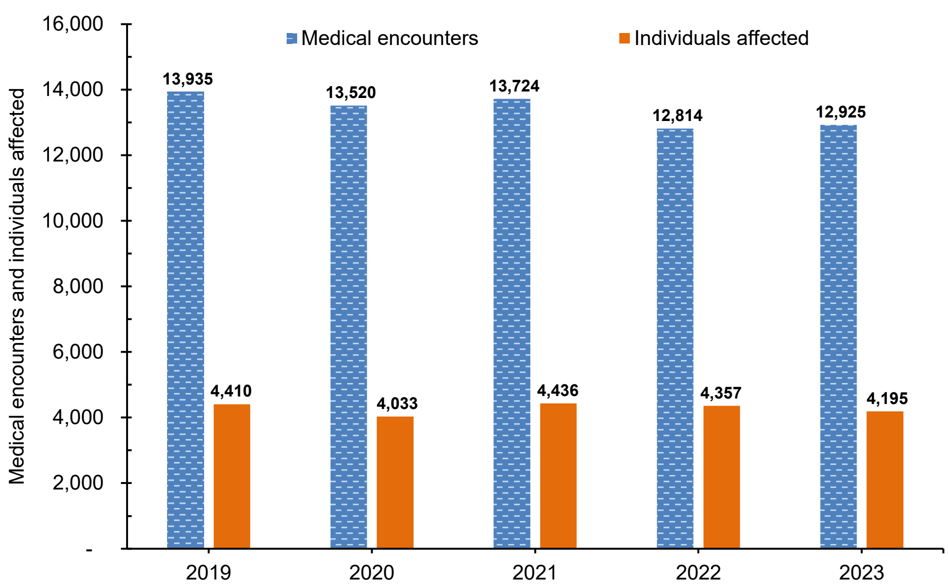
Over the last 3 decades, development of new medications, testing, and treatment strategies for infertile women have increased at a rapid pace.[17] Women in active military service may receive diagnostic services to identify physical causes of infertility and some medically necessary treatments (e.g., hormonal therapy, corrective surgery, antibiotics). TRICARE does not currently cover assisted reproductive technology services (ART), except for service-related infertility.[18] ART services are available on a 'first-come, first-serve' basis at greatly reduced cost, offered at 8 military hospitals with obstetrical / gynecological reproductive endocrinology and infertility graduate medical education programs.[18,19]

FIGURE 5. Prevalence of Infertility by Type, Active Component Service Women of Childbearing Potential, U.S. Armed Forces, 2019–2023



[a]Block, occlusion, or stenosis of the fallopian tubes.
[b]Structural abnormality of the uterus or nonimplantation (includes fibroids).

FIGURE 6. Numbers of Medical Encounters for Infertility and Numbers of Individuals Affected, Active Component Service Women, 2019–2023



Access to these infertility services may vary, depending on a range of factors such as current duty station location, career stage, cost of services, command climate, and current policy.[20] As testing services become more commonly used, analyses related to the use, safety, efficacy and quality of infertility treatments may be warranted, based on guidelines from the Centers for Disease Control and Prevention's National Public Health Action Plan for the Detection, Prevention and Management of Infertility.[10]

The results presented in this report should be interpreted as estimates defined from administrative diagnostic codes, which are methodologically different from studies that use self-reported survey tools. Furthermore, administrative diagnostic codes may underestimate the true incidence and prevalence of infertility. The prevalence estimates from this report (1.5–1.7%) remain far below self-reported data from the Department of Defense Women's Reproductive Health Survey (15.2%),[9] due to inherent methodological differences in comparing survey data with diagnostic codes from electronic health records.

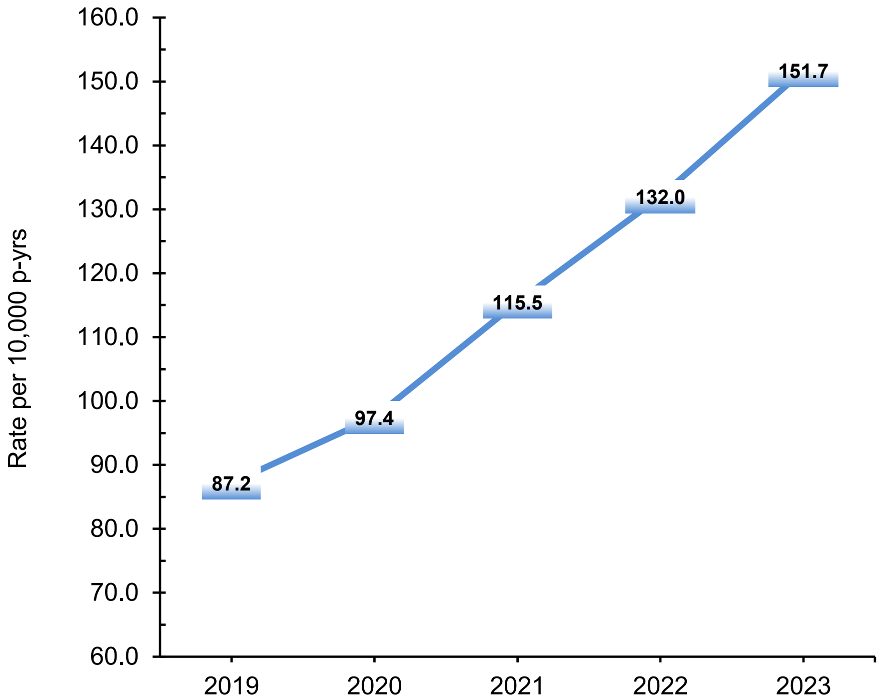
Additional limitations may be present in this report. The percentage of women who gave birth following incident infertility diagnoses is likely underestimated, as women who gave birth after leaving military service are not captured. Furthermore, this analysis did not explicitly capture recurrent pregnancy loss (ICD-9: 629.81, 646.3*; ICD-10: N96, O26.2*), which could be considered a type of infertility. Some individuals diagnosed with recurrent pregnancy loss may have received a diagnosis of unspecified infertility, however, and would have been included in this analysis.

Despite these limitations, this report provides an update on the incidence and prevalence of diagnosed infertility among active component U.S. service women. The standardized measurement of diagnosed infertility provides a basis for reviewing trends and comparing rates by sociodemographic variables, in addition to further assessing suggested risk factors,[1] such as health behaviors (e.g., alcohol or tobacco use), physical and mental health conditions (sexually transmitted infections, obesity, depression, cancer), and occupational exposures. Furthermore, the rapidly increasing rates of fertility testing among active component service women indicates need for further studies to more comprehensively describe infertility service access and use.

Disclaimer

The views and opinions expressed herein are those of the authors and do not necessarily reflect those of the U.S. Government nor any of its agencies.

FIGURE 7. Annual Rates of Fertility Testing, Active Component Service Women of Childbearing Potential, U.S. Armed Forces, 2019–2023



Abbreviations: P-yrs, person-years.

References

1. Centers for Disease Control and Prevention. Reproductive Health. Infertility FAQs. U.S. Dept. of Health and Human Services. Accessed Mar. 11, 2025. https://www.cdc.gov/reproductive-health/infertility-faq/index.html
2. Armed Forces Health Surveillance Division. Case Definition for Female Infertility. Defense Health Agency, U.S. Dept. of Defense. Accessed Apr. 22, 2025. https://health.mil/reference-center/publications/2018/09/01/female-infertility
3. Hamilton-Fairley D, Taylor A. Anovulation. *BMJ.* 2003;327(7414):546-549. doi:10.1136/bmj.327.7414.546
4. Sirmans SM, Pate KA. Epidemiology, diagnosis, and management of polycystic ovary syndrome. *Clin Epidemiol*. 2013;6:1-13. doi:10.2147/clep.s37559
5. Office on Women's Health. Infertility. U.S. Dept. of Health and Human Services. Updated Feb. 22, 2021. Accessed Mar. 11, 2025. https://womenshealth.gov/a-z-topics/infertility
6. Centers for Disease Control and Prevention. Infertility: Frequently Asked Questions. U.S. Dept. of Health and Human Services. Updated May 15, 2024. Accessed Mar. 13, 2025. https://www.cdc.gov/reproductive-health/infertility-faq/index.html
7. Bukowinski AT, Conlin AMS, Gumbs GR, et al. Department of Defense Birth and Infant Health Registry: select reproductive health outcomes, 2003–2014. *MSMR* 2017;24(11):39-49. Accessed Apr. 28, 2025. https://www.health.mil/reference-center/reports/2017/01/01/medical-surveillance-monthly-report-volume-24-number-11
8. Sharma R, Biedenharn KR, Fedor JM, Agarwal A. Lifestyle factors and reproductive health: taking control of your infertility. *Reprod Biol Endocrinol.* 2013;16(11). doi:10.1186/1477-7827-11-66
9. Meadows SO, Collins MS, Schuler M, et al. *The Women's Reproductive Health Survey (WRHS) of Active-Duty Service Members*. RAND Corp.;2022. Accessed May 21, 2025. https://www.rand.org/pubs/research_reports/RRA1031-1.html
10. Centers for Disease Control and Prevention. *National Public Health Action Plan for the Detection, Prevention and Management of Infertility*. Centers for Disease Control and Prevention;2014. Accessed Apr. 14, 2025. https://www.cdc.gov/reproductive-health/media/pdfs/infertility/drh-nap-final-508.pdf
11. Armed Forces Health Surveillance Center. Health of women after wartime deployments: correlates of risk for medical conditions among females after initial and repeat deployments to Afghanistan and Iraq, active component, U.S. Armed Forces. *MSMR.* 2012 19(7):2-10. Accessed Apr. 28, 2025. https://www.health.mil/reference-center/reports/2012/01/01/medical-surveillance-monthly-report-volume-19-number-7
12. Armed Forces Health Surveillance Center. Female infertility, active component service women, U.S. Armed Forces, 2000–2012. *MSMR*. 2013;20(9):8-12. Accessed Apr. 28, 2025. https://www.health.mil/reference-center/reports/2013/01/01/medical-surveillance-monthly-report-volume-20-number-9
13. Stahlman S, Fan M. Female infertility, active component service women, U.S. Armed Forces, 2013–2018. *MSMR*. 2019;26(6):20-26. Accessed Apr. 28, 2025. https://www.health.mil/reference-center/reports/2019/06/01/medical-surveillance-monthly-report-volume-26-number-6
14. Stahlman S, Witkop CT, Clark LL, Taubman SB. Pregnancies and live births, active component service women, U.S. Armed Forces, 2012–2016. *MSMR.* 2017;24(11):2-9. Accessed Apr. 28, 2025. https://www.health.mil/reference-center/reports/2017/01/01/medical-surveillance-monthly-report-volume-24-number-11
15. Stahlman S, Witkop CT, Clark LL, Taubman SB. Contraception among active component service women, U.S. Armed Forces, 2012–2016. *MSMR.* 2017;24(11):10-21. Accessed Apr. 28, 2025. https://www.health.mil/reference-center/reports/2017/01/01/medical-surveillance-monthly-report-volume-24-number-11
16. Armed Force Health Surveillance Division. Absolute and relative morbidity burdens attributable to various illnesses and injuries among active component members of the U.S. Armed Forces, 2023. *MSMR.* 2024;31(6):2-10. Accessed Apr. 28, 2025. https://www.health.mil/news/articles/2024/06/01/msmr-health-care-burden-active-component
17. Eskew AM, Jungheim ES. A history of developments to improve *in vitro* fertilization. *Mo Med*. 2017;114(3):156-159. Accessed Apr. 28, 2025. https://digitaleditions.walsworth.com/publication/?i=414080&p=0&view=issueviewer
18. TRICARE Communications. Understand how TRICARE covers infertility diagnosis and treatment. *TRICARE Newsroom*. Jun. 11, 2024. Accessed Mar. 13, 2025. https://newsroom.tricare.mil/news/tricare-news/article/3803153/understand-how-tricare-covers-infertility-diagnosis-and-treatment
19. TRICARE. Assisted Reproductive Technology Services. Defense Health Agency, U.S. Dept. of Defense. Accessed Mar. 13, 2025. https://www.tricare.mil/coveredservices/isitcovered/assistedreproductiveservices
20. Buechel J, Spalding CN, Brock WW, et al. A grounded theory approach to navigating infertility care during U.S. military service. *Mil Med*. 2024;189(1-2):352-360. doi:10.1093/milmed/usac174

Brief Report

Association Between Recurring Headache and Selected Women's Health Issues Among U.S. Navy and Marine Corps Women: Cross-Sectional Results of the Annual Periodic Health Assessment, 2021

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Recurring headache, a broad term that includes chronic migraine as well as other headache diagnoses, is a major cause of lost duty time among U.S. military women.[1] Migraine, in particular, is as much as 3 times more prevalent among women and is the headache type most affected by changes in estrogen levels that may result from biological processes (e.g., menopause, pregnancy) or use of exogenous hormones (e.g., hormonal contraceptives).[2]

Although prior studies have compared recurring headache among male and female service members,[3-5] few have focused on the association of recurring headache with women's health issues.[6] Furthermore, the availability of treatments for certain headache diagnoses, such as use of contraceptives to treat migraine without aura, suggests that studies of recurring headache and women's health issues could inform targeted health care strategies.[7]

This cross-sectional study of self-reported "recurring headaches/migraines," referred to in this report as "recurring headache," focused on 2 specific aims: 1) examining univariate associations of recurring headache with demographics and women's health characteristics and 2) examining age-specific associations of recurring headache with menstrual-related issues.

Methods

Data for this cross-sectional study were drawn from the 2021 Periodic Health Assessment (PHA).[8] The PHA is a standardized, annual health assessment for all military services that assesses individuals' medical readiness. The PHA is comprehensive and collects data on survey items related to chronic medical conditions such as recurring headache and women's health issues.

The PHA Data Sharing Agreement restricted analyses to U.S. Navy and Marine Corps personnel through 2021. Because a new version of the PHA questionnaire was introduced mid-2021, assessments in this study included those completed from August through December 2021. The main outcome was recorded as a closed question prompt on the PHA that asks for self-reported experience of "recurring headaches / migraines" within the prior year. The PHA asks survey participants, "Since your last PHA, have you experienced any of the following health conditions that either required medical care or impacted your duty performance (or both) and if so, what is your status?"

To examine recurring headache status (regardless of medical care or performance), we dichotomized answers to 'yes' or 'no.' Women's health variables of interest were hypothesized determinants (or surrogates for determinants) of recurring headache, reflecting putative relevance to estrogen-associated migraine: pregnancy history, contraceptive methods, history of total hysterectomy (as a surrogate for oophorectomy), post-menopausal status, and menstrual-related issues.[2] Women's health questions and possible answers from the PHA are displayed in **Table 1**. Demographics included age (in years), pay grade (% enlisted), number of deployments (% ≥1), service branch (% Marine Corps or Navy), service component (% active duty or reserve), and "temporary profile or temporary limited duty" (LIMDU/TLD) status (% 'yes').

To examine distributions of demographics for women's health characteristics—Aim 1—we displayed percentages among women with or without self-reported recurring headache. *P*-values were computed from t-tests or Chi-square tests. For Aim 2, to examine age-specific associations of recurring headache with menstrual-related issues (i.e., responding 'yes', or endorsing heavy and/or irregular menstrual cycles/pain or pre-menstrual syndrome), we used log-binomial regression to test interaction terms for statistical significance, defined as $p<0.05$. Estimates were stratified into 4 age groups: 18–29, 30–39, 40–49, and 50–64 years. Age-specific prevalence ratios (PRs) and 95% confidence intervals (CIs) were estimated from log-binomial regression of the probability of recurring headache.

Results

Overall, 17,629 women who completed the 2021 PHA were included in this study. The prevalence of self-reported recurring headache was 23.0%. **Table 1** demographics show that women with self-reported recurring headache were more likely than women without self-reported recurring headache to be older, enlisted, deployed at least once, active duty, or on LIMDU/TLD. Associations with women's health variables suggest that those with recurring headache, compared to those without, were more likely to endorse "[are] or may be pregnant,"

TABLE 1. Distribution of Demographic and Women's Health Characteristics of Respondents, With and Without Self-Reported Recurring Headaches or Migraine, Annual Periodic Health Assessment, Female U.S. Navy and Marine Corps Service Members, 2021

Characteristics	Recurring Headaches or Migraine: No (n=13,570)		Yes (n=4,059)		*P*-value [a]
	No.	%	No.	%	
Age, y [b]					<0.0001
18–24	5,324	39.2	1,008	24.8	
25–29	3,278	24.2	968	23.8	
30–34	2,159	15.9	786	19.4	
35–39	1,446	10.7	635	15.6	
40+	1,360	10.0	662	16.3	
Pay grade					<0.0001
Enlisted	10,348	76.3	3,456	85.1	
Deployments, n					<0.0001
≥1	4,143	30.5	1,507	37.1	
Service branch					0.7785
Marine Corps	2,418	17.8	716	17.6	
Navy	11,152	82.2	3,343	82.4	
Component					<0.0001
Active	10,906	80.4	3,501	86.3	
Reserves	2,658	19.6	558	13.7	
Temporary profile or LIMDU / TLD					<0.0001
Yes	1,066	7.9	674	16.6	
"Which of the following best describes you?"					<0.0001
I am or may be pregnant	645	4.8	240	5.9	
I was pregnant or just delivered within the past 6 months	609	4.5	217	5.3	
I was pregnant or delivered 6-12 months ago	423	3.1	198	4.9	
I am not pregnant now, and was not pregnant or delivered in the past 12 months	11,893	87.6	3,404	83.9	
"Since your last PHA, what contraceptive methods, if any, have you and your partner(s) been using to prevent pregnancy? Mark all that apply"					
Long term IUD (including copper or progesterone) or implant, yes	3,231	23.8	894	22.0	0.0459
Injectable—every 3 months, yes	200	1.5	63	1.6	0.9229
Daily—birth control pills, yes	1,937	14.3	493	12.1	0.0022
Monthly—contraceptive patch/vaginal ring, yes	296	2.2	111	2.7	0.1171
Emergency contraception (such as Plan B), yes	481	3.5	126	3.1	0.3879
"Have you had a total hysterectomy (uterus and cervix removed)?"					<0.0001
Yes	161	1.2	132	3.3	
"Are you postmenopausal and no longer experiencing menstrual cycles?"					<0.0001
Yes	457	3.4	156	3.8	
"Do you have heavy and/or irregular menstrual cycles / pain or premenstrual syndrome (PMS)?"					<0.0001
Yes, but I am in treatment and having no problems	766	5.6	313	7.7	
Yes, and I am having ongoing issues	2,119	15.6	1,359	33.5	
No	10,150	74.8	2,150	53.0	
Missing	535	3.9	237	5.8	

Abbreviations: n, number; No., number; y, years; LIMDU, limited duty; TLD, temporary limited duty; PHA, Periodic Health Assessment; IUD, intrauterine device; PMS, pre-menstrual syndrome.

[a] *P*-values are for the χ^2 test of independence for categorical variables.

[b] Values of age among respondents with no recurring headache do not sum to 100% because 3 respondents were age 17 years.

history of total hysterectomy, or post-menopausal status. The occurrence of menstrual-related issues was strongly associated with recurring headache, particularly among those who endorsed ongoing issues. Notably, univariate associations showed that women with recurring headache were less likely to report using a long-term intrauterine device (IUD) (22.0% vs. 23.8%, p=0.0459) or daily birth control pills (12.1% vs. 14.3%, p=0.0022).

As shown in **Table 2**, age-specific associations of recurring headache with menstrual-related issues were stronger among women in the younger age groups, particularly those who endorsed ongoing issues. *P*-values for each interaction term of age (as a continuous covariate) and menstrual-related issues ("Yes, but in treatment and no issues" or "Yes, but having ongoing issues") were p=0.6313 and p=0.0711, respectively. PRs and 95% CIs of recurring headache among women with ongoing menstrual-related issues (compared with no issues) were 2.4 (2.2, 2.6); 2.3 (2.1, 2.5); 1.7 (1.5, 2.0); and 3.1 (1.4, 7.0)—among women ages 18–29, 30–39, 40–49, and 50–64 years, respectively. Among women 50–64 years of age, wider CIs likely reflected a smaller sample in this age group.

Discussion

This study indicated a high prevalence of self-reported recurring headache (23.0%) during a 5-month period in 2021 among U.S. Navy and Marine Corps women. This study's numbers approximate 2011 findings from the Millennium Cohort Study, which included female U.S. active duty, reserve, and Guard members (n=12,409), and reported provider-diagnosed migraine or recurrent severe headache occurrence within the past year among 20.9% or 22.3% of military women, respectively.[9] These estimates are higher than the female general population's annual prevalence (17%)[10] but lower than lifetime migraine prevalence (30.1%) among female veterans.[3]

Although this study could not differentiate between specific headache diagnoses, noted associations with estrogen-related health characteristics suggest that a substantial proportion of women may be at risk for estrogen-associated migraines upon clinical evaluation.[2] This cross-sectional study could not establish temporal relationships between variables of interest, and our findings have limited ability to support causal inference. Nevertheless, the lower prevalence of recurring headache among women in treatment for menstrual-related issues warrants consideration of whether individuals reporting ongoing menstrual-related issues could benefit from hormonal contraception or other hormone-related treatments of estrogen-associated headache,[11] which is consistent with the literature.[2,12]

This work adds to the literature on recurring headache among women in the U.S. Navy and Marine Corps. Limitations of this preliminary study include an inability to differentiate between diagnostic subtypes of headache, absence of covariates of interest not recorded by the PHA, and cross-sectional analysis that precludes causal inference. Strengths of this work include its large sample size and estimation of age-specific prevalences. Additional work is needed to understand patterns of headache and migraine among U.S. military women, but this study highlights the importance and relevance of women's health issues in female service members with recurring headache.

TABLE 2. Age-Specific Prevalence and Prevalence Ratios of Self-Reported Recurring Headaches or Migraines, by "Heavy and/or Irregular Menstrual Cycles/Pain or Premenstrual Syndrome," Annual Periodic Health Assessment, Female U.S. Navy and Marine Corps Service Members, 2021

Age Group	"Heavy or Irregular Menstrual Cycles, Pain, or PMS?"[a]	Total (n)	Recurring Headache or Migraine Cases (n)	Prevalence (%)	Prevalence Ratio[b]	95% CI
18–29	No	7,592	1,071	14.1	1.0	Reference
	Yes, but in treatment and no issues	629	145	23.1	1.6	1.4–1.9
	Yes, but having ongoing issues	2,208	733	33.2	2.4	2.2–2.6
30–39	No	3,635	787	21.7	1.0	Reference
	Yes, but in treatment and no issues	320	120	37.5	1.7	1.5–2.0
	Yes, but having ongoing issues	943	467	49.5	2.3	2.1–2.5
40–49	No	1,003	283	28.2	1.0	Reference
	Yes, but in treatment and no issues	117	45	38.5	1.4	1.1–1.7
	Yes, but having ongoing issues	308	151	49.0	1.7	1.5–2.0
50–64	No	67	9	13.4	1.0	Reference
	Yes, but in treatment and no issues	13	3	23.1	1.7	0.5–5.5
	Yes, but having ongoing issues	19	8	42.1	3.1	1.4–7.0

Abbreviations: n, number; PMS, pre-menstrual syndrome; CI, confidence interval.
[a]Service members with missing responses to "heavy and/or irregular menstrual cycles/pain or premenstrual syndrome" are excluded from table totals.
[b]Prevalence ratios and 95% CIs are from age group stratified log-binomial regression of the probability of recurring headache.

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References

1. Martin CB. Migraines and other headaches, active components, US Armed Forces, 2001-2007. *MSMR*. 2008;15(4):6-10. Accessed Apr. 17, 2025. https://www.health.mil/reference-center/reports/2008/01/01/medical-surveillance-monthly-report-volume-15-number-4

2. O'Neal MA. Estrogen-associated migraine headache, including menstrual migraine. In: Barbieri RL, ed. *UpToDate*. Updated May 23, 2023. Accessed Apr. 17, 2025. https://www.uptodate.com/contents/estrogen-associated-migraine-headache-including-menstrual-migraine

3. Gasperi M, Schuster NM, Franklin B, et al. Migraine prevalence, environmental risk, and comorbidities in men and women veterans. *JAMA Netw Open*. 2024;7(3):e242299. doi:10.1001/jamanetworkopen.2024.2299

4. Sico JJ, Seng EK, Wang K, et al. Characteristics and gender differences of headache in the Veterans Health Administration: a national cohort study, fiscal year 2008-2019. *Neurology*. 2022;99(18):e1993-e2005. doi:10.1212/wnl.0000000000200905

5. Taubman SB. Risk factors for migraine after OEF/OIF deployment, active component, US Armed Forces. *MSMR*. 2009;16(12):10-13. Accessed Apr. 17, 2025. https://www.health.mil/reference-center/reports/2009/01/01/medical-surveillance-monthly-report-volume-16-number-12

6. McDermott MC, Musilli MG, Brown JE, et al. Female-specific health care of military female-designated service members and veterans: a systematic overview of reviews. *Mil Med*. 2024;189(9-10):221-223. doi:10.1093/milmed/usae101

7. Trego LL, Middleton MCA, Centi S, et al. The Military Women's Health Delphi Study: a research agenda for the next decade. *Mil Med*. 2023;188(suppl 4):32-40. doi:10.1093/milmed/usac271

8. Office of the Under Secretary of Defense for Personnel and Readiness. DoD Instruction 6200.06: Periodic Health Assessment (PHA) Program. U.S. Dept. of Defense. Updated Apr. 18, 2025. Accessed Apr. 30, 2025. https://www.esd.whs.mil/portals/54/documents/dd/issuances/dodi/620006p.pdf

9. Jankosky CJ, Hooper TI, Granado NS, et al. Headache disorders in the millennium cohort: epidemiology and relations with combat deployment. *Headache*. 2011;51(7):1098-1111. doi:10.1111/j.1526-4610.2011.01914.x

10. Cutrer FM. Pathophysiology, clinical manifestations, and diagnosis of migraine in adults. In: Swanson JW, ed. *UpToDate*. Wolters Kluwer. Updated Nov. 6, 2024. Accessed Apr. 17, 2025. https://www.uptodate.com/contents/pathophysiology-clinical-manifestations-and-diagnosis-of-migraine-in-adults

11. Ricker EA, Goforth CW, Barrett AS, Deuster PA, de la Motte SJ. Female military officers report a desire for menstrual suppression during military training. *Mil Med*. 2021;186(suppl 1):775-783. doi:10.1093/milmed/usaa339

12. Edelman A. Continuous or extended cycle vs. cyclic use of combined hormonal contraceptives for contraception. *Cochrane Database Syst Rev*. 2014;(7):cd004695. doi:10.1002/14651858.cd004695.pub3

Brief Report

Long-Acting Reversible Contraception and Unintended Pregnancy Among U.S. Active Duty Service Members, 2017–2018

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Long-acting reversible contraception (LARC) includes forms of birth control that offer strong combinations of efficacy, safety, and convenience, such as subdermal implants and intrauterine devices (IUDs).[1] In the U.S., LARC use is estimated to be twice as prevalent among active duty service members (ADSMs) compared with the general population (23.0% vs. 10.4%).[2,3] The number of active duty LARC users increased by 19.0% between 2016 and 2019, from 50,365 to 59,942.[2]

While unintended pregnancy following LARC placement is rare (<1.0%),[1,4] there is a paucity of research among ADSMs, a population in which unintended pregnancy has major implications for military readiness.[5] This descriptive study examined demographic, military, and medical characteristics of unintended pregnancies diagnosed after LARC placement in U.S. ADSMs, including pregnancies due to LARC failure as well as pregnancies undetected at time of LARC placement.

Methods

This study utilized medical encounter data from the Military Health System Data Repository, military personnel data from Defense Manpower Data Center (DMDC), as well as data abstracted from patient electronic health records (EHRs). Medical encounter data included care received at either military or civilian facilities coded with International Classification of Diseases (ICD) and Current Procedural Terminology (CPT) codes. Data were linked using the unique Electronic Data Interchange Personal Identifier assigned to each ADSM.

The study population included confirmed cases of unintended pregnancy diagnosed after LARC placement. Suspected cases were first screened from medical encounter data; this group included ADSMs who had LARC placement at a military clinic in 2017 or 2018 (ICD-10 diagnosis code Z30.430; ICD-10 procedure codes 0UH[9,C]xHZ; CPT codes 11981, 58300), indication of pregnancy within 12 months after placement (ICD-10 diagnosis codes Z32.01, Z[33,34,36].x, O[03,09,20].x, O26.3), and no indication of LARC removal or re-insertion prior to pregnancy (ICD-10 diagnosis codes Z30.43[2,3]; ICD-10 procedure codes 0UPDxHZ; CPT codes 11976, 11982-83, 58301). Suspected cases were confirmed using information abstracted from patient EHRs; all cases had no records of LARC removal prior to pregnancy diagnosis and were described as unintended pregnancies.

Cases were categorized into 2 types, based on estimated timing of conception relative to placement: LARC failure or undetected pregnancy at placement. Date of conception was calculated by adding 2 weeks to the date of last menstrual period (LMP), as obtained from patient self-reporting or pregnancy ultrasound records.[6] Estimated dates of conception occurring more than 1 week after LARC placement were considered LARC failures, while all others were estimated to be already pregnant at LARC placement.

All variables were abstracted from patient EHRs except for race and ethnicity, marital status, education, rank, and service branch, which were derived from DMDC files from the month of LARC placement. Characteristics were assessed overall and by outcome type (LARC failure or undetected pregnancy at placement) using descriptive and summary statistics. Statistical analysis was completed using SAS Enterprise Guide, version 8.3.

Institutional Review Board approval for this study was obtained from the Naval Health Research Center (protocol NHRC.1999.0003) and informed consent was waived per 32 Code of Federal Regulations §219.116(d).

Results

Initial screening identified 466 ADSMs with suspected pregnancy within 1 year following LARC placement that occurred in 2017 or 2018. After EHR review, 76 (16.3%) cases were confirmed as unintended pregnancies, of which 42 (55.3%) occurred in ADSMs who experienced LARC failure and 34 (44.7%) were among those with undetected pregnancy at LARC placement. Most cases had determined LMP from patient self-reporting at time of LARC placement versus ultrasound dating (72.4 vs. 27.6%; data not shown).

Most cases occurred among ADSMs aged 18-24 years at LARC placement (55.3%), married (52.6%), and of enlisted military rank (94.7%) **(Table 1)**. Compared with patients who experienced LARC failure, those with undetected pregnancy at placement were younger and more likely of non-Hispanic Black race or ethnicity, junior enlisted rank, in the Army, and never previously pregnant. Most LARC failures occurred among patients with an IUD (88.1%), while nearly all patients already pregnant at placement received a subdermal implant (91.2%) **(Table 2)**. Overall, almost all cases (94.7%) had completed a pregnancy test prior to LARC placement. Almost half of cases (43.4%) ended in a non-live birth outcome.

TABLE 1. Demographic, Military and Clinical Characteristics of U.S. Active Duty Service Members with LARC Placement in 2017–2018 and Diagnosed Unintended Pregnancy in the Following Year, Overall and by Outcome Type

Characteristics[a]	All Unintended Pregnancies		Outcome Type			
			LARC Failure		Undetected Pregnancy at Placement	
	No.	%	No.	%	No.	%
Total	76	—	42	—	34	—
Age, y						
18-24	42	55.3	21	50.0	21	61.8
25-34	21	27.6	12	28.6	9	26.5
≥35	13	17.1	9	21.4	4	11.8
Mean ± SD	25.2 ± 5.6		26.9 ± 6.3		23.2 ± 3.9	
Median (IQR)	23 (21-29)		24 (23-32)		23 (20-25)	
Race and ethnicity						
Hispanic	17	22.4	10	23.8	7	20.6
Black, non-Hispanic	25	32.9	10	23.8	15	44.1
White, non-Hispanic	24	31.6	16	38.1	8	23.5
All other groups[b]	10	13.2	6	14.3	4	11.8
Marital status						
Married	40	52.6	24	57.1	16	47.1
Unmarried	36	47.4	18	42.9	18	52.9
Education						
Less than bachelor's degree	68	89.5	35	83.3	33	97.1
Bachelor's degree or greater	8	10.5	7	16.7	1	2.9
Military rank						
Junior enlisted (E1-E3)	29	38.2	10	23.8	19	55.9
Enlisted (E4-E9)	43	56.6	28	66.7	15	44.1
Officer	4	5.3	4	9.5	0	0.0
Service branch						
Army	29	38.2	12	28.6	17	50.0
Navy	23	30.3	19	45.2	4	11.8
Air Force	14	18.4	7	16.7	7	20.6
Marine Corps	10	13.2	4	9.5	6	17.6
Gravidity						
0	29	38.2	10	23.8	19	55.9
1+	47	61.8	32	76.2	15	44.1
Parity						
0	31	40.8	12	28.6	19	55.9
1+	45	59.2	30	71.4	15	44.1
Body mass index (kg/m^2)						
< 18.5	0	0.0	0	0.0	0	0.0
18.5–24.9	26	34.2	14	33.3	12	35.3
25.0–29.9	31	40.8	14	33.3	17	50.0
≥ 30.0	19	25.0	14	33.3	5	14.7
Patient medical history						
Cesarean section	9	11.8	7	16.7	2	5.9
Diabetes	0	0.0	0	0.0	0	0.0
Fibroids	0	0.0	0	0.0	0	0.0
Hypertension	1	1.3	1	2.4	0	0.0
Obesity	14	18.4	9	21.4	5	14.7
Pelvic inflammatory disease	2	2.6	0	0.0	2	5.9
Sexually transmitted infection	6	7.9	3	7.1	3	8.8
LARC expulsion	3	3.9	3	7.1	0	0.0

Abbreviations: LARC, long-acting reversible contraception; y, years; SD, standard deviation; IQR, interquartile range; E, Enlisted; kg, kilogram; m, meter.

[a]Refers to patient characteristics at time of LARC placement.

[b]All other race and ethnicity groups include American Indian or Alaska Native (overall n=2), Asian or Pacific Islander (n=3), those with more than 1 race or ethnicity reported (n=4), and those with missing data (n=1).

Discussion

In this study of unintended pregnancies diagnosed after LARC placement, the majority of cases occurred among young, enlisted ADSMs; about half of cases were unmarried, and one-third were never previously pregnant. These characteristics generally suggest a patient population with reduced social support and limited independence from the military, which providers should be aware of when offering LARC-related care.

The American College of Obstetricians and Gynecologists guidelines state that implants and IUDs can be placed any time during the menstrual cycle if there is reasonable certainty a patient is not pregnant.[1] This study found only 34 instances in which providers were unable to detect or reasonably rule out pregnancy at contraceptive initiation, suggesting some variation in recommended practice guidelines,[1,7] or incomplete or inaccurate dating of patients' recent sexual histories or LMPs, albeit rare.

To be reasonably certain a patient is not pregnant at LARC placement, providers should follow the pregnancy checklist recommended by the Centers for Disease Control and Prevention, as these criteria are highly accurate in ruling out pregnancy (i.e., negative predictive value of 99–100%).[7] Editing checks within EHRs (e.g., re-entering dates to facilitate patient recall and avoid entry errors) and improved patient-provider communication (e.g., through shared decision-making vs. traditional provider-driven model[8,9]) can also help promote optimal LARC selection and timing of placement.

While calculation of a formal LARC failure rate was outside the scope of this study, only 42 failures were identified over the 2-year period, most of which were among patients with IUDs. This number is small and consistent with existing evidence that shows extremely high effectiveness (i.e., failure rates <1.0%) of LARC methods.[1,4]

Study limitations include potential misclassification of outcome type (LARC failure or undetected pregnancy at placement), as date of LMP was most often

TABLE 2. LARC Placement and Pregnancy Characteristics Among U.S. Active Duty Service Members with LARC Placement 2017–2018 and Diagnosed Unintended Pregnancy in the Following Year, Overall and by Outcome Type

Characteristics	All Unintended Pregnancies		Outcome Type: LARC Failure		Outcome Type: Undetected Pregnancy at Placement	
	No.	%	No.	%	No.	%
Total	76	—	42	—	34	—
LARC type						
Implant	36	47.4	5	11.9	31	91.2
Hormonal IUD	23	30.3	20	47.6	3	8.8
Copper IUD	17	22.4	17	40.5	0	0.0
Placement characteristics						
Pregnancy test prior to placement	72	94.7	39	92.9	33	97.1
Postpartum placement[a]	6	7.9	5	11.9	1	2.9
Days from last menses to placement						
≤7 days	12	15.8	12	28.6	0	0.0
>7 days	64	84.2	30	71.4	34	100
Placement provider type						
Certified nurse midwife	12	15.8	7	16.7	5	14.7
Nurse practitioner	17	22.4	9	21.4	8	23.5
Physician	42	55.3	24	57.1	18	52.9
Physician assistant	3	3.9	1	2.4	2	5.9
Other or unknown	2	2.6	1	2.4	1	2.9
Months from most recent delivery to placement[b]						
Mean ± SD	25.1 ± 36.8		23.1 ± 38.1		29.5 ± 35.0	
Median (IQR)	6 (2-33)		2 (2-25)		12 (4-47)	
Confirmatory imaging of LARC						
Retention	12	15.8	10	23.8	2	5.9
Expulsion	13	17.1	13	31.0	0	0.0
Perforation	1	1.3	1	2.4	0	0.0
No imaging records available	50	65.8	18	42.9	32	94.1
Months from placement to pregnancy identification						
Mean ± SD	4.5 ± 3.8		7.1 ± 3.1		1.3 ± 1.4	
Median (IQR)	4 (1-7)		7 (5-10)		1 (0-2)	
Pregnancy outcome						
Live birth	43	56.6	26	61.9	17	50.0
Stillbirth	1	1.3	1	2.4	0	0.0
Ectopic pregnancy	5	6.6	3	7.1	2	5.9
Spontaneous abortion	12	15.8	7	16.7	5	14.7
Elective or therapeutic abortion	15	19.7	5	11.9	10	29.4

Abbreviations: LARC, long-acting reversible contraception; IUD, intrauterine device; SD, standard deviation; IQR, interquartile range.
[a]Postpartum placement was defined as those occurring within 6 weeks after delivery.
[b]This measure included 42 service members with a known prior delivery.

derived from patient self-reporting at time of LARC placement rather than ultrasound dating. Available EHRs lacked information on how a provider ruled out pregnancy at LARC placement (other than performing a pregnancy test) or determined or corrected LMP from ultrasound records, further hindering LMP estimate reliability. Among the 466 ADSMs screened for unintended pregnancy following LARC placement, only 16.3% were confirmed cases, demonstrating the value of EHR use to identify true unintended pregnancies. Remaining cases were not confirmed due to various circumstances (e.g., no pregnancy, LARC removal before pregnancy). Limited resources did not allow for abstraction of LARC placements with no pregnancy; therefore, this study could not determine whether certain characteristics were associated with an increased risk for unintended pregnancy or LARC failure.

The consequences of unintended pregnancy can be significant for ADSMs, their support systems, and service units (e.g., extended non-deployability). If unintended pregnancy occurs while in a military theater of operation, increased costs incur due to medical evacuation and personnel replacement. Independent of deployment status, unintended pregnancy also results in quality of life adjustments for ADSMs as well as their unit personnel, with potential effects on ADSM retention, mission readiness, and unit cohesion.[5] Active duty status may also influence a service member's decision to maintain a pregnancy. Ongoing efforts to improve contraceptive access, use, and reliability are critical for preserving operational readiness and career advancement opportunities among this population, while also decreasing health care expenditures.

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References

1. Committee on Practice Bulletins-Gynecology, Long-Acting Reversible Contraception Working Group. Practice bulletin no. 186: long-acting reversible contraception: implants and intrauterine devices. *Obstet Gynecol*. 2017;130(5):e251-e269. doi:10.1097/aog.0000000000002400
2. Lotridge JA, Stahlman SL, Patel DM, et al. Long-acting reversible contraceptive use, active component service women, US Armed Forces, 2016-2020. *MSMR*. 2021;28(7):2-10. Accessed Apr. 18, 2025. https://www.health.mil/news/articles/2021/07/01/long-acting-msmr
3. Daniels K, Abma JC. Current Contraceptive Status Among Women Aged 15-49: United States, 2017-2019. NCHS Data Brief no. 388. National Center for Health Statistics, Centers for Disease Control and Prevention, U.S. Dept. of Health and Human Services. 2020. Accessed Mar. 13, 2025. https://www.cdc.gov/nchs/products/databriefs/db388.htm
4. Baker CC, Creinin MD. Long-acting reversible contraception. *Obstet Gynecol*. 2022;140(5):883-897. doi:10.1097/aog.0000000000004967
5. Janvrin ML, Banaag A, Lawry LL, Scott R, Koehlmoos T. Estimates of unintended pregnancy among US active-duty service women and the impact on Women Peace and Security objectives as measured by potential readiness days lost. *BMJ Mil Health*. 2025;Jan 14:e002654. doi:10.1136/military-2023-002654
6. American College of Obstetricians and Gynecologists, American Institute of Ultrasound in Medicine, Society for Maternal-Fetal Medicine. Committee opinion no 700: methods for estimating the due date: practice guideline. *Obstet Gynecol*. 2017;129(5):e150-e154. doi:10.1097/aog.0000000000002046
7. Curtis KM, Nguyen AT, Tepper NK, et al. U.S. selected practice recommendations for contraceptive use, 2024. *MMWR Recomm Rep*. 2024;73(3):1-77. doi:10.15585/mmwr.rr7303a1
8. American College of Obstetricians and Gynecologists' Committee on Health Care for Underserved Women, Contraceptive Equity Expert Work Group, Committee on Ethics. Patient-centered contraceptive counseling: ACOG committee statement number 1. *Obstet Gynecol*. 2022;139(2):350-353. doi:10.1097/aog.0000000000004659
9. Dehlendorf C, Grumbach K, Schmittdiel JA, Steinauer J. Shared decision making in contraceptive counseling. *Contraception*. 2017;95(5):452-455. doi:10.1016/j.contraception.2016.12.010

Surveillance Snapshot

Contraceptive Use Trends from the Periodic Health Assessment Among Female Active Duty U.S. Sailors and Marines, 2018–2023

Brooke K. Rodriguez, MPH; Katherine R. Gonzales, MPH; Sarah C. Kelsey, MPH

This Surveillance Snapshot highlights trends in birth control methods among female active duty U.S. sailors and marines. Birth control methods are self-reported during annual Periodic Health Assessments (PHAs) of active duty U.S. service members. This analysis captures data on birth control use including long-acting reversible contraceptives (LARCs), short-acting reversible contraceptives (SARCs), intrauterine devices (IUDs), implants, barrier methods, emergency contraception, sterilization, fertility awareness, or lack of use among individuals not actively taking steps to prevent pregnancy. These findings offer insights into active duty females' preferences and behaviors beyond clinical data and may inform Defense Health Agency (DHA) policies for enhancing female force readiness.

This analysis examined responses to question 22 on PHA DD Form 3204, versions 1 and 2, for calendar years 2018–2023.[1] The population included active duty female sailors and marines, ages 18-52 years. Version 2 of the form was introduced in August 2021 and retained the contraceptive questioning structure of version 1, allowing women to select why they may not be taking steps to prevent pregnancy. Contraceptive variables and free-text responses were used to determine prevalence of LARCs, SARCs, and other pregnancy prevention methods, which included infertility or sterilization (of the service member or partner), condom use, abstinence, fertility awareness methods, and pregnancy or breastfeeding. Alternatively, respondents could select a response indicating that pregnancy prevention was not needed (e.g., same sex partner[s], intention to conceive).

Among all PHAs completed and certified with medical provider signature (n=277,633), only 24.3% (n=67,430) included responses to assessment items on contraceptive methods. Among women with a response indicating at least 1 birth control method during the study period, the **Figure** illustrates the distribution of birth control methods by type. Self-reported SARC and condom use decreased from 34.6% to 18.1%, and 30.1% to 15.5%, respectively, from 2018 to 2023. Self-reported LARC use showed an upward trend, rising from 19.6% in 2018 to 31.0% in 2023. During the study period, the percentage of active duty women reporting same-sex relationships increased from 0.6% to 1.8%, but remained below 2%; abstinence increased from 0.3% to 2.8%, but remained below 3%; infertility increased from 8.0% to 9.0%; cycle tracking and family planning increased from 1.8% to 3.6%. Breastfeeding as a method to prevent pregnancy remained consistently low during the period of analysis, never exceeding 2.8% of responses. PHAs with free-text responses to 'other' contraceptive methods (n=1,713), which could not be classified into the categories described, were excluded from the analysis.

It is important to note that PHA data consist of self-reported physical health information and do not represent actual diagnoses, or prescriptions written, filled, or taken. Nevertheless, this information has value, providing insights into reproductive health trends affecting force readiness and resilience, for informed health care strategies.

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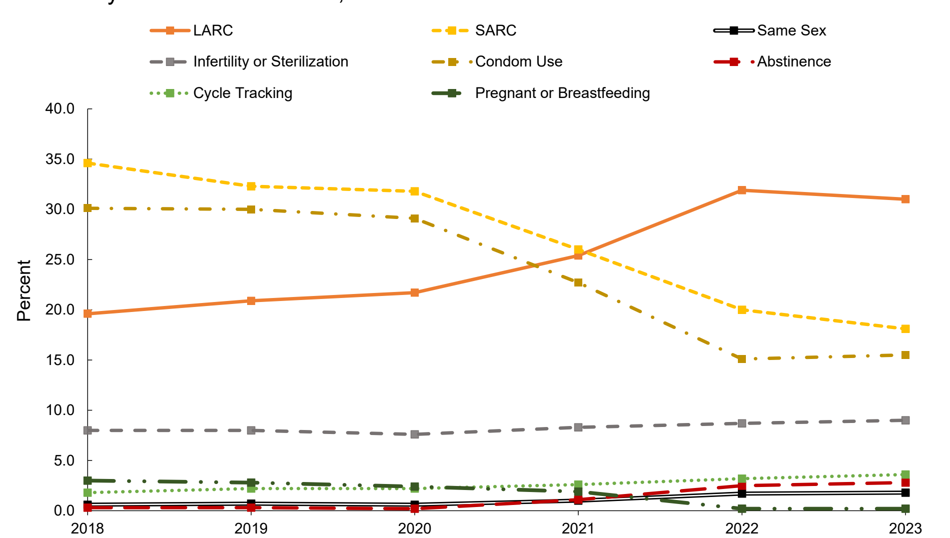
Reference

1. Department of Defense Forms Management Program. DD3024. Accessed Apr. 10, 2025. https://www.esd.whs.mil/directives/forms/dd3000_3499/dd3024

FIGURE. Prevalence of Birth Control Method, Reported on Periodic Health Assessments, Active Duty Sailors and Marines, 2018–2023



Abbreviations: PHA, Periodic Health Assessment; LARC, long-acting reversible contraception; SARC, short-acting reversible contraception.

Guest Editorial

Optimizing Female Warfighter Health and Performance in Environmental Extremes

Gabrielle E. W. Giersch, PhD; Karleigh E. Bradbury, PhD; Nisha Charkoudian, PhD

The ongoing non-combat threats of extreme environmental exposure—including heat, cold, high altitudes, and subterranean areas—have always been important focuses for research and development of effective countermeasures, both within the military as well as other domains requiring prolonged outdoor activity. Over the past decade, the increased frequency of weather phenomena associated with climate change—such as extreme heat waves, violent storms, catastrophic flooding—have brought the biomedical risks and gaps in knowledge associated with extreme environmental exposure into sharper focus, both in the biomedical literature and mainstream media.[1,2]

In military medicine, threats due to environmental exposure are particularly relevant, as small units and dismounted warfighters are often directly exposed to a given set of extreme environmental conditions. Until the past decade, much of the military medical literature on environmental stressors relied on data collected primarily from men. With women representing a growing percentage of the military force, both in the U.S. and around the world, it is increasingly necessary to understand the physiological and pathophysiological responses of both sexes for optimizing the health of all warfighters, in mission-critical scenarios as well as training.

The environmental physiology community, including the U.S. Army Research Institute of Environmental Medicine (USARIEM) and many academic laboratories and research teams, have recently increased focus on the female warfighter, to improve knowledge and awareness of individualized risk management for individuals exposed to extreme terrestrial environments.[3-8] This editorial provides an update on the state of the science to aid military medical providers' understanding of where and when sex-specific considerations in environmental exposure risk are necessary and—equally importantly—are not.

Threats of Extreme Environmental Exposure

Heat Stress

Heat-related illnesses remain a major threat to warfighters, with 2,000 or more individuals each year experiencing mild forms of heat illness, and approximately 500 individuals experiencing exertional heat stroke (EHS), which is the most severe, and potentially fatal, heat illness. It was previously assumed that women are at an increased risk for heat-related illnesses compared to their male counterparts,[9,10] without appropriate evidence.

Recently, the Thermal and Mountain Medicine Division of USARIEM evaluated epidemiological data, using a case-control analysis, from an Army-wide analysis of EHS, the most severe form of heat illness, and found no differences in risk of EHS between men and women.[11,12] While sex-related differences for EHS risk are not apparent, recent evidence suggests potential differences in organ damage between men and women following EHS. In a cohort of EHS cases from Fort Benning, the Thermal and Mountain Medicine Division of USARIEM also found that biomarkers of end organ damage were lower in women compared to men, despite similar highest recorded body temperatures.[13] This may suggest that women suffer less damage than men from EHS of similar severity, but more research is needed to fully elucidate physiological mechanisms to support that hypothesis.

Risk for developing other less severe, heat-related illnesses has recently been evaluated. Kazman et al. (2024) reported an increased risk for "mild" heat illness (i.e., heat exhaustion) in recruits,[14] but more research to elucidate the mechanism for this potential difference is warranted. In the yearly heat illness active updates from *MSMR*, men and women consistently demonstrate similar rates of reported heat exhaustion, including heat injury (diagnosed as heat exhaustion with evidence of end organ damage).

While risk of heat-related illness does not appear to be affected by sex, relatively low-impact differences in thermoregulation between men and women exist. Namely, and likely the most effective, are the physical differences between men and women, where women are, on average, smaller with larger body surface area to mass ration (BSA:mass^{-1}), which can enhance heat dissipation in some environments.[15] This may provide women with a relative advantage in certain situations where heat dissipation is not impeded by clothing or the surrounding environment. Situations in which heat dissipation capacity is impeded, or work rate is very high (i.e., load carriage occurs), instead could turn women's BSA:mass^{-1} into a disadvantage; lower lean body mass carrying an absolute load in clothing with less evaporative capacity leads to greater thermal stress. Additionally, there is evidence to suggest lower sweating rate in women at very high work loads,[16,17] which may affect military personnel when performing ruck marches or runs, but also may not yield significant differences in total heat loss or core temperature responses, despite less sweat produced.[18]

Female sex hormones also have pronounced effects on the thermoregulatory system, as previously thoroughly described,[19] but those hormonal or menstrual cycle differences do not seem to affect body temperature following exercise, when evaluated in a meta-analysis.[20] Contraceptive status did appear to influence esophageal temperature during exercise,[21] with progestin-only contraceptive users experiencing higher core temperatures at baseline and throughout exercise, which may suggest that type of contraceptive influences thermoregulatory response in women.

Besides physiological differences, there are also well-described behavioral differences in thermoregulation between men and women, including pacing[22] and behavioral thermoregulation.[23] Behavioral mechanisms may be more effective than physiological mechanisms for thermoregulation[24] and should be considered for future research in addition to practical prevention strategies.

Cold Stress

Female-specific responses during cold stress are less well-understood. Female sex hormones and cold stress responses have been thoroughly reviewed,[7] with findings indicating that estradiol may enhance cutaneous vasodilatory responses[25-27] and progesterone observed to shift the core temperature threshold to higher temperatures,[25,28] which may affect shivering onset and sensitivity[29,30] (although that finding varies in the literature,[31] without consistent methodologies in reported investigations). Interestingly, if elevated progesterone concentrations, like those observed in the luteal phase of the menstrual cycle, do influence shivering onset, it is likely such effect is due to elevated core temperatures observed with high progesterone and would not influence risk of injury, impaired performance, nor loss of dexterity during cold stress.

Manual dexterity decreases with cold stress, and cold-induced vasodilation, a reflex that opens the blood vessels to the extremities to provide blood flow, likely occurs to prevent freezing cold injuries.[32] Women have been shown to have lower finger temperatures than men, with no differences in cold-induced vasodilation or dexterity measures between sexes,[33] but sex hormones were not evaluated systematically in that investigation.

The impacts of estradiol and progesterone, particularly with fluctuations that occur not only during the menstrual cycle, but throughout reproductive lifespan as well as with contraceptive use, require further investigation.

Women do appear to have a greater prevalence of Raynaud's phenomenon,[34,35] but there is currently not evidence to suggest specific influence of female sex hormones or menstrual cycle phases on Raynaud's prevalence or severity.[36] Raynaud's phenomenon may pose an increased risk in developing freezing cold injuries such as frostbite.[37]

The physical differences that largely govern differences between men and women in heat stress may also affect cold stress, with greater subcutaneous fat potentially providing insulation in women[38] and greater average BSA:mass^{-1} potentially increasing heat loss in cold environments. It is unclear if these physical differences influence risk of injury or decreased performance during cold stress.

High Altitude Stress

It is well-established that humans experience myriad physiological responses upon exposure to high terrestrial altitude due to associated decrease in partial pressure of oxygen (PO_2).[39] The decrease in PO_2 is the primary cause of the decrements in both physical and cognitive performance[40] that occur with altitude exposure.

Both acute and chronic responses to hypoxia occur with a primary goal of increasing oxygen delivery throughout the body. Acute responses include, but are not limited to, increases in heart rate, ventilation, diuresis, and sympathetic nervous system activity.[3,41] Longer-term adaptations, known as acclimatization, include increases in hemoglobin mass, alterations in substrate utilization (e.g., enhanced carbohydrate metabolism), and improvements in capillary O_2 extraction.[40] The current literature presents some sex differences in physiological variables such as ventilation and hemoglobin mass at sea level baseline, but these differences do not appear to influence acute physiological responses to altitude nor the process of acclimatization in women.[41]

Ventilation has been shown to be influenced by sex and female sex hormones.[42] Progesterone is a ventilatory stimulant that acts on both the peripheral and central chemoreceptors to increase ventilation[41] and, concomitantly, lower partial pressures of end tidal CO_2 ($PETCO_2$). Higher ventilation and lower $PETCO_2$ have been reported in women in comparison to men, as well as during the luteal versus follicular phase of the menstrual cycle.[43] Despite the presence of progesterone, there are no sex differences in the acute hypoxic ventilatory response[43] or in the time course of ventilatory acclimatization.[44]

One potential limitation for females at altitude is an increased work of breathing. Women experience increased work of breathing compared to men, even when corrected for body and lung size,[45] a result of smaller airways that increase air flow resistance during ventilation.[46] This physiological difference between sexes may be of particular importance during load carriage at altitude, when increased work of breathing intensifies due to increased thoracic resistance caused by the external load.

Increased work of breathing for a specific ventilation is caused by elevated oxygen demand and greater respiratory muscle use.[47,48] In situations when respiratory muscle metabolic rates are increased, blood flow is redistributed to the diaphragm and other respiratory muscles because of increased sympathetic nerve activity, concomitant with vasoconstriction to blood vessels of other active or inactive muscles (i.e., respiratory muscle metaboreflex). Recent work has demonstrated attenuated sympathetic responses in women to increases in inspiratory muscle work, both at rest[49] and during exercise,[50] but the implications of these findings for blood flow redistribution during high levels of respiratory muscle work (i.e., during load carriage at altitude), and whether women are at a disadvantage due to increased work of breathing, are unknown.[51,52]

High altitude illness is an important risk consideration for those ascending in altitude. The most common high altitude illness is acute mountain sickness

(AMS), which occurs when individuals rapidly ascend to altitudes to 2,500 meters or higher, with symptom prevalence and severity increasing with higher elevations.[53,54] Symptoms of AMS often include nausea, dizziness, fatigue, headache, and gastrointestinal distress. Other, but less common, altitude-associated illnesses include high altitude cerebral and pulmonary edemas (HACE and HAPE, respectively). One formative study reported that men may be more likely to develop AMS,[55] but other reports suggest that women may be at a greater risk[56]—or that there are no differences between the sexes.[53] Additional research to investigate potential sex differences in high altitude illness risk, while also exploring potential mechanisms, are needed.

Subterranean and Hypercapnic Environments

Environments with elevated levels of carbon dioxide, which can result in hypercapnia, are an environmental stressor that recently has gained interest in the military community, after relatively little research. In normal ambient air, the concentration of carbon dioxide (CO_2) is very low (~0.034%), but in certain situations such as subterranean environments (including underground tunnels and buildings),[57] or when individuals are wearing personal protective equipment,[58] CO_2 concentration can be as high as 7%.[59] Small increases in ambient CO_2 can cause symptoms such as decreased focus, fatigue, and weakness, as well as increased levels of anxiety, but higher concentrations (10-15%) can lead to unconsciousness and suffocation within minutes of exposure, with further increases resulting in death.[60]

Similar to hypoxia, hypercapnia triggers a robust ventilatory response.[61,62] Several investigations have sought to distinguish sex differences during ventilatory response to increased CO_2, known as hypercapnic ventilatory response (HCVR). Some investigations have reported a greater HCVR in men, but when corrected for body size—including body mass index, body surface area, and lung size—those differences no longer exist.[63,64] While HCVR appears to be similar in both sexes, the ventilatory threshold for increase in ventilation is lower in women.[65]

Previous studies have explored the influence of increased CO_2 on both physical[59] and cognitive performance,[66] but those studies included few women. Sex differences in physiological responses to increased CO_2 remains to be investigated.

Editorial Comment

With the increased proportional and absolute numbers of women in the U.S. military, it is vital to better understand female physiological responses to, and unique requirements for, environmental extremes. Continued research should seek to investigate these potential sex differences to ensure suitable policy recommendations for both women and men in uniform.

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References

1. Hannan FM, Leow MK, Lee JK, et al. Endocrine effects of heat exposure and relevance to climate change. *Nat Rev Endocrinol*. 2024;20(11):673-684. doi:10.1038/s41574-024-01017-4
2. Pinho-Gomes A, Mcintosh A, Woodward M. Sex differences in mortality associated with heatwaves: a systematic review and meta-analysis. *Eur J Public Health*. 2024;34(suppl 3):ckae144.283. doi:10.1093/eurpub/ckae144.283
3. Giersch GEW, Charkoudian N, McClung HL. The rise of the female warfighter: physiology, performance, and future directions. *Med Sci Sports Exerc*. 2022;54(4):683-691. doi:10.1249/mss.0000000000002840
4. de Jonge XJ, Thompson B, Han A. Methodological recommendations for menstrual cycle research in sports and exercise. *Med Sci Sports Exerc*. 2019;51(12):2610-2617. doi:10.1249/mss.0000000000002073
5. Sims ST, Heather AK. Myths and Methodologies: Reducing scientific design ambiguity in studies comparing sexes and/or menstrual cycle phases. *Exp Physiol*. 2018;103(10):1309-1317. doi:10.1113/ep086797
6. Stachenfeld NS, Taylor HS. Challenges and methodology for testing young healthy women in physiological studies. *Am J Physiol Endocrinol Metab*. 2014;306(8):e849-e853. doi:10.1152/ajpendo.00038.2014
7. Greenfield AM, Charkoudian N, Alba BK. Influences of ovarian hormones on physiological responses to cold in women. *Temperature (Austin)*. 2022;9(1):23-45. doi:10.1080/23328940.2021.1953688
8. Hutchins KP, Borg DN, Bach AJ, et al. Female (under) representation in exercise thermoregulation research. *Sports Med Open*. 2021;7(1):43. doi:10.1186/s40798-021-00334-6
9. Alele F, Malau-Aduli B, Malau-Aduli A, Crowe M. Systematic review of gender differences in the epidemiology and risk factors of exertional heat illness and heat tolerance in the armed forces. *BMJ Open*. 2020;10(4):e031825. doi:10.1136/bmjopen-2019-031825
10. Carter R, Cheuvront SN, Williams JO, et al. Epidemiology of hospitalizations and deaths from heat illness in soldiers. *Med Sci Sports Exerc*. 2005;37(8):1338-1334. doi:10.1249/01.mss.0000174895.19639.ed
11. Giersch GE, Taylor KM, Caldwell AR, Charkoudian N. Body mass index, but not sex, influences exertional heat stroke risk in young healthy men and women. *Am J Physiol Regul Integr Comp Physiol*. 2023;324(1):r15-r19. doi:10.1152/ajpregu.00168.2022
12. Taylor KM, Giersch GE, Caldwell AR, Epstein Y, Charkoudian N. Relation of body surface area-to-mass ratio to risk of exertional heat stroke in healthy men and women. *J Appl Physiol*. 2024;136(3):549-554. doi:10.1152/japplphysiol.00597.2023
13. Goodwin KC, Giersch GE, Murray TA, DeGroot DW, Charkoudian N. Sex differences in biomarkers of end-organ damage following exertional heat stroke in humans. *J Appl Physiol (1985)*. 2024;137(5):1434-1445. doi:10.1152/japplphysiol.00597.2023
14. Kazman JB, Nelson DA, Ahmed AE, et al. Risk for exertional heat illness among US army enlistees: climate indexes, intrinsic factors and their interactions. *BJSM*. 2024;59(4). doi:10.1136/bjsports-2024-108441
15. Cramer MN, Jay O. Biophysical aspects of human thermoregulation during heat stress. *Auton Neurosci*. 2016;196:3-13. doi:10.1016/j.autneu.2016.03.001
16. Gagnon D, Crandall CG, Kenny GP. Sex differences in postsynaptic sweating and cutaneous vasodilation. *J Appl Physiol (1985)*. 2013;114(3):394-401. doi:10.1152/japplphysiol.00877.2012
17. Gagnon D, Kenny GP. Sex modulates whole-body sudomotor thermosensitivity during exercise. *J Physiol*. 2011;589(pt 24):6205-6217. doi:10.1113/jphysiol.2011.219220
18. Gagnon D, Jay O, Lemire B, Kenny GP. Sex-related differences in evaporative heat loss: the importance of metabolic heat production. *Eur J Appl Physiol*. 2008;104(5):821-829. doi:10.1007/s00421-008-0837-0
19. Charkoudian N, Stachenfeld NS. Reproductive hormone influences on thermoregulation

in women. *Compr Physiol*. 2014;4(2):793-804. doi:10.1002/cphy.c130029
20. Giersch GEW, Morrissey MC, Katch RK, et al. Menstrual cycle and thermoregulation during exercise in the heat: a systematic review and meta-analysis. *J Sci Med Sport*. 2020;23(12):1134-1140. doi:10.1016/j.jsams.2020.05.014
21. Stachenfeld NS, Silva C, Keefe DL. Estrogen modifies the temperature effects of progesterone. *J Appl Physiol (1985)*. 2000;88(5):1643-1649. doi:10.1152/jappl.2000.88.5.1643
22. Millard-Stafford M, Sparling PB, Rosskopf LB, et al. Fluid intake in male and female runners during a 40-km field run in the heat. *J Sports Sci*. 1995;13(3):257-263. doi:10.1080/02640419508732235
23. Vargas NT, Chapman CL, Sackett JR, et al. Thermal behavior differs between males and females during exercise and recovery. *Med Sci Sports Exerc*. 2019;51(1):141-152. doi:10.1249/mss.0000000000001756
24. Flouris AD, Schlader ZJ. Human behavioral thermoregulation during exercise in the heat. *Scand J Med Sci Sports*. 2015;25:52-64. doi:10.1111/sms.12349
25. Kolka MA, Stephenson LA. Interaction of menstrual cycle phase, clothing resistance, and exercise on thermoregulation in women. *J Therm Biol*. 1997;22(2):137-141. doi:10.1016/S0306-4565(97)00003-x
26. Charkoudian N, Johnson JM. Altered reflex control of cutaneous circulation by female sex steroids is independent of prostaglandins. *Am J Physiol*. 1999;276(5):h1634-h1640. doi:10.1152/ajpheart.1999.276.5.H1634
27. Shoemaker LN, Haigh KM, Kuczmarski AV, et al. ETB receptor-mediated vasodilation is regulated by estradiol in young women. *Am J Physiol Heart Cir Physiol*. 2021;321(3):h592-h598. doi:10.1152/ajpheart.00087.2021
28. Kolka MA, Stephenson LA. Resetting the thermoregulatory set-point by endogenous estradiol or progesterone in women. *Ann N Y Acad Sci*. 1997;813:204-206. doi:10.1111/j.1749-6632.1997.tb51694.x
29. Hessemer V, Bruck K. Influence of menstrual cycle on thermoregulatory, metabolic, and heart rate responses to exercise at night. *J Appl Physiol (1985)*. 1985;59(6):1911-1917. doi:10.1152/jappl.1985.59.6.1911
30. Gonzalez RR, Blanchard LA. Thermoregulatory responses to cold transients: effects of menstrual cycle in resting women. *J Appl Physiol (1985)*. 1998;85(2):543-553. doi:10.1152/jappl.1998.85.2.543
31. Blondin DP, Maneshi A, Imbeault MA, Haman F. Effects of the menstrual cycle on muscle recruitment and oxidative fuel selection during cold exposure. *J Appl Physiol (1985)*. 2011;111(4):1014-1020. doi:10.1152/japplphysiol.00293.2011
32. Cheung SS. Responses of the hands and feet to cold exposure. *Temperature (Austin)*. 2015;2(1):105-120. doi:10.1080/23328940.2015.1008890
33. Reading J, Roberts D, Prusaczyk W. *Gender Differences in Finger Temperatures During Cold Air Exposure*. Citeseer;1997.
34. Suter LG, Murabito JM, Felson DT, Fraenkel L. The incidence and natural history of Raynaud's phenomenon in the community. *Arthritis Rheum*. 2005;52(4):1259-1263. doi:10.1002/art.20988
35. Gifford RW, Hines EA. Raynaud's disease among women and girls. *Circulation*. 1957;16(6):1012-1021. doi:10.1161/01.cir.16.6.1012
36. Bartelink MEL. *Vasospasm and Female Sex Hormones: Studies in Raynaud's Phenomenon and Migraine*. Dissertation. Catholic University Nijmegen;1992.
37. Hamlet M. Peripheral cold injury. *Arbete Och Halsa Vetenskaplig Skriftserie*. 1998:127-131.
38. Burse RL. Sex differences in human thermoregulatory response to heat and cold stress. *Hum Factors*. 1979;21(6):687-99. doi:10.1177/001872087912210606
39. West JB. Human responses to extreme altitudes. *Integr Comp Biol*. 2006;46(1):25-34. doi:10.1093/icb/icj005
40. Department of the Army. Technical Bulletin (TB MED 505): Altitude Acclimatization and Illness Management. U.S. Dept. of Defense. 2010.
41. Raberin A, Burtscher J, Citherlet T, et al. Women at altitude: sex-related physiological responses to exercise in hypoxia. *Sports Med*. 2024;54(2):271-287. doi:10.1007/s40279-023-01954-6
42. Gargaglioni LH, Marques DA, Patrone LGA. Sex differences in breathing. *Comp Biochem Physiol A Mol Integr Physiol*. 2019;238:110543. doi:10.1016/j.cbpa.2019.110543
43. MacNutt MJ, Laursen PB, Kedia S, et al. Acclimatisation in trekkers with and without recent exposure to high altitude. *Eur J Appl Physiol*. 2012;112:3287-3294. doi:10.1007/s00421-012-2308-x
44. Muza SR, Rock PB, Fulco CS, et al. Women at altitude: ventilatory acclimatization at 4,300 m. *J Appl Physiol (1985)*. 2001;91(4):1791-1799. doi:10.1152/jappl.2001.91.4.1791
45. LoMauro A, Aliverti A. Sex and gender in respiratory physiology. *Eur Respir Rev*. 2021;30(162):210038. doi:10.1183/16000617.0038-2021
46. Dominelli PB, Ripoll JG, Cross TJ, et al. Sex differences in large conducting airway anatomy. *J Appl Physiol (1985)*. 2018;125(3):960-965. doi:10.1152/japplphysiol.00440.2018
47. Faghy MA, Shei RJ, Armstrong NC, White M, Lomax M. Physiological impact of load carriage exercise: current understanding and future research directions. *Physiol Rep*. 2022;10(21):e15502. doi:10.14814/phy2.15502
48. Sheel AW, Guenette JA. Mechanics of breathing during exercise in men and women: sex versus body size differences? *Exerc Sport Sci Rev*. 2008;36(3):128-134. doi:10.1097/jes.0b013e31817be7f0
49. Leahy MG, Kipp S, Benbaruj JM, et al. Effects of sex and ageing on the human respiratory muscle metaboreflex. *J Physiol*. 2023;601(3):689-702. doi:10.1113/JP283838
50. Katayama K, Smith JR, Goto K, et al. Elevated sympathetic vasomotor outflow in response to increased inspiratory muscle activity during exercise is less in young women compared with men. *Exp Physiol*. 2018;103(4):570-580. doi:10.1113/ep086817
51. Archiza B, Reinhard PA, Welch JF, Sheel AW. Sex differences in diaphragmatic fatigue: effects of hypoxia during inspiratory loading. *J Physiol*. 2021;599(4):1319-1333. doi:10.1113/jp280704
52. Archiza B, Leahy MG, Kipp S, Sheel AW. An integrative approach to the pulmonary physiology of exercise: when does biological sex matter? *Eur J Appl Physiol*. 2021;121(9):2377-2391. doi:10.1007/s00421-021-04690-9
53. Derstine M, Jean D, Beidleman BA, et al. Acute mountain sickness and high altitude cerebral edema in women: a scoping review–UIAA Medical Commission recommendations. *High Alt Med Biol*. 2023;24(4):259-267. doi:10.1089/ham.2023.0043
54. Roach RC, Hackett PH, Oelz O, et al. The 2018 Lake Louise Acute Mountain Sickness Score. *High Alt Med Biol*. 2018;19(1):4-6. doi:10.1089/ham.2017.0164
55. Beidleman BA, Tighiouart H, Schmid CH, Fulco CS, Muza SR. Predictive models of acute mountain sickness after rapid ascent to various altitudes. *Med Sci Sports Exerc*. 2013;45(4):792-800. doi:10.1249/mss.0b013e31827989ec
56. Hou YP, Wu JL, Tan C, et al. Sex-based differences in the prevalence of acute mountain sickness: a meta-analysis. *Mil Med Res*. 2019;6(1):38. doi:10.1186/s40779-019-0228-3
57. Monsé C, Broding HC, Sucker K, et al. Exposure assessment of potash miners at elevated CO_2 levels. *Int Arch Occup Environ Health*. 2014;87:413-421. doi:10.1007/s00420-013-0880-y
58. Smith CL, Whitelaw JL, Davies B. Carbon dioxide rebreathing in respiratory protective devices: influence of speech and work rate in full-face masks. *Ergonomics*. 2013;56(5):781-790. doi:10.1080/00140139.2013.777128
59. Ryan BJ, Seeley AD, Pitsas DM, et al. Influence of graded hypercapnia on endurance exercise performance in healthy humans. *Am J Physiol Regul, Integr Comp Physiol*. 2022;323(5):r638-r647. doi:10.1152/ajpregu.00132.2022
60. Headquarters DotA. *Subterranean Operations*. Vol. 3-12.51. *Army Technique Publications*. Nov. 1, 2019.
61. Asmussen E, Nielsen M. Ventilatory response to CO_2 during work at normal and at low oxygen tensions. *Acta Physiol Scand*. 1957;39(1):27-35. doi:10.1111/j.1748-1716.1957.tb01406.x
62. Ogoh S, Hayashi N, Inagaki M, Ainslie PN, Miyamoto T. Interaction between the ventilatory and cerebrovascular responses to hypo- and hypercapnia at rest and during exercise. *J Physiol*. 2008;586(17):4327-4338. doi:10.1113/jphysiol.2008.157073
63. Jensen D, Wolfe LA, O'Donnell DE, Davies GA. Chemoreflex control of breathing during wakefulness in healthy men and women. *J Appl Physiol (1985)*. 2005;98(3):822-828. doi:10.1152/japplphysiol.01208.2003
64. Goldberg S, Ollila HM, Lin L, et al. Analysis of hypoxic and hypercapnic ventilatory response in healthy volunteers. *PLoS One*. 2017;12(1):e0168930. doi:10.1371/journal.pone.0168930
65. MacNutt MJ, De Souza MJ, Tomczak SE, Homer JL, Sheel AW. Resting and exercise ventilatory chemosensitivity across the menstrual cycle. *J Appl Physiol (1985)*. 2012;112(5):737-747. doi:10.1152/japplphysiol.00727.2011
66. Gill M, Natoli MJ, Vacchiano C, et al. Effects of elevated oxygen and carbon dioxide partial pressures on respiratory function and cognitive performance. *J Appl Physiol (1985)*. 2014;117(4):406-412. doi:10.1152/japplphysiol.00995.2013

Guest Editorial

Enhancing Military Women's Health and Readiness Through Targeted Research Initiatives

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Health and wellness are vital aspects of military mission readiness. The Congressionally Directed Medical Research Programs (CDMRP), a funding organization within the Defense Health Agency (DHA), supports research on over 90 different diseases, conditions, and topics that are directed by Congress. The CDMRP's vision is to transform health care through innovative and impactful research.

The CDMRP has implemented multiple initiatives to enhance women's health since its inception in 1992. Military women's health care needs and experiences differ from those of male service members, in addition to those of civilian women. Women who served in the military have a higher risk or incidence of some conditions compared to the civilian population, including breast cancer,[1] multiple sclerosis,[2] dementia,[3] and eating disorders.[4] Better prevention, diagnosis, and treatment ensure mission readiness not only as it relates to the service members' health, but for the health and well-being of their families as well.[5]

To achieve its vision, the CDMRP adheres to a mission of responsibly managing collaborative research that discovers, develops, and delivers health care solutions for service members, veterans, their families, and the American public. In fiscal years 2022-2023, the CDMRP funded approximately $979.1 million in women's health research across many different conditions and topics that affect women exclusively, disproportionately, or differently **(Table)**.

This editorial provides an overview of the CDMRP and its women's health research initiatives, including the directive on Inclusion of Women and Minorities as Subjects in Clinical Research and the directive on Sex as a Biological Variable in Research. The editorial also describes efforts to prioritize women's health research and highlights examples of relevant CDMRP-funded studies to advance military women's health research.

CDMRP Women's Health Initiatives—Past to Present

Women's health is a foundational element of the CDMRP. The breast and ovarian cancer research programs established by the U.S. Congress in 1993 and 1997, respectively, provided funding that contributed to U.S. Food and Drug Administration (FDA)-approved drugs in addition to improved diagnostic approaches, prognostic tests, and changes in clinical practice. Those advancements continue to benefit service members and beneficiaries throughout the Military Health System (MHS).

Over the past 30 years, women's health research funded by the CDMRP has expanded to include Alzheimer's disease, autoimmune disorders (e.g., lupus, rheumatoid arthritis, scleroderma, celiac disease), cardiovascular disease, endometriosis, various cancers, sleep disorders, and chronic fatigue syndrome. Patients, survivors, and caregivers—including active duty service members and veterans—add critical perspectives and a sense of urgency within every aspect of the CDMRP's program cycle, serving as full voting members on both peer review panels as well as programmatic panels that contribute to funding decisions, program priorities, and investment strategies.

Consistent with *The Belmont Report*[6] and Congressional legislation, inclusion of women and minorities in clinical studies funded or supported by the CDMRP has been emphasized. Since 2009, the CDMRP's funding opportunity announcements have contained language encouraging the inclusion of women and minorities in clinical trials so the burdens and benefits of participating in clinical research may be applied to all affected populations. The CDMRP collaborated with partners at the National Institutes of Health (NIH) Office of Research on Women's Health, a leader in women's health research initiatives, to develop 2 important directives to ensure results from CDMRP-funded studies benefit both men and women from affected populations. These directives mirror policies already established by the NIH[9,10] and incorporate their many years of lessons learned.

The first directive, in 2020, requires inclusion of women and minorities, as appropriate for a study's objectives, in all clinical research studies funded by the CDMRP, including clinical trials.[7]

In 2024, the CDMRP took its women's health initiatives a step further by implementing its directive requiring researchers to consider sex as a biological variable in their research designs and reporting, including pre-clinical studies with animal models.[8] Failure to account for sex as a biological variable may undermine research rigor, transparency in participant population selection, and generalizability of research findings.

In fiscal year 2024 funding opportunities, the CDMRP began explicitly encouraging research on health areas and conditions that affect women uniquely, disproportionately, or differently from men. This research should relate anticipated findings to improvements in women's health

TABLE. CDMRP Investments in Women's Health Research, Fiscal Years 2022–2023

Research Topic	Investment (millions)	Number of Awards
Breast cancer	$264.8	159
Neurological disorders	$178.6	140
Psychological health	$106.9	49
Gynecological cancers	$103.3	128
Other[a]	$94.1	56
Autoimmune disorders	$67.1	73
Other cancers	$50.9	65
Cardiovascular diseases	$37.7	17
Alzheimer's disease	$26.3	23
Pain	$20.2	15
Musculoskeletal disorders	$13.7	11
Sensory system disorders	$8.8	10
Gynecological and reproductive disorders	$6.5	9
Grand Total	$979.1	755

[a] Includes diabetes, fragile X syndrome, Gulf war illness, neurofibromatosis, pancreatitis, Rett syndrome, toxic exposures, tuberous sclerosis complex.

outcomes or advancements in knowledge for women's health. Several programs have made targeted efforts to prioritize women's health as a focus area. The Peer Reviewed Orthopaedic Research Program, for example, offered a funding mechanism specifically to support research on orthopaedic injuries affecting women in combat roles.

Groundbreaking research is underway to advance military women's health throughout the many programs managed by the CDMRP. Three current CDMRP-funded studies advancing research for prevention and treatment of important conditions—breast cancer, pelvic pain, and post-traumatic stress disorder (PTSD)—with unique effects on military women are described in the following section.

CDMRP-funded Study Highlights

Breast Cancer Risk and Polycyclic Aromatic Hydrocarbons

Breast cancer is the most common non-skin cancer in women and the deadliest cancer in women under age 40 years,[11,12] and its incidence rate in women aged 40-59 years is higher among active duty service members than in the general population. In 2020, the CDMRP's Breast Cancer Research Program funded a research project totaling $3.1 million to address the challenge of identifying determinants of breast cancer initiation, risk, and susceptibility among female active duty service members. Cumulative environmental exposures have been identified as a potential factor that may contribute to the difference in breast cancer rates among women of similar ages in military service and the civilian population.[1]

Investigators Celia Byrne, PhD, at the Uniformed Services University of the Health Sciences, and Mary Beth Terry, PhD, at Columbia University Medical Center, are partnering in a case-control study utilizing the Department of Defense (DOD) Cancer Registry in addition to serum samples and data from the DOD's Armed Forces Health Surveillance Division (AFHSD). These investigators aim to quantify exposure to environmental contaminants called polycyclic aromatic hydrocarbons and evaluate breast cancer risk associated with exposures to such contaminants for female active duty service members. The study will also evaluate whether genetic variations affect susceptibility to environmental exposures.

If successful, findings from this study will identify specific exposures that contribute to breast cancer risk, leading to further understanding of the biological factors involved in breast cancer incidence.

Pelvic Pain Conservative Care in Female Service Members

Chronic pelvic pain, defined as persistent or recurrent pain perceived to be in and around the pelvis that lasts for at least 6 months that is not attributable to cancer,[13,14] disproportionately affects female service members. The disproportionate occurrence of chronic pelvic pain in female service members may result from higher incidence of hip and pelvic injuries, inadequate urogenital hygiene in deployed environments, or sexual trauma.[15,16]

The CDMRP's Peer Reviewed Orthopaedic Research Program funded a $2.5 million research project in 2024 to assess clinical effectiveness and physiological efficacy of 3 physical therapy treatments for chronic pelvic pain in female service members. This clinical trial, led by Shane Koppenhaver, PhD, at Baylor University, will randomly assign 300 women with chronic pelvic pain to 3 treatment groups. The study will test the hypothesis that field-expedient interventions are superior to usual care and not inferior to the highest or 'gold standard' of care. These interventions could enable injured female service members to remain on the battlefield or on mission without need for evacuation or medical discharge.

In addition to potential changes in clinical care guidelines, the study team aims to develop a clinical decision tool to predict subgroups of women with chronic pelvic pain who are most likely to benefit from emerging field-expedient care and differentiate those requiring 'gold standard' intravaginal specialist care.

Post-Traumatic Stress Disorder Prevention and Treatment with Microbiome-based Therapies

Women, service members, and veterans are more likely to develop PTSD than the general population, and there is an urgent need to identify more effective interventions.[17,18] To address this need, in 2023 the CDMRP's Traumatic Brain Injury and Psychological Health Research Program awarded $6.3 million to Brigham and Women's Hospital, for Yang-Yu Liu, PhD, to examine and target the relationship between PTSD and the gut microbiome, employing both human and animal studies.

Dr. Liu aims to develop a synbiotic therapeutic of prebiotics and probiotics to reduce PTSD symptoms. The study utilizes existing data and resources from the large, well-characterized cohort of women in the Nurses' Health Study II.[19] This CDMRP-funded study's 4 research projects will 1) differentiate the gut microbiomes in women who have experienced PTSD, trauma, or resilience, 2) reveal causation between PTSD and gut microbiome using a novel computational method, 3) quantify the effect of trauma exposure on the gut microbiome and neuronal activity in mice, and 4) test the efficacy of microbiome-based therapeutics in reversing stress-induced behavioral alterations in mice.

If successful, this effort will provide foundational evidence for microbiome-targeted interventions for PTSD treatment for improved life quality and function among women and others affected by PTSD.

Editorial Comment

Many more CDMRP-funded women's health-related studies are complete or ongoing. Results from these funded studies will continue to advance the medical profession's understanding and ability to prevent, assess, and treat diseases and conditions that affect military women's readiness. Prioritizing research on the diseases and conditions that affect women uniquely, disproportionately, or differently, considering sex as a biological variable in all stages of research while ensuring appropriate representation of the diverse affected populations in clinical research, will accelerate medical solutions for all military women and enhance mission readiness. The CDMRP's ongoing commitment to women's health research will contribute to research advancements that will benefit not only service members, but their families, veterans, and the American public at large.

To learn more about the CDMRP's programs and funded studies, or receive funding opportunity notifications by email, visit https://cdmrp.health.mil. Women's health portfolio inquiries can be submitted to dha.detrick.cdmrp.mbx.public-affairs@health.mil.

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Disclaimer

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References

1. Bytnar JA, McGlynn KA, Nealeigh MD, et al. Cancer incidence in the US military: an updated analysis. *Cancer*. 2024;130(1):96-106. doi:10.1002/cncr.34978
2. Deussing EC, Jankosky CJ, Clark LL, Otto JL. Estimated incidence of multiple sclerosis among United States Armed Forces personnel using the Defense Medical Surveillance System. *Mil Med*. 2012;177(5):594-600. doi:10.7205/milmed-d-11-00326
3. Yaffe K, Lwi SJ, Hoang TD, et al. Military-related risk factors in female veterans and risk of dementia. *Neurology*. 2019;92(3):205-211. doi:10.1212/wnl0000000000006778
4. Murray JH, Mabila SL, McQuistan AA. Trends in the incidence of eating disorders among active component service members, 2017 to 2021. *MSMR*. 2023;30(1):19-25. Accessed May 21, 2025. https://www.health.mil/news/articles/2023/01/01/incidence-of-eating-disorders
5. Segal MW, Lane MD, Fisher AG. Conceptual model of military career and family life course events, intersections, and effects on well-being. *Mil Behav Health*. 2015;3(2):95-107. doi:10.1080/21635781.2015.1009212
6. Department of Health, Education and Welfare, National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. *The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research*. Office for Human Research Protections, U.S. Dept. of Health and Human Services. 1979. Accessed Mar. 12, 2025. https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/read-the-belmont-report/index.html
7. U.S. Army Medical Research and Development Command. Congressionally Directed Medical Research Programs Directive on Inclusion of Women and Minorities as Subjects in Clinical Research. ebrap.org. U.S. Dept. of Defense. 2022. Accessed Dec. 23, 2024. https://ebrap.org/eBRAP/public/ViewTemplate.htm?fileTemplateId=1380&fileType=pdf
8. U.S. Army Medical Research and Development Command. Congressionally Directed Medical Research Programs Directive on Sex as a Biological Variable in Research. ebrap.org. U.S. Dept. of Defense. 2024. Accessed Dec. 23, 2024. https://ebrap.org/eBRAP/public/ViewTemplate.htm?fileTemplateId=1891&fileType=pdf
9. National Institutes of Health. NIH Policy and Guidelines on The Inclusion of Women and Minorities as Subjects in Clinical Research. U.S. Dept. of Health and Human Services. 1994. Accessed Dec. 23, 2024. https://grants.nih.gov/policy/inclusion/women-and-minorities/guidelines.htm
10. Office of Research on Women's Health. Consideration of Sex as a Biological Variable in NIH-funded Research. National Institutes of Health, U.S. Dept. of Health and Human Services. 2016. Accessed May 21, 2025. https://orwh.od.nih.gov/sites/orwh/files/docs/not-od-15-102_guidance_508.pdf
11. U.S. Cancer Statistics Working Group. United States Cancer Statistics: Data Visualizations, Cancer Statistics at a Glance. National Cancer Institute, Centers for Disease Control and Prevention U.S. Dept. of Health and Human Services. 2024. https://www.cdc.gov/cancer/dataviz
12. Surveillance, Epidemiology, and End Results Program, National Cancer Institute. Cancer Stat Facts: Cancer Among Adolescents and Young Adults (AYAs) (Ages 15-39). National Institutes of Health, U.S. Dept. of Health and Human Services. Accessed Apr. 14, 2025. https://seer.cancer.gov/statfacts/html/aya.html
13. Alappattu MJ, Bishop MD. Psychological factors in chronic pelvic pain in women: relevance and application of the fear-avoidance model of pain. *Phys Ther*. 2011;91(10):1542-1550. doi:10.2522/ptj.20100368
14. Speer LM, Mushkbar S, Erbele T. Chronic pelvic pain in women. *Am Fam Physician*. 2016;93(5):380-387. Accessed May 21, 2025. https://www.aafp.org/pubs/afp/issues/2016/0301/p380.pdf
15. Wright J, Albright TS, Gehrich AP, et al. Pelvic pain presenting in a combat environment. *Mil Med*. 2006;171(9):841-843. doi:10.7205/milmed.171.9.841
16. Cichowski SB, Rogers RG, Clark EA, et al. Military sexual trauma in female veterans is associated with chronic pain conditions. *Mil Med*. 2017;182(9):e1895-e1899. doi:10.7205/milmed-d-16-00393
17. Meadows SO, Engel CC, Collins RL, et al. 2018 Department of Defense Health Related Behaviors Survey (HRBS): Results for the Reserve Component. RAND.org. Published April 28, 2021. Accessed May 21, 2025. https://www.rand.org/pubs/research_reports/RR4222.html
18. Steenkamp MM, Litz BT, Marmar CR. First-line psychotherapies for military-related PTSD. *JAMA*. 2020;323(7):656. doi:10.1001/jama.2019.20825
19. Nurses' Health Study. Brigham and Women's Hospital, Harvard Medical School, Harvard T.H. Chan School of Public Health. Accessed Mar. 6, 2025. https://nurseshealthstudy.org

Surveillance Snapshot

Mid-Season Vaccine Effectiveness Estimates for Influenza: The Department of Defense Global Respiratory Pathogen Surveillance Program, 2024–2025 Season

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The Department of Defense Global Respiratory Pathogen Surveillance Program (DoDGRPSP) is an active sentinel respiratory surveillance program that resides at the Defense Centers for Public Health–Dayton (DCPH-D), located at Wright-Patterson Air Force Base. The DoDGRPSP assesses influenza vaccine effectiveness (VE) among Military Health System (MHS) beneficiaries at 118 sites worldwide.

This mid-season analysis includes respiratory specimens from MHS beneficiaries who sought outpatient medical care from November 24, 2024 through March 15, 2025 at a military hospital or clinic and met the influenza-like illness (ILI) case definition. DoDGRPSP methods, including ILI case definition, questionnaire submission, vaccination ascertainment, specimen collection, transportation, testing, and sequencing, have been previously described.[1]

A test-negative, case-control study design was used to estimate influenza VE against symptomatic laboratory-confirmed influenza. Cases were defined as an ILI patient testing positive for any influenza virus (sub)type with control specimens that had tested negative for influenza. Vaccinated patients were those receiving the 2024-2025 influenza vaccine at least 14 days before symptom onset. Those vaccinated less than 14 days before specimen collection were excluded. VE methodology has previously been described.[2,3]

Specimens were analyzed at Landstuhl Regional Medical Center, Incirlik AB, and DCPH-D by real-time reverse transcriptase-polymerase chain reaction (RT-PCR) and/or viral culture (at DCPH-D only). VE analyses were conducted for influenza A (any subtype), influenza A(H1N1)pdm09, and A(H3N2) for all beneficiaries, adults as well as children. VE estimates were adjusted for confounding factors such as age group, month of illness, and geographic region. Service members, patients less than 6 months old, and individuals with unknown vaccination status were excluded from VE analysis. The analysis included 295 participants who tested positive for influenza and 965 controls who tested negative for influenza.

Adjusted VE estimates among all beneficiaries for influenza A (any subtypes), influenza A(H1N1)pdm09, and influenza A(H3N2) were 25% (95% confidence interval [CI] -1, 44), 58% (95% CI, 31, 74), and 42% (95% CI, 14, 62), respectively. Adjusted VE for children was 27% (95% CI, -5, 50), 69% (95% CI, 43, 83), and 36% (95% CI, -5, 61), while among adults it was 17% (95% CI, -35, 49), 37% (95% CI, -43, 72), and 52% (95% CI, 2, 76) for influenza A (any subtype), influenza A(H1N1)pdm09, and influenza A(H3N2), respectively. VE for influenza B was not calculated due to a small number of cases.

This study reports low to moderate VE, but not all estimates were significant. There was moderate effectiveness against influenza A(H1N1)pdm09 in all beneficiaries and children ages 6 months to 17 years. In adults (ages 18-64 years) and all beneficiaries there was moderate effectiveness against influenza A(H3N2). VE estimates against influenza A (any subtype) for all beneficiaries, children, and adults were non-significant and not effective among children for influenza A(H3N2) and in adults for influenza A(H1N1)pdm09.

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TABLE. Influenza Vaccine Effectiveness Against Symptomatic Laboratory-Confirmed Ambulatory Influenza, Military Health System Beneficiaries, 2024–2025 Season

Type of Influenza	Population	Vaccinated	Cases		Controls		Crude VE (95% CI)	Adjusted VE[a] (95% CI)
			No.	%	No.	%		
A (any subtype)	Adults	Yes	56	61.5	217	64.2	11 (-44, 45)	17 (-35, 49)
		No	35	38.5	121	35.8		
A (any subtype)	Children	Yes	136	66.7	434	69.2	11 (-25, 36)	27 (-5, 50)
		No	68	33.3	193	30.8		
A (any subtype)	All beneficiaries	Yes	192	65.1	651	67.5	10 (-18, 32)	25 (-1, 44)
		No	103	34.9	314	32.5		
A(H1N1)pdm09	Adults	Yes	14	53.8	217	64.2	35 (-45, 71)	37 (-43, 72)
		No	12	46.2	121	35.8		
A(H1N1)pdm09	Children	Yes	21	45.7	434	69.2	63 (32, 80)	69 (43, 83)
		No	25	54.3	193	30.8		
A(H1N1)pdm09	All beneficiaries	Yes	35	48.6	651	67.5	54 (26, 72)	58 (31, 74)
		No	37	51.4	314	32.5		
A(H3N2)	Adults	Yes	18	46.2	217	64.2	52 (7, 75)	52 (2, 76)
		No	21	53.8	121	35.8		
A(H3N2)	Children	Yes	51	55.4	434	69.2	45 (14, 65)	36 (-5, 61)
		No	41	44.6	193	30.8		
A(H3N2)	All beneficiaries	Yes	69	52.7	651	67.5	46 (22, 63)	42 (14, 62)
		No	62	47.3	314	32.5		

Abbreviations: CI, confidence interval; No., number; VE, vaccine effectiveness.
[a] Adjusted for age group, geographic region and month of illness.

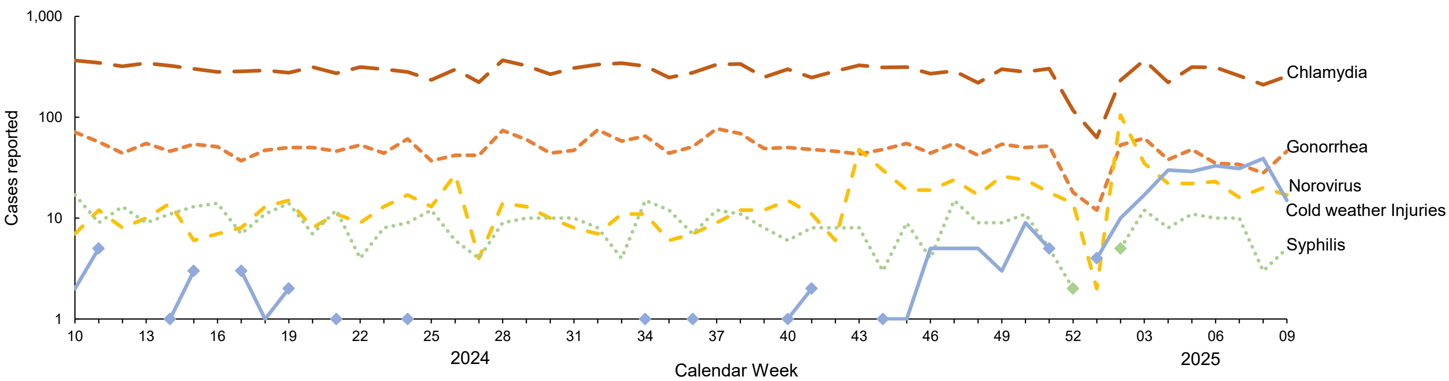
REFERENCES

1. Kwaah B, Gruner WE, DeMarcus L, et al. Surveillance trends for SARS-CoV-2 and other respiratory pathogens among US military health system beneficiaries, 27 September 2020–2 October 2021. *MSMR*. 2022;29(7):2-10. Accessed Apr. 29, 2025. https://www.health.mil/news/articles/2022/07/01/sur-sar2-msmr
2. Hu W, Gruner WE, DeMarcus LS, et al. Influenza surveillance trends and influenza vaccine effectiveness among Department of Defense beneficiaries during the 2019–2020 influenza season. *MSMR*. 2021;28(3):2-8. Accessed Apr. 29, 2025. https://www.health.mil/news/articles/2021/03/01/influenza-surv-msmr-2021
3. Eick-Cost AA, Thervil JW, Hu Z, DeMarcus LS. Mid-season influenza vaccine effectiveness estimates among DOD populations: a composite of data presented at VRBPAC–the Vaccines and Related Biological Products Advisory Committee–2024 meeting on influenza vaccine strain selection for the 2024-2025 influenza season. *MSMR*. 2024;31(3):20-23. Accessed Apr. 29, 2025. https://www.health.mil/news/articles/2024/03/01/msmr-flu-vaccine-effectiveness

Reportable Medical Events at Military Health System Facilities Through Week 9, Ending March 1, 2025

Idalia Aguirre, MPH; Matthew W. R. Allman, MPH; Anthony R. Marquez, MPH; Katherine S. Kotas, MPH

TOP 5 REPORTABLE MEDICAL EVENTS[a] BY CALENDAR WEEK, ACTIVE COMPONENT (MARCH 9, 2024–MARCH 1, 2025)



Abbreviation: RMEs, reportable medical events.

[a]Cases are shown on a logarithmic scale.

Note: There were 0 reported cold weather injury cases during weeks 12–13, 16, 20, 22–23, 25–33, 35, 37–39, 42–43, 52. There were no syphilis cases reported during week 1 of 2025.

Reportable Medical Events (RMEs) are documented in the Disease Reporting System internet (DRSi) by health care providers and public health officials throughout the Military Health System (MHS) for monitoring, controlling, and preventing the occurrence and spread of diseases of public health interest or readiness importance. These reports are reviewed by each service's public health surveillance hub. The DRSi collects reports on over 70 different RMEs, including infectious and non-infectious conditions, outbreak reports, STI risk surveys, and tuberculosis contact investigation reports. A complete list of RMEs is available in the *2022 Armed Forces Reportable Medical Events Guidelines and Case Definitions*.[1] Data reported in these tables are considered provisional and do not represent conclusive evidence until case reports are fully validated.

Total active component cases reported per week are displayed for the top 5 RMEs for the previous year. Each month, the graph is updated with the top 5 RMEs, and is presented with the current month's (February 2025) top 5 RMEs, which may differ from previous months. COVID-19 is excluded from these graphs due to changes in reporting and case definition updates in 2023.

For questions about this report, please contact the Disease Epidemiology Branch at the Defense Centers for Public Health–Aberdeen. Email: dha.apg.pub-health-a.mbx.disease-epidemiologyprogram13@health.mil

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References

1. Armed Forces Health Surveillance Division. Armed Forces Reportable Medical Events. Accessed Feb. 28, 2024. https://health.mil/reference-center/publications/2022/11/01/armed-forces-reportable-medical-events-guidelines
2. Defense Manpower Data Center. Department of Defense Active Duty Military Personnel by Rank/Grade of Service. Accessed Feb. 28, 2024. https://dwp.dmdc.osd.mil/dwp/app/dod-data-reports/workforce-reports
3. Defense Manpower Data Center. Armed Forces Strength Figures for January 31, 2023. Accessed Feb. 28, 2024. https://dwp.dmdc.osd.mil/dwp/app/dod-data-reports/workforce-reports
4. Navy Medicine. Surveillance and Reporting Tools–DRSI: Disease Reporting System Internet. Accessed Feb. 28, 2024. https://www.med.navy.mil/navy-marine-corps-public-health-center/preventive-medicine/program-and-policy-support/disease-surveillance/drsl

TABLE. Reportable Medical Events, Military Health System Facilities, February 2025[a]

Reportable Medical Event[b]	Active Component					MHS Beneficiaries[d]
	February 2025	January 2025	YTD 2025	YTD 2024	Total 2024	February 2025
	No.	No.	No.	No.	No.	No.
Amebiasis	2	4	6	1	15	0
Arboviral diseases, neuroinvasive and non-neuroinvasive	0	0	0	0	3	0
Brucellosis	0	0	0	0	1	0
COVID-19-associated hospitalization or death	2	3	5	15	41	13
Campylobacteriosis	10	23	33	25	326	11
Chikungunya virus disease	0	0	0	0	1	0
Chlamydia trachomatis	1,042	1,185	2,227	2,842	15,637	127
Cholera	0	0	0	0	3	0
Coccidioidomycosis	2	0	2	17	53	2
Cold weather injury[e]	121	87	208	113	172	N/A
Cryptosporidiosis	3	8	11	19	82	0
Cyclosporiasis	0	0	0	0	11	0
Dengue virus infection	0	1	1	1	12	0
E. coli, Shiga toxin-producing	2	4	6	5	93	1
Ehrlichiosis/anaplasmosis	0	0	0	0	1	0
Giardiasis	5	9	14	17	98	4
Gonorrhea	142	211	353	535	2,768	21
Haemophilus influenzae, invasive	1	0	1	1	3	3
Heat illness[e]	13	6	19	24	1,277	N/A
Hepatitis A	0	0	0	1	7	0
Hepatitis B, acute and chronic	7	6	13	26	106	3
Hepatitis C, acute and chronic	3	0	3	9	29	6
Influenza-associated hospitalization[f]	14	19	33	27	54	73
Lead poisoning, pediatric[g]	N/A	N/A	N/A	N/A	N/A	5
Legionellosis	0	0	0	3	5	0
Leprosy	0	0	0	0	1	0
Listeriosis	0	1	1	0	0	0
Lyme disease	2	1	3	9	101	1
Malaria	0	0	0	2	21	0
Meningococcal disease	0	0	0	0	2	0
Mpox	0	1	1	2	14	0
Mumps	0	0	0	0	0	1
Norovirus	74	185	259	48	653	68
Pertussis	2	6	8	3	39	6
Post-exposure prophylaxis against Rabies	37	33	70	95	623	28
Q fever	0	0	0	0	3	0
Rubella	0	0	0	0	0	1
Salmonellosis	4	4	8	14	160	3
Schistosomiasis	0	0	0	0	1	0
Shigellosis	2	2	4	7	53	1
Spotted fever rickettsiosis	2	1	3	0	22	0
Syphilis (all)[h]	28	36	64	122	518	9
Toxic shock syndrome	0	0	0	1	2	0
Trypanosomiasis	0	1	1	1	5	0
Tuberculosis	0	0	0	1	7	0
Tularemia	0	0	0	1	1	0
Typhoid fever	0	0	0	0	1	0
Typhus fever	0	1	1	1	2	1
Varicella	1	1	2	4	18	6
Zika virus infection	0	0	0	1	1	0
Total case counts	1,521	1,839	3,360	3,993	23,046	394

Abbreviations: MHS, Military Health System; YTD, year-to-date; no., number; *E., Escherichia*; N/A, not applicable.

[a] RMEs submitted to DRSi as of Mar. 24, 2025. RMEs were classified by date of diagnosis or, where unavailable, date of onset. Monthly comparisons are displayed for the period of Jan. 1, 2025–Jan. 31, 2025 and Feb. 1, 2025–Feb. 28, 2025. YTD comparison is displayed for the period of Jan. 1, 2025–Feb. 28, 2025 for MHS facilities. Previous year counts are provided as the following: previous YTD, Jan. 1, 2024-Feb. 29, 2024; total 2024, Jan. 1, 2024–Dec. 31, 2024.

[b] RME categories with 0 reported cases among active component service members and MHS beneficiaries for the time periods covered were not included in this report.

[c] Services included in this report include the Army, Navy, Air Force, Marine Corps, Coast Guard, and Space Force, including personnel classified as Active Duty, Cadet, Midshipman, or Recruit in DRSi.

[d] Beneficiaries include: individuals classified as Retired and Family Members (including Spouse, Child, Other, Unknown). National Guard, Reservists, civilians, contractors, and foreign nationals were excluded from these counts.

[e] Only reportable for service members.

[f] Influenza-associated hospitalization is reportable only for individuals under age 65 years.

[g] Pediatric lead poisoning is reportable only for children aged 6 years or younger.

[h] The observed drop in syphilis cases from 2024 to 2025 may be due, in part, to an updated case validation process that began Jan. 2024.


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On the cover: *Chief Master Sgt. Tiffany Zaloudek, Deputy SERE Career Field Program Manager, is the first female SERE (Survival, Evasion, Resistance and Escape) Specialist to earn the rank of Chief Master Sergeant.*

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