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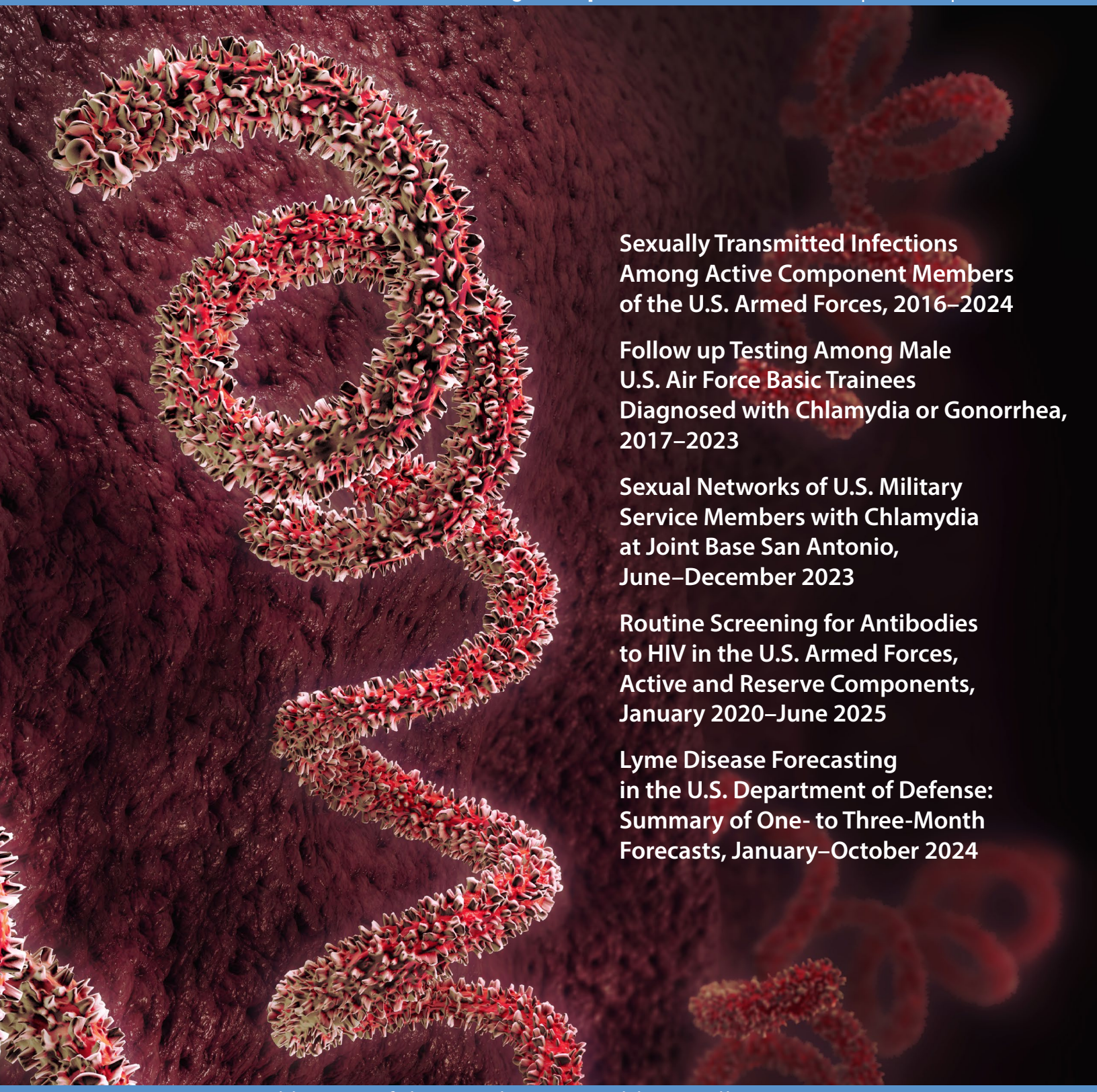

Sexually Transmitted Infections Among Active Component Members of the U.S. Armed Forces, 2016–2024

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Medical Surveillance for Military Readiness

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Update

Sexually Transmitted Infections Among Active Component Members of the U.S. Armed Forces, 2016–2024

This report summarizes incidence rates and trends of the 5 most frequently occurring sexually transmitted infections (STIs) from 2016 through 2024 among active component service members of the U.S. Armed Forces. The data for this report were derived from medical and public health surveillance of chlamydia, gonorrhea, and syphilis as nationally notifiable diseases; case data for 2 additional STIs, human papillomavirus (HPV) and genital herpes simplex virus (HSV), are also presented. Chlamydia infections were the most common during the surveillance period, followed, in decreasing order of frequency, by HPV, gonorrhea, genital HSV, and syphilis. In 2024, both chlamydia and gonorrhea rates dropped to their lowest points of the period of surveillance, falling 25.5% and 26.4%, respectively, from their 2019 peaks. Declines were predominantly concentrated among service members younger than 25 years of age—who were the largest contributors to overall incidence. Notably, syphilis incidence rose steadily throughout the surveillance period, among all age groups, and both sexes, with steepest rises after 2021, increasing nearly 70%. Non-Hispanic Black service members continue to bear the highest syphilis burden, among whom incidence peaked in 2023, before declining approximately 15% in 2024. Syphilis rates continued to rise among all other racial and ethnic groups through 2024, with the largest relative increase, 456%, among non-Hispanic White service women under age 25 years. Genital HSV demonstrated a downward trend throughout the surveillance period, with overall incidence reaching its lowest point in 2024. Incidence of genital HPV also decreased among all service members, with a more pronounced decrease among men.

What are the new findings?

Chlamydia, gonorrhea, and genital HSV incidence rates dropped to their lowest points of the 9-year surveillance period. In contrast, total syphilis incidence rose among all age groups, and both sexes, with the highest incidence among service women ages 17-19 years. While syphilis incidence rates remain highest among non-Hispanic Black service members, its incidence has risen sharply in all other racial and ethnic groups, reflecting an evolving and expanding syphilis epidemiology within the military in addition to the general U.S. population.

What is the impact on readiness and force health protection?

STIs can adversely affect service member ability and availability to perform assigned duties and can result in serious medical sequelae if left untreated. Syphilis infection in reproductive age military women can cause miscarriage, stillbirth, or congenital syphilis, affecting women's health, deployability, and overall force readiness, while increasing health care costs. Expanded prevention, testing, and treatment, along with comprehensive sexual health education, particularly targeting those younger than age 25 years, are warranted to curb transmission and maintain operational effectiveness.

Sexually transmitted infections (STIs) represent one of the highest health care burdens attributable to infectious diseases among active component service members (ACSMs) of the U.S. Armed Forces.[1] A National Academies of Sciences, Engineering and Medicine committee, convened to provide recommendations for prevention and control of STIs in the U.S., concluded that military recruits and active duty service members warrant focused consideration due to their elevated risk of STIs.[2] While multiple and inter-related factors influence STI risk within military populations, the strongest risk factors are age and sex.[3] Since the military population consists of young (mean age 26 years) and predominantly male (85%) service members, rates are not directly comparable to the general U.S. population, unless adjusted for those demographics.

The U.S. Centers for Disease Control and Prevention (CDC) publishes annual summaries of national surveillance data for notifiable diseases, including *Chlamydia trachomatis* (chlamydia), *Neisseria gonorrhoeae* (gonorrhea), and *Treponema pallidum* (syphilis), under federally funded control programs.[4] Although relatively common bacterial STIs are curable with antibiotics, there is continued concern about the threat of multi-drug resistance.[5-7]

Common viral STIs in the U.S. include infections caused by human papillomavirus (HPV) and genital herpes simplex virus (HSV).[8,9] While most HPV infections resolve spontaneously, a subset can persist and progress to HPV-associated cancers, including cervical cancer in women, as well

as anal, penile, and oropharyngeal cancers in both sexes.[10] Similarly, genital HSV can lead to recurrent genital ulcer disease with sustained transmission within the population due to asymptomatic shedding. Suppression of recurrent herpes is attainable using anti-viral medication, and a vaccine prevents infection from 4 of the most common HPV serotypes, as well as 5 additional cancerous types.[11]

This report presents an update to the previous *MSMR* article on these 5 STIs among U.S. ACSMs, covering the surveillance period of 2016 through 2024.[12]

Methods

The surveillance population for this report consists of all ACSMs of the U.S. Army, Navy, Air Force, or Marine Corps who served at any time during the surveillance period of January 1, 2016 through December 31, 2024. Diagnoses of STIs were ascertained from medical administrative data and reports of notifiable medical events routinely provided to the Armed Forces Health Surveillance Division and maintained in the Defense Medical Surveillance System (DMSS) for health surveillance. STI cases were also derived from positive laboratory test results recorded in the Health Level 7 (HL7) chemistry and microbiology databases compiled by the Defense Centers for Public Health–Portsmouth.

The number of days in active service for each service member was ascertained, which were then aggregated to a total for all service members for each calendar year. The resultant annual totals are expressed as person-years (p-yrs) of service, used as the denominators for calculating annual incidence rates. Person-time not considered time at risk for an STI was excluded, such as the 30 days following each incident chlamydia or gonorrhea infection and all person-time following an initial diagnosis, medical event report, or positive laboratory test of HSV, HPV, or syphilis. Incidence rates were calculated as incident cases of a given STI per 100,000 p-yrs of active component service, with percent changes in incidence calculated by un-rounded rates.

An incident case of chlamydia was defined by either 1) a case-defining diagnosis **(Table 1)** in the first or second diagnostic position of a record of an outpatient or in-theater medical encounter, 2) a confirmed notifiable disease report, or 3) a positive laboratory test (for any specimen source or test type). An incident case of gonorrhea was similarly defined by 1) a case-defining diagnosis in the first or second diagnostic position of an inpatient, outpatient, or in-theater encounter record, 2) a confirmed notifiable disease report, or 3) a positive laboratory test (for any specimen source or test type). For both chlamydia and gonorrhea, an individual could be counted as having a subsequent case only if more than 30 days occurred between the dates recorded for each case-defining diagnosis.

An incident case of syphilis was defined by either 1) a qualifying International Classification of Diseases, 9th or 10th Revision (ICD-9/ICD-10) code in the first, second, or third diagnostic position of a hospitalization record, 2) at least 2 outpatient or in-theater encounters within 30 days with a qualifying ICD-9/ICD-10 code in the first or second position, 3) a confirmed notifiable disease report for any type of syphilis, or 4) a record of a positive polymerase chain reaction or treponemal laboratory test. Stages of syphilis (primary, secondary, late, latent) could not be distinguished because HL7 laboratory data do not allow for stage differentiation, and because a high degree of misclassification is associated with use of ICD diagnosis codes for stage determination.[13,14] An individual could be considered an incident case of syphilis only once during the surveillance period; those with evidence of prior syphilis infection were excluded.

Incident cases of genital HSV were identified by either 1) presence of requisite ICD-9/ICD-10 codes in either the first or second diagnostic positions of an outpatient or in-theater encounter record or 2) a positive laboratory test from a genital specimen source. Antibody tests were excluded because they do not allow distinction between genital and oral infections. Incident cases of genital HPV were similarly identified by either 1) presence of requisite ICD-9/ICD-10 codes in either the first or second diagnostic positions of an outpatient or in-theater encounter record or 2) a positive laboratory test from any specimen source or test type. Outpatient encounters for HPV with evidence of HPV immunization within 7 days before or after an encounter date were excluded, as were outpatient encounters with a procedural or Current Procedural Terminology (CPT) code indicating HPV vaccination, as such encounters were potentially related to vaccination administration. An individual could be counted as an incident case of HSV or HPV only once during the surveillance period. Individuals with diagnoses of HSV or HPV infection before the surveillance period were excluded.

TABLE 1. ICD-9 and ICD-10 Diagnostic Codes Used to Identify STI Cases in Electronic Health Care Records

STI	ICD-9	ICD-10
HPV	078.11, 079.4, 795.05, 795.09, 795.15, 795.19, 796.75, 796.79	A63.0, R85.81, R85.82, R87.81, R87.810, R87.811, R87.82, R87.820, R87.821, B97.7
Chlamydia	099.41, 099.5*	A56.*
Genital HSV	054.1*	A60.*
Gonorrhea	098.*	A54.*
Syphilis	091.*, 092.*, 093.*–096.*, 097.0, 097.1, 097.9	A51.* (excluding A51.31), A52.*, A53.0, A53.9

Abbreviations: ICD-9, International Classification of Diseases, 9th Revision; ICD-10, International Classification of Diseases, 10th Revision; STI, sexually transmitted infection; HPV, human papillomavirus; HSV, herpes simplex virus.
Note: Asterisk (*) indicates that any subsequent digit or character is included.

To characterize trends during the surveillance period, age- and sex-specific percent changes relative to each group's peak rate were calculated. Recent trends were assessed through annual percentage changes that compare 2024 with 2023. When notable differences in rates or trends were observed, absolute differences in incidence rates from peak levels were calculated to identify which age- and sex-specific groups contributed most to the overall decline. Results are presented as age- and sex-specific trends for the entire 2016–2024 surveillance period, and as recent changes from 2023 to 2024, for each STI. Incidence rates are expressed per 100,000 p-yrs.

Results

General incidence and distribution patterns

Chlamydia infections were the most common during the surveillance period, followed, in decreasing order of infection frequency, by HPV, gonorrhea, genital herpes, and syphilis **(Table 2)**. Chlamydia accounted for the majority of reported STI cases during the surveillance period, with nearly twice as many cases as the combined total of the other 4 STIs, and nearly 5-fold higher than HPV, the next most frequently identified STI. Except for syphilis, incidence was generally higher in female service members; for gonorrhea, total incidence rates were similar between sexes.

The highest concentration of cases was among service members ages 20-24 years, who comprised over half of chlamydia (58%) and gonorrhea (52%) cases, as well as 36-42% of cases for the other 3 STIs. The 25-29-years age group accounted for the next largest proportion of cases for all STIs, comprising 19-27% of cases. HPV was most common (22%) STI among those aged 30-34 years.

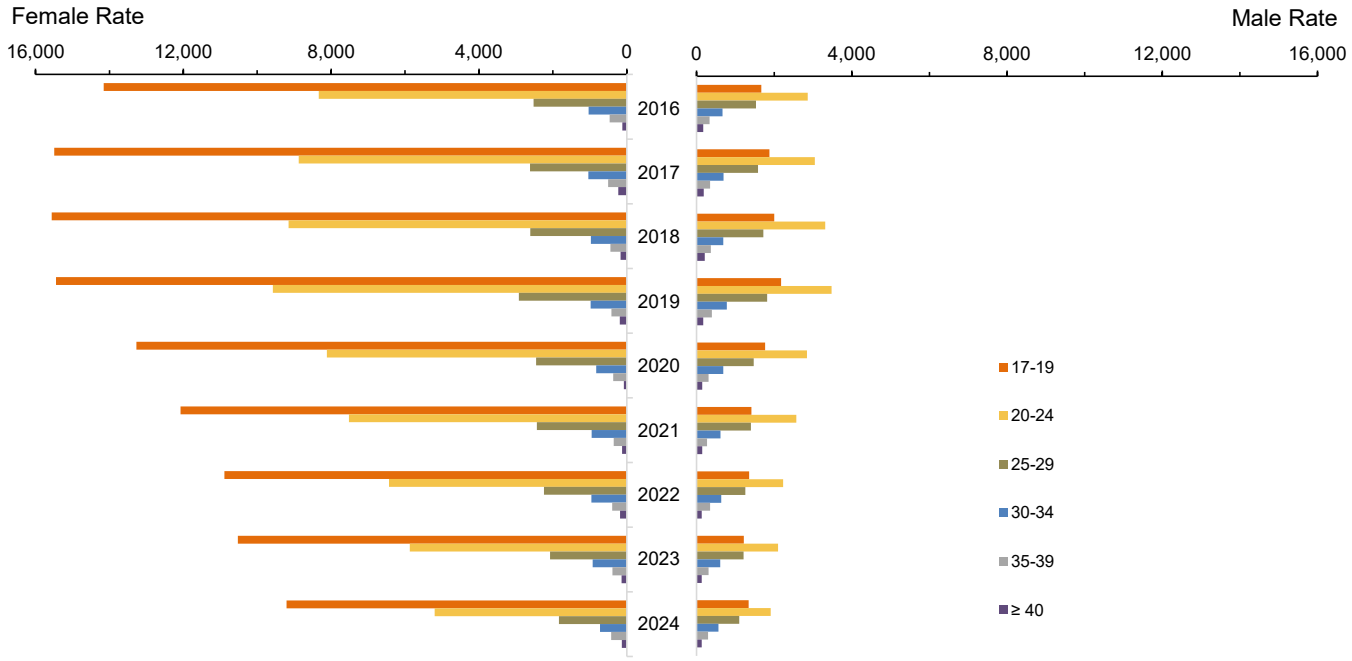
Incidence rates for all 5 STIs were highest among those who had never married (among those with defined marital status) as well as non-Hispanic Black service members. With the exception of HPV, rates of infection were also highest among individuals with a high school education or less, and among junior enlisted members; in contrast, HPV revealed a different pattern, with the highest incidence observed among those with educations beyond high school, and among junior officers. Chlamydia and gonorrhea incidence were highest in the Army, syphilis and genital HPV incidence were highest in the Navy, while genital HSV rates were generally comparable among service branches.

Chlamydia

Age- and sex-stratified trends

Annual chlamydia rates continued to decline in 2024, extending the downward trend observed since 2020, as previously reported **(Figure 1)**.[12] In 2024, chlamydia incidence fell to its lowest point in 9 years, to 1,395.9 cases per 100,000 p-yrs, a 43.8% decline from the 2019 peak rate of 2,484.1 cases per 100,000 p-yrs. The largest reductions from peak rates occurred in younger age groups, who accounted for most of the total incidence rate decline. Among female service members, over 88% of the total decline (12,144 fewer overall cases

FIGURE 1. Incidence Rates[a] of *Chlamydia Trachomatis* Infection Among Women and Men, by Age, Active Component, U.S. Armed Forces, 2016–2024



Abbreviation: p-yrs, person-years.
[a] Incidence rates per 100,000 p-yrs.

TABLE 2. Incident Counts and Incidence Rates of STIs, Active Component, U.S. Armed Forces, 2016–2024

	Chlamydia		Gonorrhea		Syphilis		Genital HSV		Genital HPV	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	227,653	1,955.8	38,987	334.5	7,466	64.2	24,276	211.4	47,629	424.2
Sex										
Male	142,375	1,472.5	30,978	320.1	6,412	66.4	12,848	134.1	15,099	158.8
Female	85,278	4,327.4	8,009	405.1	1,054	53.4	11,428	601.2	32,530	1,893.3
Age group, y										
<20	31,654	3,810.0	4,154	498.7	803	96.4	1,811	217.6	566	67.9
20–24	132,048	3,585.1	20,235	548.0	2,817	76.4	10,272	280.0	17,038	465.7
25–29	44,083	1,627.7	8,829	325.6	1,910	70.6	6,377	238.4	12,659	481.0
30–34	13,250	706.1	3,584	190.9	1,075	57.4	3,174	172.7	10,405	591.8
35–39	4,797	344.2	1,492	107.0	517	37.2	1,651	122.1	4,319	339.0
≥40	1,821	158.7	693	60.4	344	30.1	991	88.9	2,642	246.4
Race and ethnicity										
White, non-Hispanic	82,856	1,303.7	9,910	155.8	2,289	36.0	10,255	163.2	21,431	348.3
Black, non-Hispanic	75,330	4,019.9	19,692	1,048.3	2,648	141.5	7,332	401.1	10,723	600.3
Hispanic	46,940	2,327.5	5,926	293.4	1,675	83.1	4,406	221.1	9,163	470.4
Other, unknown	22,527	1,616.1	3,459	247.9	854	61.3	2,283	165.7	6,312	471.1
Education										
High school or less	197,278	2,683.9	32,457	440.8	5,498	74.8	17,224	236.4	28,265	392.2
Some college	13,538	983.7	2,738	198.8	736	53.6	2,742	204.9	6,482	509.1
Bachelor's, advanced degree	14,331	543.9	3,317	125.8	1,088	41.4	3,892	150.7	11,579	466.9
Other, unknown	2,506	900.3	475	170.6	144	51.8	418	152.0	1,303	484.4
Marital status										
Single, never married	162,191	3,157.3	26,853	521.6	4,842	94.2	13,292	260.3	23,341	462.2
Married	51,802	873.3	9,874	166.4	2,170	36.6	8,516	146.1	18,648	328.9
Other, unknown	13,660	2,390.8	2,260	394.9	454	79.6	2,468	451.6	5,640	1,111.9
Service branch										
Army	93,258	2,234.6	18,706	447.6	2,753	66.0	10,224	248.6	16,474	407.8
Navy	54,587	1,841.9	9,662	325.6	2,790	94.3	5,977	204.5	13,991	491.0
Air Force	44,841	1,549.4	5,971	206.1	1,233	42.6	5,454	191.4	12,782	463.8
Marine Corps	34,967	2,173.6	4,648	288.5	690	42.9	2,621	164.1	4,382	276.8
Rank, grade										
Junior enlisted (E1–E4)	169,188	3,415.8	26,816	540.1	4,786	96.6	13,227	267.9	21,825	443.9
Senior enlisted (E5–E9)	49,083	1,066.8	10,144	220.3	2,092	45.6	8,307	184.9	17,440	403.1
Junior officer (O1–O3)	7,957	681.1	1,522	130.2	401	34.4	1,979	171.3	6,083	539.7
Senior officer (O4–O10)	848	113.3	348	46.5	138	18.5	554	75.6	1,833	261.9
Warrant officer (W01–W05)	577	341.2	157	92.8	49	29.0	209	127.8	448	285.1
Military occupation										
Combat-specific[b]	26,703	1,689.0	4,783	302.2	670	42.4	2,501	159.5	3,298	212.2
Motor transport	10,970	3,217.9	2,087	610.9	431	126.5	920	272.8	1,816	546.2
Pilot, air crew	2,273	543.3	315	75.3	92	22.0	454	109.9	1,162	288.3
Repair, engineering	62,948	1,851.1	10,486	308.0	1,667	49.1	6,204	184.5	11,147	336.8
Communications, intelligence	56,561	2,268.1	10,751	430.5	1,658	66.6	6,611	270.6	13,396	567.7
Health care	17,014	1,703.9	2,897	289.8	619	62.1	2,637	269.5	7,196	771.9
Other	51,184	2,126.8	7,668	318.2	2,329	96.8	4,949	208.0	9,614	411.5

Abbreviations: STIs, sexually transmitted infections; HSV, herpes simplex virus; HPV, human papillomavirus; No., number; y, years.
[a] Incidence rate per 100,000 person-years.
[b] Infantry, artillery, combat engineering, armor.

per 100,000 p-yrs; 46.5% decrease from 2019 peak) was among women ages 17-24 years (data not shown). Among male service members, the largest declines were among those aged 20-24 years (1,570 fewer cases per 100,000 p-yrs; 45.1% decrease from peak), followed by those aged 17-19 years (838 fewer cases per 100,000 p-yrs, 38.5% decrease), and 25-29 years of age (716 fewer cases per 100,000 p-yrs, 39.3% decrease) (data not shown).

Chlamydia rates among female service members were generally 3 times higher than among male service members throughout the 9-year surveillance period. Throughout the surveillance period, for individuals aged 17-19 years, rates were 7–9 times higher among women than men. Older groups (≥ age 30 years) accounted for a much smaller share of the total incidence and contributed minimally to overall declines in both sexes. Declines in chlamydia rates were consistent among all racial and ethnic groups **(Figure 2)**.

Age- and sex-specific changes in 2024 versus 2023

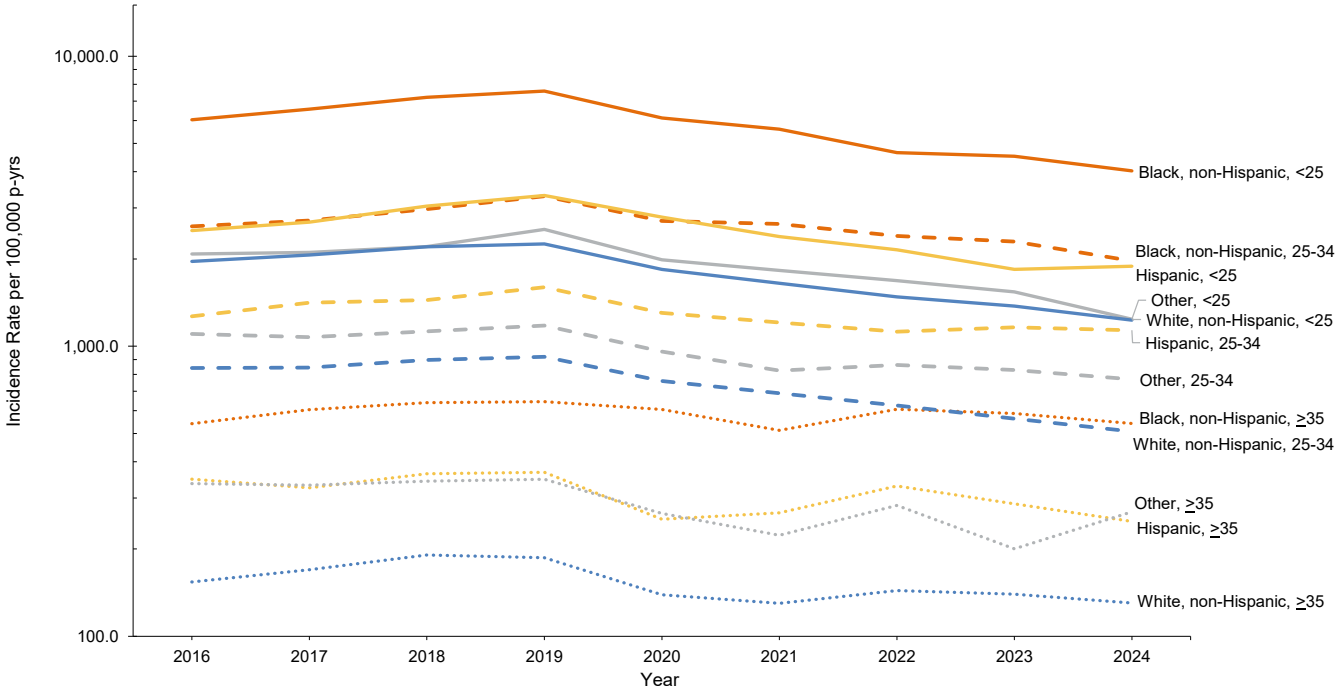
Total chlamydia incidence rates declined by 11.8% (from 3,310.4 cases per 100,000 p-yrs in 2023 to 2,919.5 cases per 100,000 p-yrs in 2024) among female and 7.9% (from 1,155.6 cases per 100,000 p-yrs in 2023 to 1,064.7 cases per 100,000 p-yrs in 2024) among male service members. Declines among female service members were concentrated among those aged 17-24 years, with 17-19-year-olds driving the largest decrease: 12.5% (data not shown). In contrast, rates among male service members in the same 17-19-years age range increased by 9.7%. Divergent changes were also observed among older age groups (35-39 years), with incidence rates increasing (+10.2%) among women and decreasing (-4.4%) among men. In the 40 years and older age group, differences were minor, with slight declines in women (-5.5%) and small increases (+2.2%) in men.

Gonorrhea

Age- and sex-stratified trends

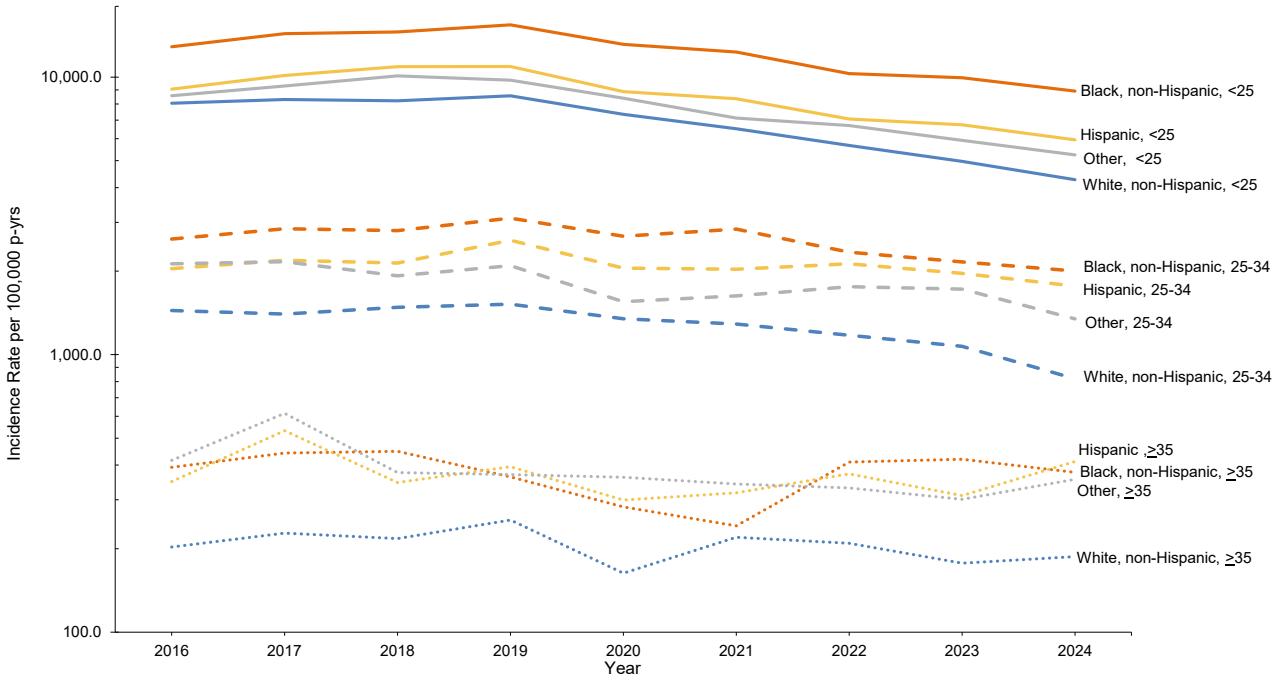
Gonorrhea incidence rates continued to decline for both female and male service members in 2024, following increases that peaked prior to 2020. These trends parallel those observed for chlamydia **(Figure 3)**. The largest reductions in gonorrhea incidence occurred among younger age groups. Among female service members, total crude incidence decreased from 490.9 per 100,000 p-yrs at the 2018 peak to 254.9 per 100,000 p-yrs in 2024 (-48.1%), with those younger than age 25 years accounting for 72.4% of this reduction. Similarly, the total crude incidence among male service members declined from 347.0 per 100,000 p-yrs at the 2019 peak to 276.6 per 100,000 p-yrs in 2024 (-20.3%), with those younger than age 30 years accounting for nearly all (98.8%) of the total decline. Women older than age 25 years also experienced notable declines (range -42% to -66%),

FIGURE 2a. Incidence Rates[a] of *Chlamydia Trachomatis* Infection Among Women, by Age and Racial and Ethnic Group, Active Component, U.S. Armed Forces, 2016-2024



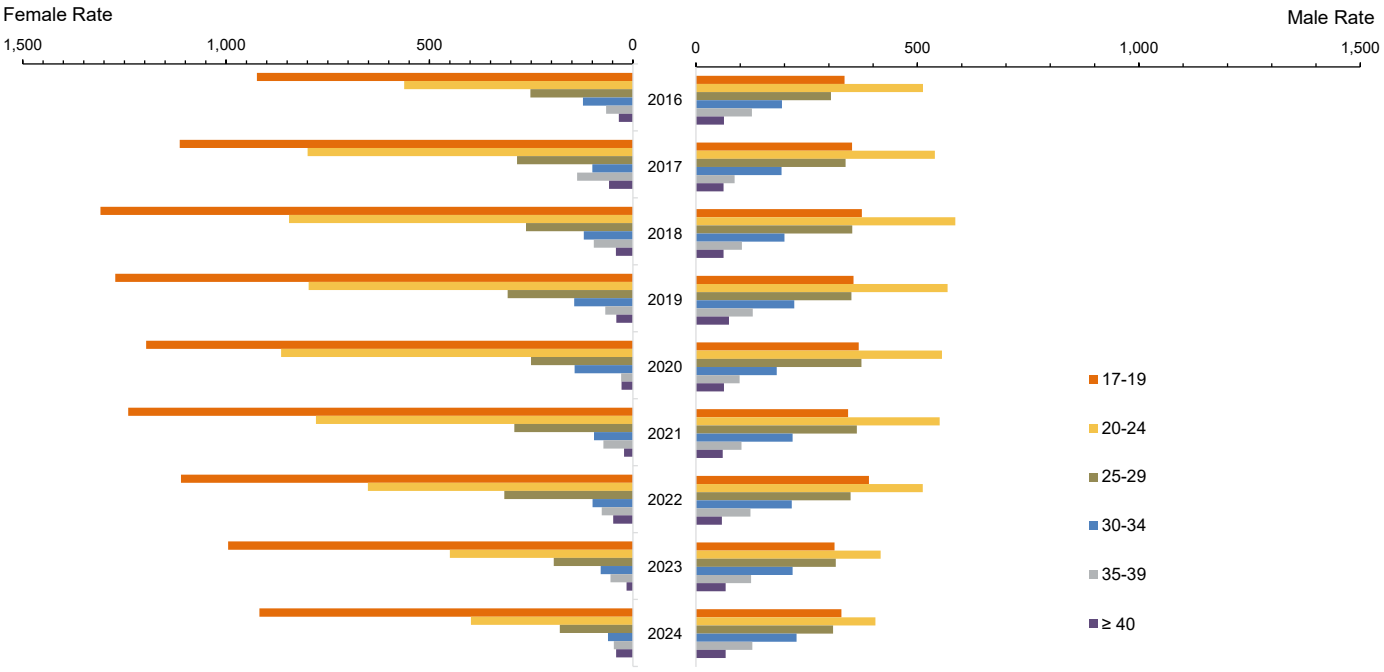
Abbreviation: p-yrs, person-years.
[a] Rates presented on a logarithmic scale.

FIGURE 2b. Incidence Rates[a] of *Chlamydia Trachomatis* Infection Among Men, by Age and Racial and Ethnic Group, Active Component, U.S. Armed Forces, 2016-2024



Abbreviation: p-yrs, person-years.
[a] Rates presented on a logarithmic scale.

FIGURE 3. Incidence Rates[a] of Gonorrhea Infection Among Women and Men, by Age, Active Component, U.S. Armed Forces, 2016–2024



Abbreviation: p-yrs, person-years.
[a] Incidence rates per 100,000 p-yrs.

while incidence among men aged 30 years and older remained relatively stable over the surveillance period.

As observed with chlamydia infections, female service members aged 17-19 years demonstrated highest gonorrhea incidence, with rates nearly 3 times higher than their male counterparts. Sex disparities in other age groups were less pronounced, although men older than age 35 years tended to have higher gonorrhea rates than women of the same age (data not shown).

Age- and sex-specific changes in 2024 versus 2023

Gonorrhea incidence among service women declined by 9.3% from 2023 to 2024, with the largest decrease among those aged 30-34 years (-22.9%). The total rate among service men declined slightly (-1.2%), with no notable changes in age-stratified rates (data not shown).

Syphilis

Age- and sex-stratified trends

Syphilis incidence increased from 2016 through 2024 among all age groups, and both sexes, with the largest increases observed after 2021 **(Figure 4)**. In 2024 a remarkable shift occurred in syphilis incidence: The total incidence rate among female service members surpassed that of male service members for the first time during the surveillance period **(Figure 5)**. The steepest increase among service women was observed in those aged 17-19 years, among whom incidence rose nearly 4-fold, from a low of 52.7 per 100,000 p-yrs in 2018 to approximately 200 cases per 100,000 p-yrs from 2022 through 2024. Rates among women rose approximately 3-fold from 2016 to 2024 among those aged 20-24 years, from 28.7 cases per 100,000 p-yrs in 2016 to 95.4 cases per 100,000 p-yrs in 2024, with a peak of 107.1 cases in 2023. Although incidence rates were lower in the older female age groups, they demonstrated 3- to 5-fold increases.

Syphilis incidence among service men aged 17-19 years peaked at 124.4 per 100,000 p-yrs in 2022, before declining to 96.4 per 100,000 p-yrs in 2024, which still represented a 1.4-fold increase from the 2016 low of 67.7 per 100,000 p-yrs. The 20-24-years male age group showed a smaller (1.2-fold) increase from 2016 to 2024, while incidence rates among men ages 25-34 years increased 1.7- to 1.9-fold, reaching incidence rate levels comparable to the youngest age groups in 2024. Substantial rises in incidence were also observed among older males: 2.6-fold (from 21.5 to 55.2 per 100,000 p-yrs) among those aged 35-39 years and 2.2-fold (from 19.1 to 42.1 per 100,000 p-yrs) among those aged 40 years and older.

Syphilis burden was highest among non-Hispanic Black service members, with incidence rates 2- to 5-times greater (depending upon age group) than those of non-Hispanic White service members, who had the lowest incidence. Non-Hispanic Black men younger than age 25 years accounted for a disproportionate number of syphilis cases, and had the highest incidence rates, which peaked in 2023 at 271.9 per 100,000 p-yrs before declining to 197.1 (-27.5%) per 100,000 p-yrs in 2024. Rates among non-Hispanic Black women younger than age 25 years peaked at 196.9 per 100,000 p-yrs in 2023, followed by 15.1% decline to 167.1 per 100,000 p-yrs in 2024.

Despite lower baseline levels, other racial and ethnic groups demonstrated substantial increases in syphilis incidence throughout the surveillance period. In particular, among women younger than age 25 years, the largest relative increase, 455.5%, was observed among non-Hispanic White women, whose rate in 2024 was the highest (11.3 per 100,000 p-yrs in 2016 to 62.9 per 100,000 p-yrs in 2024), followed by service members in the 'other' (+398.1%, from 27.7 in 2017 to 137.8 in 2024) and Hispanic racial and ethnic categories (+303.4%, from 42.4 in 2016 to 171.0 in 2023).

In general, female service members had lower syphilis rates than their male counterparts, but among those aged 17-19 years, female rates exceeded male rates during 7 of the 9 years of surveillance. Rise in overall incidence of syphilis among service men was relatively modest, with the smallest increase (+27.6%) observed among Hispanic service members, and the largest (+68.2%) among non-Hispanic Black service members.

Age- and sex-specific changes in 2024 versus 2023

Changes in syphilis rates in 2024 compared to 2023 diverged by sex. Overall incidence increased from 79.5 per 100,000 p-yrs in 2023 to 84.9 per 100,000 p-yrs in 2024 (+6.7%) among women but declined 3.5% among men (from 83.5 to 80.6 per 100,000 p-yrs). Incidence among women increased among all age groups, except those aged 20-24 years, among whom syphilis declined by 11%, from 107.1 in 2023 to 95.4 per 100,000 p-yrs in 2024. Decreases among men were concentrated in younger age groups, particularly those aged 17-24 years (-16.9%, from 116.0 in 2016 to 96.4 in 2024). In contrast, incidence increased among older men, most notably those aged 35-39 years (+17.9%, from 46.8 in 2016 to 55.2 in 2024).

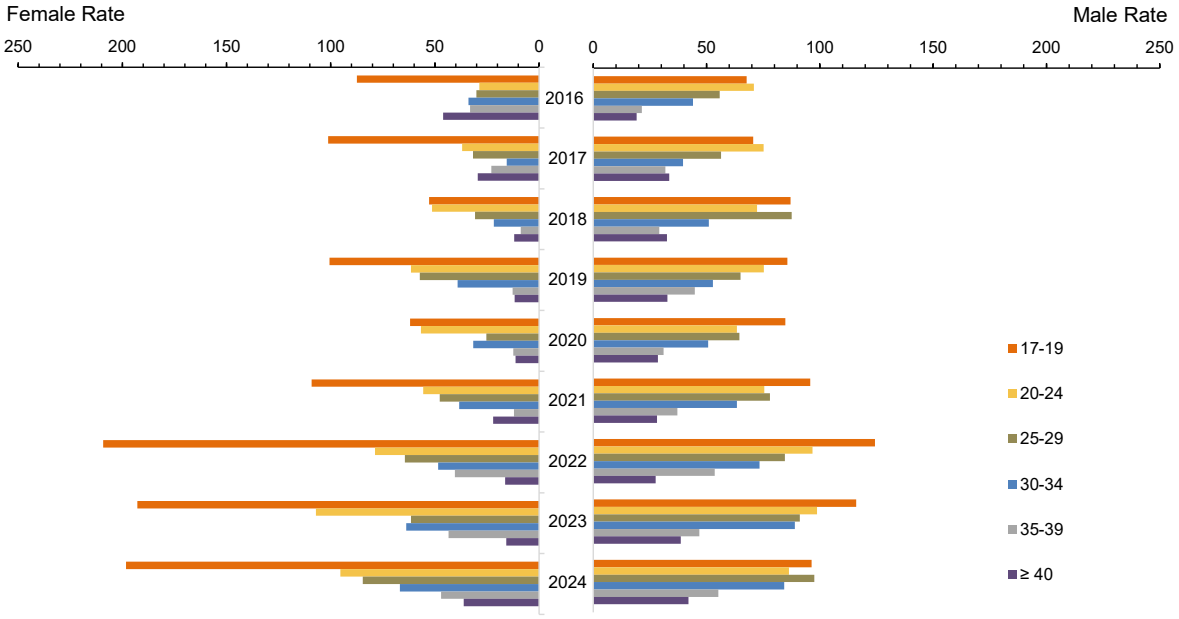
Genital human papillomavirus

Age- and sex-stratified trends

Crude annual incidence rates of genital HPV infections among all ACSMs decreased by 24.1%, from 511.3 cases per 100,000 p-yrs in 2016 to 388.0 cases per 100,000 p-yrs in 2024, with a more pronounced decrease among service men. On average, HPV rates in female service members were 10 times higher than those of male service members. Incidence rates of genital HPV infections among male service members overall followed a steadily downward trajectory, with a minor uptick in 2021, decreasing from a high of 220.6 cases per 100,000 p-yrs in 2016 to the lowest level, 119.7 cases per 100,000 p-yrs, in 2024 (-45.7%) **(Figure 6)**. Incidence among female service members declined from a high of 2,278.8 per 100,000 p-yrs in 2016 to 1,775.7 cases per 100,000 p-yrs in 2024 (-22.1%), with the lowest point in 2022, at 1,584.4 cases.

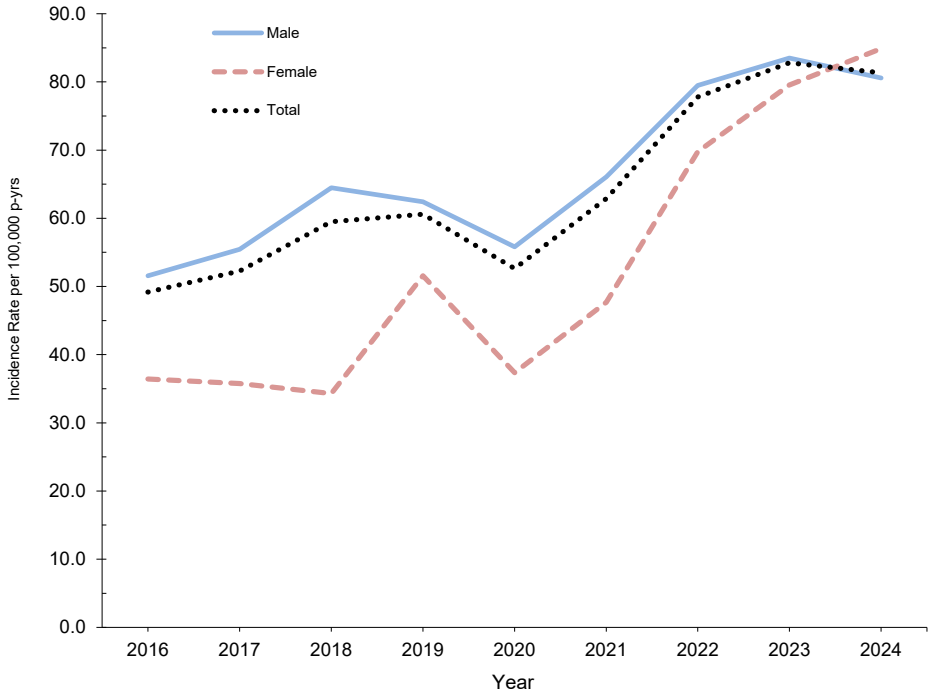
Service women in the 17-19-years age group showed the largest reduction (-85.8%) in genital HPV, dropping from 381.3 per 100,000 p-yrs in 2016 to 54.0 per 100,000 p-yrs in 2024. Declines in older age groups were modest, ranging from approximately 19% to 29%. Among those aged 30-34 years—the female age group with the largest detection rate of HPV—incidence

FIGURE 4. Incidence Rates [a] of Syphilis Infection Among Women and Men, by Age, Active Component, U.S. Armed Forces, 2016–2024



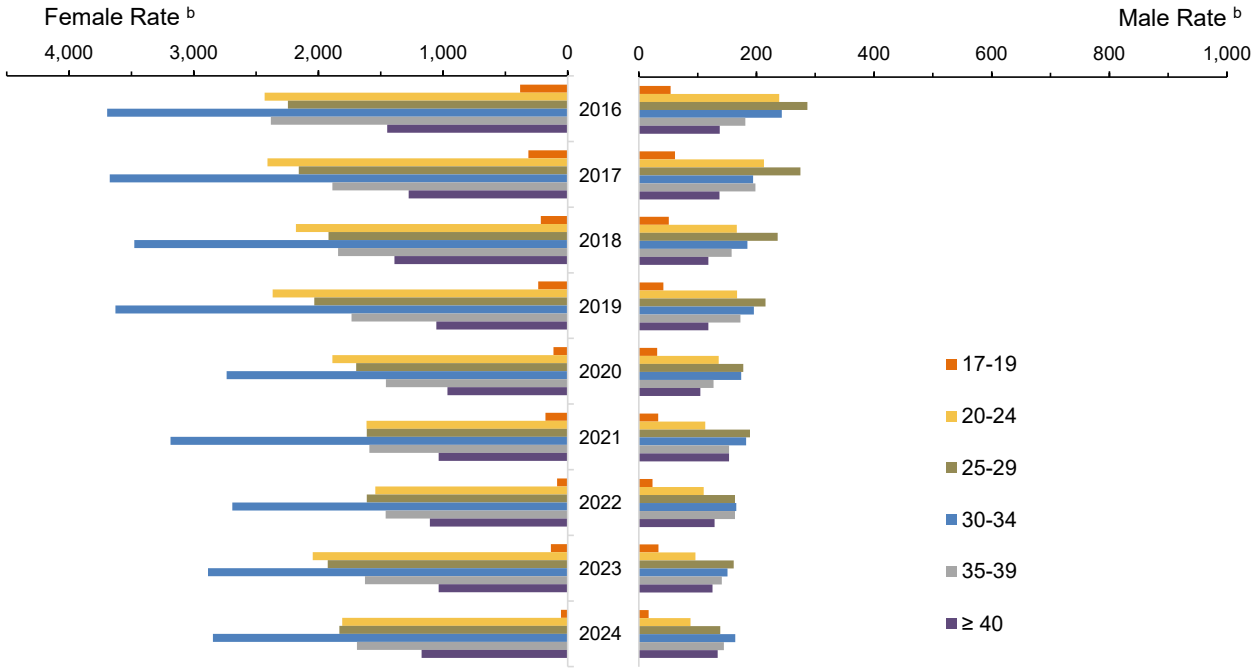
Abbreviation: p-yrs, person-years.
[a] Incidence rates per 100,000 p-yrs.

FIGURE 5. Incidence Rates[a] of Syphilis by Sex, Active Component, U.S. Armed Forces, 2016–2024



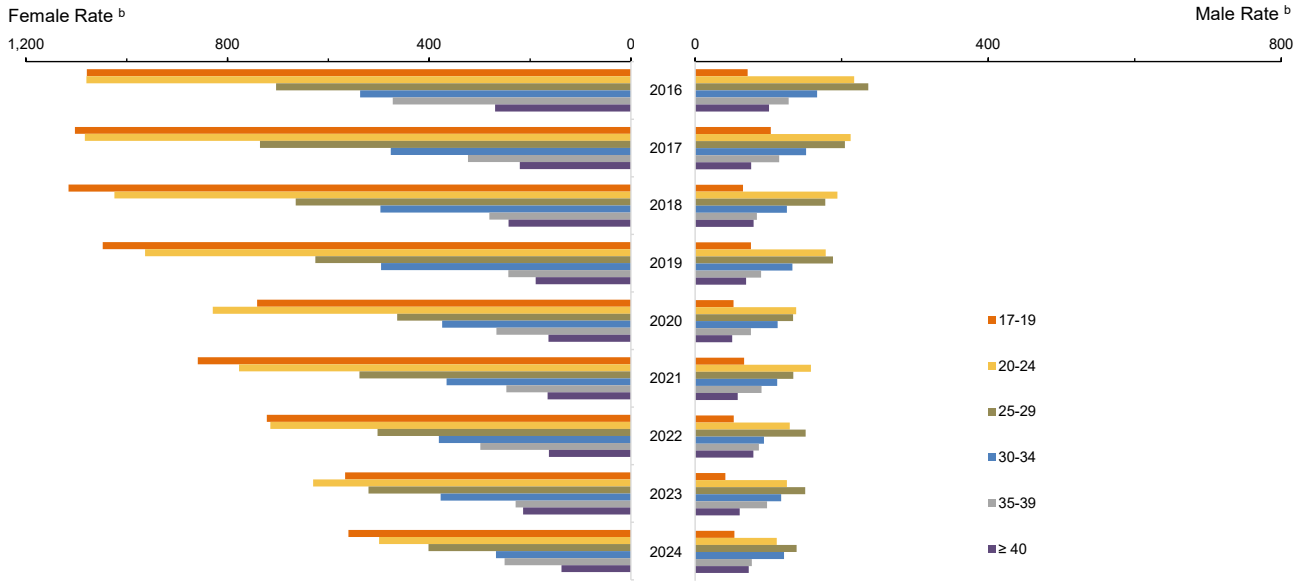
Abbreviation: p-yrs, person-years.
[a] Incidence rates per 100,000 p-yrs.

FIGURE 6. Incidence Rates[a] of Genital HPV Infection Among Women and Men, by Age, Active Component, U.S. Armed Forces, 2016–2024



Abbreviations: HPV, human papillomavirus; p-yrs, person-years.
[a] Incidence rates per 100,000 p-yrs.
[b] Axis bounds are sex-specific.

FIGURE 7. Incidence Rates[a] of Genital HSV Infection Among Women and Men by Age Group, Active Component, U.S. Armed Forces, 2016–2024



Abbreviations: HSV, herpes simplex virus; p-yrs, person-years.
[a] Incidence rates per 100,000 p-yrs.
[b] Axis bounds are sex-specific.

decreased by 23% from 3,694.2 to 2,845.4 cases per 100,000 p-yrs from 2016 to 2024.

Declines among service men were pronounced from their peak levels for most age groups. The magnitude of reduction progressively decreased with increasing age, with the greatest drop observed among those aged 17-19 years (-83.0%, from 61.7 in 2017 to 16.8 per 100,000 p-yrs in 2024), followed by those aged 20-24 years (-63.2%, from 238.9 in 2016 to 88.0 in 2024), and 25-29 years (-51.6%, from 286.4 in 2016 to 138.5 in 2024). Older groups of male service members experienced more gradual declines, with those aged 30-39 years experiencing an approximately 30% decrease over the entire surveillance period, and those aged 40 years and older group remaining largely stable, declining by only 2.8% from 137.7 in 2016 to 133.9 in 2024.

Age- and sex-specific changes in 2024 versus 2023

The magnitude of annual reduction in HPV incidence among service women from 2023 to 2024 progressively decreased with increasing age, from 59.9% (134.8 in 2023 to 54.0 per 100,000 in 2024) among those aged 17-19 years, to 1.4% (2,886.2 in 2023 to 2,845.4 per 100,000 p-yrs in 2024) among those aged 30-34 years. In older female age groups, this trend reversed, with rates among those aged 35-39 years increasing 4.1% (from 1,625.3 in 2023 to 1,691.3 per 100,000 p-yrs in 2024), and among those aged 40 years and older, rates increased 13.1% (from 1,035.4 in 2023 to 1,171.5 per 100,000 p-yrs in 2024). Among men, the youngest (17-19-years) age group continued to decline sharply, from 33.6 in 2023 to 16.8 in 2024 (-49.9%), with moderate levels of decline, 9–14%, among men aged 20-29 years. Similar to the HPV rate declines among women, incidence rates among men older than age 30 years showed a reversal of trending declines, rebounding 3-9%, which indicates a shift in the HPV burden towards older ages in both sexes.

Genital herpes simplex virus

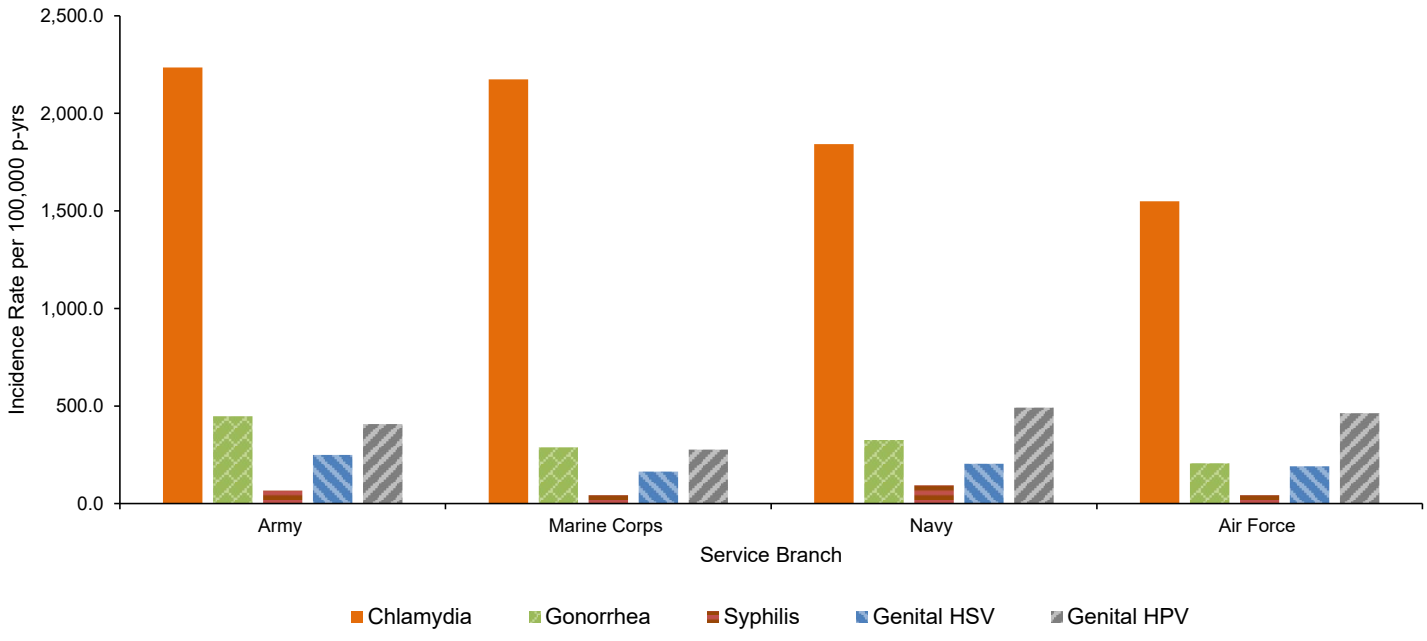
Age- and sex-stratified trends

From 2016 through 2024, both female and male service members experienced substantial declines in HSV, but their extents and patterns differed. Total female incidence fell from 773.9 cases per 100,000 p-yrs in 2016 to 382.9 cases per 100,000 p-yrs in 2024 (-50.5%). Male incidence decreased from 180.9 in 2016 to 107.4 in 2024 (-40.6%). The largest declines for both male and female service members occurred among those aged 20-24 years (-53.8% and -48.6%, respectively). Other age groups also experienced notable decreases during the surveillance period, more pronounced among females. Women aged 17-19 years had approximately 3 times as many cases as their male counterparts, with the incidence rate per 100,000 revealing a female-to-male rate ratio of about 14:1. The rate ratio declined with increasing age.

Age- and sex-specific changes in 2024 versus 2023

In 2024, changes in patterns diverged by sex. Total incidence rates among women fell nearly 20%, from 478.0 in 2023 to 382.9 per 100,000 p-yrs in 2024, among all age groups except those aged 35-39 years, among whom HSV increased by 9.6%,

FIGURE 8. Incidence Rates of STIs, Active Component, U.S. Armed Forces, 2016–2024



Abbreviations: STIs, sexually transmitted infections; p-yrs, person-years; HSV, herpes simplex virus; HPV, human papillomavirus.

from 228.5 to 250.3 per 100,000 p-yrs. In contrast, male trends indicated more variable results, with total rates declining by only 6% (from 114.4 to 107.4 per 100,000 p-yrs) while increasing by over 20% among individuals aged 17-19 years (from 41.2 to 53.5 per 100,000) and over age 40 years (from 60.9 to 73.2 per 100,000) (data not shown).

Discussion

This report provides a surveillance update on 3 nationally notifiable bacterial STIs—chlamydia, gonorrhea, and syphilis—as well as 2 viral STIs, genital HSV and HPV. Chlamydia was the most frequently reported STI during the surveillance period, with total cases and incidence rates exceeding those of HPV, the second-most common STI, approximately 5 times. Gonorrhea was the third most reported STI, followed by genital HSV and syphilis.

Chlamydia and gonorrhea

Chlamydia and gonorrhea are both bacterial infections that are frequently asymptomatic and typically tested together due to shared screening programs and diagnostic laboratory methods. [15] Consequently, temporal trends in incidence rates for both infections tend to reflect the other, as observed in this analysis.

During the initial 4 years of the surveillance period, both chlamydia and gonorrhea showed upward trends, peaking in 2019, before declining in 2020. The declines for the 2 STIs persisted through 2024: 40% for both infections among service women, and over 20% for gonorrhea among service men. Women under age 25 years and men under age 30 years accounted for most cases, who, correspondingly, experienced the largest reductions in incidence.

The trend pattern observed over the past 5 years aligns with the recent CDC data, which indicate that between 2019 and 2023, the total rates of both chlamydia and gonorrhea decreased among general population women by approximately 12–14% and among men by approximately 8%.[16] Gonorrhea, however, showed little change, or increased slightly, by approximately 2%, among men in the general population. Over the longer period, from 2014 through 2023, CDC data show that chlamydia rates in the general population diverged between sexes, increasing by 33.4% among men and decreasing by only 1.8% among women.

In contrast, in this analysis, which covers a comparable period, from 2016 through 2024, chlamydia rates among ACSMs demonstrated relatively steady downward trend, declining by more than 30% in both sexes. Corresponding rates for gonorrhea showed decreases by 10.1% among service men and 26.6% among service women. Chlamydia incidence rates were markedly higher among service members, with rates among males approximately 4–5 times, and females about 7 times, higher than those of civilian counterparts. Corresponding military to civilian ratios for gonorrhea were 1.4–2.7 times higher among men and 3.1–4.0 times higher among women.

Higher rates in military populations are likely due to a combination of demographic, behavioral, and structural factors. The military population is predominantly young, highly mobile, with frequent relocations and deployments, and often residing in close social environments, which are factors known to increase the risk of STI acquisition.[2,13] Additionally, the military implements aggressive screening programs (e.g., routine and mandatory testing among women younger than age 25 years) to maintain a fit and ready military force, coupled with no-cost access to preventive and primary care, which facilitate more comprehensive case detection.[17,18] Electronic health records within the Military Health System (MHS) further enable more complete disease burden capture for notifiable disease reporting. Nevertheless, these rate comparisons should be interpreted cautiously, as differences in surveillance and reporting practices between military and civilian populations may introduce surveillance bias.[19]

Laboratory and medical encounter data from service members in 2022 supplemented chlamydia case rates, as those cases had no medical event report and would have been unidentifiable without supplemental electronic health record data. Routine surveillance reports do not assess anatomical sites from gonorrhea case reports and laboratory records, which could provide more comprehensive understanding of extragenital infections in high risk populations.

National guidelines recommend gonorrhea screening, including pharyngeal or rectal testing, at least annually for both men who have sex with men (MSM) and HIV-positive patients. Extragenital gonorrhea screening may be considered for women on the basis of reported sexual behaviors and exposure.[20] Despite these recommendations, extragenital screening for high risk civilian and military populations is under-used.[21,22] A recent assessment of extragenital STI screening by primary care physicians for HIV-positive male Air Force service members found that approximately one-third of patients had undetected STIs, the majority due to extragenital infections of the rectum and pharynx.[22]

Syphilis

The trend in syphilis rates reveals a pattern that differs from the other 2 bacterial STIs, reflecting differing epidemiological factors and clinical dynamics. Total syphilis incidence trends mirror national trends in the civilian population. CDC data indicate that rates of primary and secondary syphilis among women in the general U.S. population increased nearly 5-fold nationally from 2015 through 2024, rising 392.9% from 1.4 to 6.9 cases per 100,000 population. In contrast, corresponding rates among men over the same period increased 29.4%, from 13.6 to 17.6 cases per 100,000 population. Syphilis rates were highest among non-Hispanic Black service members of both sexes, consistent with national data evidencing persistently elevated rates in this population. While syphilis incidence among non-Hispanic Black service members declined in 2024, they continue to bear the highest burden of infection, evincing the persistence of syphilis in this population and potentially reflecting ongoing challenges in delivering effective prevention, testing, and treatment services.

Conversely, syphilis incidence among service members of other racial and ethnic groups, especially women younger than age 25 years, continued to increase through the end of the surveillance period.

The largest relative increase was observed among non-Hispanic White female service members, a group previously associated with the lowest syphilis burden, increasing 456% from 2016 to 2024. These trends correlate with the findings of a recent study that found declining syphilis incidence among historically highly-burdened population groups, while concurrently increasing in lesser-burdened groups.[23]

The sharp rise in syphilis incidence observed among reproductive age women is a significant public health concern due to the risk of maternal and congenital syphilis. The rate of maternal syphilis among female MHS beneficiaries rose by 233% from 2012 to 2022, while the rate of congenital syphilis among newborn MHS beneficiaries increased by 355%.[24] Nationally, the maternal syphilis rate increased by 222% from 2016 to 2022, and congenital syphilis cases rose 700% over the past decade, from 2015 to 2024.[25,16] These findings indicate critical gaps in prevention, screening and treatment for young service women, and reinforce U.S. Preventive Services Task Force recommendations for early syphilis infection screening in all pregnant women.[26]

This cycle of syphilis resurgence appears to have begun in the early 2000s, in both civilian and military populations, with steady and notable increases among active component service members reported since the early 2010s.[27,28] Early increases were primarily attributed to MSM, a group also at elevated risk for HIV infection. Recent data suggest that among MSM, especially those under age 25 years, syphilis and HIV infections may increasingly co-occur, underscoring the need for integrated prevention and control strategies that address both infections concurrently.[16,29]

Collectively, these findings suggest shifting syphilis epidemiology, from the moderate resurgence in 2010s described by Garges in 2016[28] to a sustained and broader increase across the force. Further studies are needed to understand the underlying drivers of these trends, including sexual behaviors and risk factors that are influenced by military service, the reach and effectiveness of existing prevention and screening programs, and unique "social context of soldiers, sailors, airmen, and marines"[28] affecting syphilis transmission.

Human papillomavirus

HPV rates among male and female service members declined steadily over the surveillance period, with the largest reductions, over 80%, observed in the youngest cohorts (ages 17-19 years) of both sexes. These data are consistent with CDC data that show the incidence of HPV infection, particularly in younger populations, declining significantly since the introduction of the HPV vaccine in 2006.[30] Specifically, the prevalence of vaccine type HPV strains (6, 11, 16, 18) dropped 86% among young women ages 14-19 years within the decade following vaccine introduction.[31]

Vaccination alone, however, does not fully explain the drastic decline observed among the youngest service members, who now represent almost a negligible proportion of the total recorded burden of HPV. Previous studies have documented suboptimal vaccine uptake among service members.[32,33] Between 2007 and 2017, only approximately 27% of eligible service women and 6% of service men initiated HPV vaccination, and completion of the 3-dose series was even lower.[33] Contributing factors include inadequate awareness and education, lack of centralized vaccine monitoring within the MHS, the voluntary nature of vaccination, and the mobile lifestyle of service members.[34] It is also possible that HPV vaccination records are incomplete. The HPV vaccine is typically recommended during early adolescence (i.e., before military service), and prior vaccination may not have been reported or recorded, leading to an under-estimation of actual vaccination coverage

An additional factor contributing to the dramatic decline in rates of HPV detection among women ages 17-20 years is MHS implementation of updated national cervical cancer screening guidelines, which recommend delaying screening until age 21 years. Furthermore, routine screening is not recommended for men, resulting in under-detection within this population.[15]

In contrast, HPV detection rates were highest among women ages 20-39 years, with the greatest burden observed in those aged 30-34 years. A strong cohort effect was evident, with the magnitude of HPV rate reductions progressively diminishing with increasing age, and even reversing in 2024 among individuals older than age 35 years. This observed pattern likely reflects lower vaccination among older cohorts, HPV infection persistence, and expanded or more frequent screening practices in those age groups. Supporting this hypothesis, a recent study on cervical cancer screening modalities found that MHS screening practices align with national guideline updates, including increased use of HPV co-testing and expanded screening among women ages 30-64 years.[34] Concurrently, cervical cancer screening has decreased among women younger than age 21 years, consistent with recommendations to delay initiation of screening in that age group.[35]

Targeted efforts are warranted to improve HPV vaccine awareness, accessibility, and completion among service members, and reinforcing education for both health care providers and personnel could strengthen vaccine uptake and help reduce the long-term burden of HPV-related diseases within the armed forces.

Herpes simplex virus

The trends in the incidence of genital HSV in the U.S. military are consistent with the CDC's National Health and Nutrition Examination Survey (NHANES) rounds that show declining seroprevalence in the U.S. population since the late 1990s. National seroprevalence among individuals aged 14-49 years dropped from 18% in 1999-2000 to around 12% by 2015-2020.[36,37] Total incidence among service members decreased by roughly 40% to 50%, depending on the age group and sex, between 2016 and 2024.

No sexual risk behavior data were available for this report, but prior surveys of military personnel indicate increased behaviors of possible concern. The 2018 Department of Defense Health Related Behaviors Survey (HRBS) documented that 19.3% of active component respondents reported 2 or more sexual partners within the past year, with 34.9% reporting sex without condom use with a new partner in the past year—percentages almost double those in the 2011 survey.[38]

This report has several limitations. Changes in incidence rates may reflect, at least in part, temporal changes in case detection, including more aggressive screening. Furthermore, STI diagnoses can be incorrectly coded. For example, STI-specific 'rule out' diagnoses or vaccinations (e.g., HPV vaccination) may be reported with STI-specific diagnostic codes, which would result in over-estimated STI incidence.

Cases of syphilis, genital HSV, and genital HPV infections based solely upon laboratory test results are considered 'suspect' because laboratory results cannot distinguish between active and chronic infections. Because incident cases of syphilis, genital HSV, and genital HPV were identified based upon a first qualifying encounter or laboratory result, it is likely most cases were acute and not chronic.

STI cases coded in the medical record using symptom codes (e.g., urethritis) rather than STI-specific codes may not be captured. In addition, counts of STI diagnoses reported herein may under-estimate actual diagnoses because some service members may have been diagnosed and treated by non-military health care providers (e.g., county health departments, family planning centers) that were not reimbursed, or in deployed settings (e.g., overseas training exercises, combat operations, aboard ships). Laboratory tests ordered from purchased care or in a shipboard facility, battalion aid station, or in-theater facility were not captured in this analysis.

Lack of standard service and installation practices for STI screening, testing, treatment, and reporting complicates interpretations of detected differences between services, military and demographic subgroups, as well as locations. For some STIs, detection of prevalent infection may occur long after initial infection. Standard STI screening, testing, treatment, and reporting among the services, along with consistent adherence, can improve detection and characterization of STI-related health threats. Continued behavioral risk reduction interventions are still required to counter STIs among military service members.

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Follow up Testing Among Male U.S. Air Force Basic Trainees Diagnosed with Chlamydia or Gonorrhea, 2017–2023

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While female U.S. Air Force and Space Force basic military trainees are screened universally for gonorrhea and chlamydia, male basic trainees are tested only when symptomatic or upon patient request. Epidemiology and follow-up testing of male basic trainees who test positive for gonorrhea or chlamydia in training is unclear. All active duty male basic trainees at Joint Base San Antonio–Lackland who tested positive for gonorrhea or chlamydia from 2017 through 2023 (50 of 182,726 total male trainees, 0.03%) were matched, 1-to-1, by age and accession date, with active duty female basic trainees who tested positive for the same pathogen. Medical records from military hospitals and clinics were reviewed for follow-up testing within 12 months of the initial positive test and subsequent diagnoses for chlamydia and gonorrhea up to 3 years afterwards, or July 1, 2024, whichever occurred first. Among 50 male basic trainees, 30 (60%) reported symptoms when presenting for testing. Most cases (86%) were due to chlamydia. Only 56% (n=28) of male trainees had follow-up testing within 1 year, compared to 76% (n=38) of matched female basic trainees (OR 0.4, 95% CI: 0.17, 0.95). Low screening for chlamydia and gonorrhea among male basic trainees may contribute to reduced follow-up testing and represents a missed opportunity to identify infections, prevent transmission, and reduce the burden of infection in this population.

What are the new findings?

Male basic military trainees who tested positive for gonorrhea or chlamydia had follow-up testing rates significantly below guideline recommendations. Rates of future infections among male basic trainees were not, however, statistically lower than female trainee rates of future infections.

What is the impact on readiness and force health protection?

These findings support universal gonorrhea and chlamydia screening for male trainees at higher risk for infection to reduce the impact of untreated infections on military readiness for individuals and their partners, in addition to facilitating provision of available methods of sexually transmitted infection prevention.

Service in the U.S. military has been associated with increased risk of sexually transmitted infections (STIs) such as gonorrhea and chlamydia.[1] Before basic military training (BMT), all potential enlistees undergo medical evaluation including HIV testing, to ensure they meet criteria for accession, but they are not tested for chlamydia[2-6] or gonorrhea. BMT is an 8-week training program that is the sole point for civilian entry into the enlisted ranks of the U.S. Air Force and Space Force. During BMT, all trainees have access to universal, no-cost health care at both primary care clinics and emergency care facilities on base.[7] Because male BMT trainees are not screened for gonorrhea or chlamydia, they are only tested if they are symptomatic or request testing.

A recent study of universally screened male Air Force BMT trainees found similar overall rates of chlamydia with female Air Force BMT trainees, although most infections were asymptomatic.[8] Women entering U.S. Air Force and Space Force BMT are universally screened for chlamydia and gonorrhea due to known long-term sequelae of untreated infections, previously documented high rates of positivity, and guidelines recommending universal female screening. Positivity rates among female BMT trainees are approximately 0.3% for gonorrhea and 5.0% for chlamydia. With the exception of the Army, all services require universal screening for female BMT trainees.[7]

Current U.S. Centers for Disease Control and Prevention (CDC) guidelines recommend testing for re-infections 3 months after a gonorrhea or chlamydia diagnosis, regardless of patient sex or risk factors for future infection.[5] Additionally, guidelines recommend that men at high risk for STIs, such as men who have sex with men, should be screened at least annually for chlamydia and gonorrhea. Annual chlamydia screening is required by all services for female service members under age 25 years.[7]

While the screening disparity between male and female BMT trainees is evident, it is unclear how this may affect future testing and STI diagnoses for male trainees who test positive for chlamydia or gonorrhea during BMT. Previously evaluated 2006-2021 data from 5,022 female BMT trainees who tested positive for gonorrhea or chlamydia showed a high follow-up testing rate (69.7%) within 1 year, as well as a relatively high rate (15.9%) of positivity upon repeat testing.[2] This study investigated the incidence of gonorrhea and chlamydia

in male Air Force and Space Force BMT trainees from 2017 through 2023 and compared follow-up testing and clinical outcomes with female BMT trainees.

Methods

This retrospective matched cohort study evaluated all active duty male BMT trainees who tested positive (i.e., cases) for gonorrhea or chlamydia at Joint Base San Antonio–Lackland during any point in their BMT from 2017 through 2023. Additionally, during this study period, from November 2021 through March 2022, 352 male BMT trainees as well as active duty, reserve, and National Guard members were tested for gonorrhea and chlamydia as part of a previously published universal screening study that did not evaluate follow-up testing, so they were also included in this study. All male cases were matched 1-to-1 with female BMT trainees (i.e., controls) by age, date of military accession, and pathogen testing positive during training to determine sex-based differences in follow-up testing.[8] Urinary testing for gonorrhea and chlamydia was performed by nucleic acid amplification testing (Hologic, Marlborough, MA) throughout the entire study period.[2]

For all positive male cases, a retrospective chart review in the Joint Legacy Viewer and MHS GENESIS electronic health records was performed. These systems include all military hospital and clinic records, regardless of geographic location. Variables including patient demographics, indications for testing, and testing facility were collected for each case. While current CDC guidelines recommend follow-up testing for re-infection at 3 months, this study evaluated whether a patient underwent repeat testing within 12 months of a positive test.[2]

Chart reviews identified positive laboratory test results for gonorrhea and chlamydia in BMT trainees. Test results for 3 years after original gonorrhea or chlamydia diagnosis were reviewed, or until July 1, 2024 if a period of 3 years following original diagnosis had not elapsed by initiation of data collection, as that period of time was used for a previous study.[9]

Nominal variables were compared by Fisher's Exact Test due to small sample size, and continuous variables were compared by a Mann-Whitney U test due to non-parametric data distribution. Standard odds ratios (ORs) with 95% confidence intervals (CIs) were also calculated. A *p*-value less than 0.05 was pre-determined to be statistically significant.

This study was reviewed by the 59th Medical Wing Human Protections Office and determined to be exempt from Institutional Review Board approval due to its retrospective nature, and thus, consent was not obtained from subjects.

Results

Of the 182,726 male BMT trainees from 2017 through 2023, 50 active duty male trainees (0.03%) tested positive for gonorrhea or chlamydia during their 8 weeks of training (data not shown). Most cases (n=43, 86%) were due to chlamydia, with the remainder positive for gonorrhea **(Table 1)**. There were no cases of co-infection among male BMT trainees **(Table 1)**. During the same period, 5-6% of female trainees screened positive for chlamydia, and 0.2–0.4% screened positive for gonorrhea (data not shown).

The median age of male BMT trainees was 20 years (IQR 19-21). Most cases (n=44, 88%) were detected in primary care settings, with a minority of cases (n=4, 8%) diagnosed in the emergency department. The median time in training until diagnosis was 12.5 days (IQR 8-27).

Thirty male trainees (60%) had symptoms on presentation for chlamydia and gonorrhea testing, with dysuria (n=20, 40%) and penile discharge (n=15, 30%) the most common **(Table 1)**. Nine (18%) male trainees were tested as part of the previously reported screening protocol,[8] while 10 (20%) were tested after being notified of STI exposure by a partner (data not shown). Four (8%) additional male BMT trainees were asymptomatically screened for chlamydia and gonorrhea after presenting to a medical provider for another medical problem, including 1 service member who tested positive during HIV screening (data not shown).

TABLE 1. Description of Chlamydia and Gonorrhea Diagnoses, Testing and Symptomology Among 50 Male U.S. Air Force and Space Force Basic Trainees

	No.	%
Diagnosis		
Chlamydia	43	86
Gonorrhea	7	14
Both chlamydia and gonorrhea	0	0
Location of testing		
Primary Care	44	88
Emergency department	4	8
Occupational Health	1	2
Infectious Diseases	1	2
Indication for testing[a]		
Symptoms	27	54
Screening	13	26
Contact	7	14
Symptoms and contact	3	6
Symptoms		
Dysuria	10	20
Dysuria and penile discharge	9	18
Penile discharge	6	12
Genital pain	3	6
Dysuria and penile vesicles	1	2
Groin pruritic	1	2
No symptoms	20	40
Training days elapsed until diagnosis		
	Median	IQR
	12.5	[8-27]

Abbreviations: No., number; IQR, interquartile range.
[a] Indication for testing exceeds number of patients, as some patients had multiple testing indications.

Of the male BMT trainees with chlamydia or gonorrhea, 28 (56%) had repeat testing in 1 year, with 5 testing positive for chlamydia and 1 for gonorrhea **(Table 2)**. Male trainees had statistically significant lower follow-up testing within 1 year compared to female trainees (56% vs. 76%; OR 0.41, 95% CI 0.17, 0.95) **(Table 2)**. Despite this difference in follow-up testing, there was no statistically significant difference in chlamydia and gonorrhea diagnoses during the next 3 years: a total of 8 diagnoses among men versus 12 among women (OR 0.6, 95% CI 0.22, 1.63) **(Table 2)**.

TABLE 2. Follow up Testing and Recurrence Among 50 Male U.S. Air Force and Space Force Basic Trainees with Matched Female Basic Trainees Diagnosed with Chlamydia or Gonorrhea, 2017–2023

	Males (n=50)		Females (n=50)			
	No.	%	No.	%	OR	CI (95%)
Follow-up within 1 year	28	56	38	76	0.41	0.17–0.95
STI within 3 years	8	16	12	24	0.60	0.22–1.63
Chlamydia	5	10	10	20	0.44	0.14–1.40
Gonorrhea	1	2	0	0	3.06	0.10–77.0
Both	2	4	2	4	1.00	0.14–7.40
None	42	84	38	76	1.66	0.61–4.49
HIV PrEP within 3 years	1	2	0	0	3.06	0.10–77.0

Abbreviations: No., number; OR, odds ratio; CI, confidence interval; STI, sexually transmitted infection; HIV, human immunodeficiency virus; PrEP, pre-exposure prophylaxis.

Discussion

This retrospective matched cohort study evaluated 50 male Air Force and Space Force BMT trainees who tested positive for gonorrhea or chlamydia from 2017 through 2023. The majority of male BMTs who tested positive in this study presented for testing due to symptoms consistent with an STI. Only 56% of the men in this study received follow-up testing within 1 year.

When compared to prevalence rates of gonorrhea and chlamydia among the universally-screened female BMT population, the rate observed among the male BMT trainee population in this study is much lower than expected. When universally screened, 4.8% of male BMT trainees tested positive for chlamydia.[8] While the universal screening study included National Guard and reserve trainees in addition to active duty personnel, if that rate were applied to the population in this study, 8,771 cases of chlamydia would be expected among male BMT trainees. Given that only 43 cases of chlamydia were diagnosed in this study, it appears as though only 0.5% of expected cases of chlamydia were captured in this cohort. Notably, 9, or nearly 20%, of the cases in this study were identified through the previously published universal screening study. These results show that relying upon symptoms or partner notification likely missed thousands of infectious in the male BMT population.

Despite universal access to medical care, only 54% of male BMT trainees who tested positive for an STI in this study were re-tested within a year. CDC guidelines[5,11] recommend repeat testing in 3 months post-diagnosis due to the high risk of re-infection with the same or new STI pathogen. Similar to previous reports of follow-up testing in women in basic training, a relatively high positivity (18%) results on repeat testing. This finding suggests that a population with a bacterial STI who undergoes testing might be at greater risk for future infections in a male trainee population, and that there may be benefit from interventions such as Doxycycline Post-Exposure Prophylaxis (DoxyPEP), which has shown benefit in other populations, even decreasing incidence within a population.

There are several challenges related to STI testing in a military trainee population. First, due to the low reported incidence of STIs in BMT men, even if symptomatic, they are often not tested for bacterial STIs. Additionally, there is significant stigma related to STI positivity throughout the military that may be amplified in the BMT environment, the first stage of a service member's military career, during which trainees experience significant stressors unrelated to their sexual health. Other unique challenges within the military population can contribute to lower than ideal follow-up testing rates. The majority of BMT trainees are assigned to a different duty station after graduation, resulting in lack of continuity of care that likely contributes to diminished follow-up testing, although notably, female BMT trainees with gonorrhea or chlamydia who moved to a different military base evinced a higher follow-up rate than women who stayed on the base where they originally tested positive. Finally, military members often have a career-long focus on maintaining mission readiness, and preventive medical care, which can potentially change an individual's 'mission ready' status, is often avoided, as described in other military populations.[13,18]

There are limitations to consider when interpreting these results. First, initial diagnoses and the start of data collection occurred within close temporal proximity. Although periods of time for follow-up testing were artificially shortened for some individuals, they should be similar for paired individuals, as matching was by accession date.

Second, the periods of service for men and women with chlamydia or gonorrhea may be different, which was not captured in this study and could lead to differences in observational time between men and women. Future studies could use person-time rates to adjust for varying follow-up durations.

In addition, patients empirically treated without testing were not captured, and the methodology did not allow ascertainment of the total number of male BMT trainees who tested negative for gonorrhea and chlamydia, and thus testing rates could not be determined.

This study did not evaluate extragenital testing, which has lower uptake compared to genital testing[22] and could have identified more individuals, resulting in more conservative estimates of infection.

Furthermore, the small sample of 50 men and 50 women may have limited this study's power to detect statistically significant differences between the 2 groups. Testing records before or after BMT for patients who did not test positive during the study period were not available for review, which likely contributed to an overall under-calculation of follow-up testing rates and new infection rates for both groups of BMT trainees.

There are potential benefits as well as drawbacks of implementing a universal STI screening program for male service members in the U.S. Air Force. While the true incidence of gonorrhea and chlamydia in this population is likely under-estimated due to asymptomatic infections and lack of routine screening, a screening program could identify individuals at risk and inform them of preventive health strategies. Furthermore, studies suggest that universal screening can be cost effective through the prevention of long-term health issues in female partners. Universal BMT male screening is not currently in place, however, due to the lack of long-term complications in men from untreated infections, its cost, and the administrative burden of testing. Despite these challenges, STI testing remains important for interrupting disease transmission, which has the potential to affect mission readiness through complications in female partners as well as increased HIV risk in both sexes.

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Disclaimers
The views expressed herein are those of the authors and do not reflect official policy nor position of the Defense Health Agency, Brooke Army Medical Center, the Department of Defense, or the U.S. Government.

The data that support the findings of this study are available on request from the corresponding author. All data are freely accessible. This study was reviewed by the Defense Health Agency San Antonio Market Institutional Review Board, protocol FWH20240006E, and determined to be exempt and informed consent not necessary.

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Sexual Networks of U.S. Military Service Members with Chlamydia at Joint Base San Antonio, June–December 2023

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Limited data on sexual networks in the U.S. military makes designing strategies to combat sexually transmitted infections (STIs) challenging. This retrospective evaluation assessed reported sexual networks of military service members with chlamydia, to inform future interventions for decreasing transmission of the infection. Thirty-two active duty service members at Joint Base San Antonio–Fort Sam Houston tested positive for chlamydia infection during the evaluation period, June through December 2023. Service members who tested positive for chlamydia were interviewed by Army Public Health Nursing staff and were asked to identify their sexual partners from the preceding 60 days, for routine contact tracing. Patient responses were then anonymized for comparisons of sexual networks of military service members—by sex, branch of service, and whether they were participating in military training or had completed training ("permanent party"). Service members with chlamydia were predominantly female (n=19, 59.4%), in the Army (n=18, 56.3%), and in military training (n=20, 62.5%). Of the 45 sexual contacts of the 32 service members identified through contact tracing, the majority (n=30, 66.7%) of those sexual contacts were civilians. Those still in military training were more likely to report sexual contacts who were also military service members, compared to permanent party service members (n=12, 50% vs. n=3, 14.3%, *p*=0.014). This evaluation determined that most service members who developed chlamydia were in sexual networks with only a single partner (n=22, 68.8%). These data should form an initial assessment of a military sexual network that needs to be confirmed in larger settings.

What are the new findings?

An analysis of sexual networks at Joint Base San Antonio–Fort Sam Houston involving 32 military service members with chlamydia found that sexual networks for service members who were in training had a greater proportion of sexual partners who were also in the military compared to service members who were not in training (50% vs. 14.3%, *p*=0.014).

What is the impact on readiness and force health protection?

In this population, the sexual networks of trainees diagnosed with chlamydia generally had a single partner, suggesting that broader testing strategies may be warranted to identify individuals who are at high risk for chlamydial infections.

Compared to civilian populations, U.S. military service members have had a greater burden of sexually transmitted infections (STIs). For example, the rate of new chlamydia infections for male service members ages 20-24 years is 1.5 times greater than their civilian peers.[1,2]

Current U.S. Centers for Disease Control and Prevention (CDC) guidelines recommend annual screening for women under age 25 years to prevent complications of STIs such as pelvic inflammatory disease, in addition to consideration for screening of men and women ages 25 years and older who are in populations with high incidence of infection.[3] The U.S. military currently annually screens all women ages 25 years and younger, according to the CDC guidelines, and all services except the Army additionally screen women upon accession to military service. There is no universal screening program for men in the U.S. military.

The highest rates of chlamydia in the U.S. miliary are found in junior-enlisted women, and those age 24 years and younger.[2] Despite national U.S. military data suggesting a higher chlamydia burden among women, when universally screened, asymptomatic infections rates between male and female trainees are similar.[4,5] This underscores the need to evaluate increasing screening efforts among high-risk cohorts within the military.

Limited understanding of military sexual networks is a significant challenge for identifying high-risk cohorts within the military. Contact tracing serves as a useful epidemiological tool for uncovering such sexual networks, in addition to disrupting transmission events and re-infections.[6] This retrospective evaluation utilized Army Public Health Nursing (APHN) contact tracing data to identify the sexual networks of service members infected with chlamydia at a single military base, to inform future interventions.

Methods

Active duty military service members who tested positive for chlamydia from June through December 2023 at Joint Base San Antonio–Fort Sam Houston were included in this evaluation of local sexual networks. Joint Base San Antonio–Fort Sam Houston supports 2 distinct groups: trainees and permanent party service members. Trainees, who are completing job-specific training following basic military training, live in congregate settings on base while fulfilling the requisite qualifications for their future military specialties. Trainees have restrictions on their abilities to physically leave their assigned military installations. Permanent party military service members, who have completed military training, have autonomy for their time off duty.

Military service members, regardless of training status, have universal access to no-cost medical care through Military Health System primary care, specialty, and emergency clinics. Women under age 25 years in the U.S. military are universally screened annually for chlamydia, while other populations are screened and tested based on symptoms and risk factors, as previously described.[4] All military service members are tested for chlamydia using the Aptima Combo 2 assay (Hologic, Marlborough, MA), and those who test positive are interviewed by a trained APHN nurse, for contact tracing to identify their sexual partners for the 60 days preceding diagnosis. In addition, those service members receive education on prevention of STIs and their re-infection.

In this retrospective evaluation of local sexual networks, the contact tracing results were anonymized to only specify the sex and training status of the source patient, and the sex and military status of their partner(s). Comparison of nominal variables between trainees and permanent party service members was performed with Fisher's Exact Test. A *p*-value of less than 0.05 was pre-determined to be significant.

Because this study involved analysis of de-identified, aggregate data only, it was classified as non-human subject research by the Brooke Army Medical Center Office of Human Research Protections Office (#23-17747) and consent was not required from participants.

Results

Thirty-two active duty service members tested positive for chlamydia at Joint Base San Antonio–Fort Sam Houston during the study period, June through December 2023, and underwent contact tracing with APHN staff. The majority of service members who tested positive were female (n=19, 59.4%). Most service members who tested positive were in the Army (n=18, 56.3%), followed by the Navy (n=10, 31.3%), and Air Force (n=4, 12.5%). There were more trainees (n=20, 62.5%) than permanent party service members (n=12, 37.5%) among those who tested positive.

Ten male service members reported only female partners, 2 reported only male partners, and 1 reported male and female partners. All 19 female service members reported only male partners. The median number (interquartile range) of partners reported was 1 (1-2). Of the 45 partners identified through contact tracing, the majority (n=30, 66.7%) were not affiliated with the military.

Sexual networks differed by service member sex as well as training status **(Table)**. Both male trainees and permanent party members had majority female sexual partners (n=6, 85.7% and n=8, 72.7%, respectively) or who were civilians (n=5, 71.4% and n=9, 81.8%, respectively). Female permanent party members had predominantly civilian sexual partners (n=9, 90%) as well, while female trainees had majority military sexual partners (n=10, 58.8%). Service members in trainee status were more likely to have sexual contacts who were also military service members, when compared to permanent party service members (n=12, 50% vs. n=3, 14.3%, *p*=0.014).

TABLE. Sexual Networks of Military Service Members with Chlamydia, by Sex and Training Status

Source Patient		Total Partners	Median Partners	Military Partners[a]						Civilian Partners[a]					
				Total		Male		Female		Total		Male		Female	
	No.	No.	No. (IQR)	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total	32	45		15		12		3		30		19		11	
Males															
Permanent Party	7	11	1 (1-2)	2	18.2	1	9.1	1	9.1	9	81.8	2	18.2	7	63.6
Trainees	6	7	1 (1-1)	2	28.6	0	0.0	2	28.6	5	71.4	1	14.3	4	57.1
Females															
Permanent Party	5	10	2 (1-3)	1	10.0	1	10.0	0	0.0	9	90.0	9	90.0	0	0.0
Trainees	14	17	1 (1-2)	10	58.8	10	58.8	0	0.0	7	41.2	7	41.2	0	0.0

Abbreviation: IQR, interquartile range.

[a] Of total partners by sex and training status.

Discussion

Despite elevated rates of chlamydia infection in military service members in comparison to their civilian counterparts, the sexual networks of the U.S. military population remain unknown.[4] In this evaluation cohort, most patients reported only 1 partner within the 60 days preceding diagnosis. Additionally, female trainees were more likely to have sexual partners who were also military service members.

Published data on sexual networks in U.S. military population are limited.[7-9] In 1 previously published study of 2,453 shipboard U.S. active duty Navy and Marine Corps personnel, 67% of most recent sexual partners were either service members or military beneficiaries, and among women this result increased to almost 80%.[7] In this retrospective evaluation, however, the majority of service members who tested positive for chlamydia had civilian partners. The findings of the prior study are consistent, however, with this evaluation's finding of a majority military-affiliated sexual contacts among those in trainee status. In the earlier study, around 50% of women surveyed stated that they believed they had contracted an STI from a fellow service man, whereas 25% of service men stated that they believed they had contracted an STI from a service woman.[7] Those data are also congruent with this evaluation, suggesting that small sexual networks might facilitate transmission to both men and women, as seen in civilian populations.[10]

Numerous studies have demonstrated multiple sexual partners as a risk for STI acquisition within the active duty military population.[8,9,11] Satterwhite et al. found, in the general U.S. population, regardless of sex, that reporting 2 to 4 sexual partners or 5 or more sexual partners within the past 12 months were significant predictors of reported STIs.[12] While this evaluation only investigated sexual networks from the preceding 60 days, the majority of active duty service members with chlamydia only reported 1 sexual partner. While this finding may represent under-reporting by service members to public health officers, or reflect the timing of contact tracing in relation to military duties, it is comparable to the number of sexual partners reported in other populations, such as college campuses.[13] Similarly, 2008 survey data of military women suggested that a majority (68.3%) had only 1 sexual partner in the last 12 months.[11]

These data, taken together, may imply that certain high-risk populations have limited sexual networks. Unfortunately, limited sexual networks are harder to identify via contact tracing for an infection that is frequently asymptomatic.[14] Expanded or universal screening may be necessary to fully identify the STI burdens for such populations. Increased education efforts and prevention methods—such as condoms, which have demonstrated greater use by individuals with history of an STI,[15] as well as doxycycline post-exposure prophylaxis in populations that may benefit—may be useful strategies for military bases to consider.[16,17] Studies that demonstrate the effectiveness of specific STI prevention practices within military populations are currently lacking, however.[18]

There are several limitations to this local evaluation of sexual networks. As a retrospective evaluation of anonymized records, the available data lack patient demographics, indications for testing or screening, setting of initial tests, and presence or absence of symptoms. An additional limitation is the small number of participants. Additionally, significant perceived stigma surrounds sexual health, and source patients are susceptible to reporting bias, potentially under-reporting their sexual contacts.[19,20] Notably, this project evaluated the sexual networks of service members who tested positive only for chlamydia, which may be different from sexual networks in relation to other STI transmission. Finally, as this sample is from 1 large military base, where the majority of testing is of female service members,[21] the external validity and extrapolation potential of these data are unknown.

Contact tracing provides insight into the sexual networks of military service members at a military base, which can inform more targeted local prevention and intervention strategies. From these data, it appears that limited sexual networks exist among military service members diagnosed with chlamydia, especially among trainees. These findings, from an initial evaluation at a single base, should be replicated in larger populations to produce more robust data, analyses, and findings for determining optimal prevention strategies throughout the U.S. military services.

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Disclaimers
The views expressed in this manuscript reflect the results of research conducted by the authors and do not reflect official policy nor position of the Defense Health Agency, Brooke Army Medical Center, the Department of Defense, or the U.S. Government.

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This study protocol was reviewed by the Brooke Army Medical Center Institutional Review Board for ethical approval (#23-17747) and was determined to be non-human research.

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Update

Routine Screening for Antibodies to Human Immunodeficiency Virus in the U.S. Armed Forces, Active and Reserve Components, January 2020–June 2025

This report provides an update, through June 2025, of routine screening results for antibodies to the human immunodeficiency virus (HIV) among members of the U.S. military. The HIV-antibody seropositivity rates for active component service members from 2024 through mid-year 2025 were highest for the Navy (0.23 per 1,000 tested) and Marine Corps (0.22 per 1,000 tested), followed by the Army (0.17 per 1,000 tested), and lowest for the Air Force (0.13 per 1,000 tested) and Coast Guard (0.11 per 1,000 tested). Mid-year HIV seropositivity rates, in comparison to 2024, increased for active component service members of the Army but decreased or remained stable for all other services, as of June 2025.

What are the new findings?

From January 2020 through June 2025, approximately 7 million U.S. military service members among the active component, reserve component, National Guard) were tested for antibodies to HIV, and 1,463 were identified as HIV-antibody-positive (seropositivity 0.21 per 1,000 tested). Of the 1,463 new infections identified during this period, only 40 (2.7%) were among female service members.

What is the impact on readiness and force health protection?

The HIV-antibody screening program remains an important element of U.S. force health protection, particularly for men under age 35 years, for all branches of service and service components. The measurement of military retention for HIV-positive service members reflects changes in U.S. Department of Defense policies that allow asymptomatic individuals with undetectable viral loads to serve without restrictions.

The U.S. Department of Defense (DOD) has conducted an active surveillance program for HIV since 1986. All service members of the active component, reserve component and National Guard are screened at specific points in time: prior to entry (all accessions must be HIV-negative prior to the start of service), before deployment or any change in status (e.g., change in component, between branches, or commissioning), and once every 2 years while a member of the U.S. military.[1] From 1990 through 2024, over 46 million tests for HIV antibodies were conducted to screen service members of the U.S. Armed Forces, resulting in the identification of 11,280 HIV new diagnoses (24.3 per 100,000 persons tested). While initial control efforts barred HIV-positive individuals from entering or serving in the military, leading to a precipitous drop in the rate of HIV diagnoses during the first decade of screening, the rate has remained stable for the last 2 decades.[2]

Infection with HIV remains a disqualifying diagnosis for entry into U.S. military service; however, in June 2022, the DOD amended policies to prevent HIV-positive service members with an undetectable viral load from being discharged or separated solely on the basis of HIV status.[1] In addition, HIV-positive personnel are not non-deployable solely for a positive status, as decisions related to deployability should be made on a case-by-case basis, justified by a service member's ability to perform assigned duties.[3]

Summaries of HIV seropositivity for members of the U.S. military have been published with *MSMR* since 1995. The current report summarizes numbers and trends of newly identified HIV-antibody seropositivity from January 1, 2020 through June 30, 2025 among military members of 5 services under the active and reserve components of the U.S. Armed Forces, in addition to the Army and Air Force National Guard.

Methods

The surveillance population included all individuals eligible for HIV antibody screening from January 1, 2020 through June 30, 2025 while serving in the active or reserve components of the U.S. Army, Navy, Air Force, Marine Corps, or Coast Guard. Space Force service members were categorized as Air Force for this analysis. All individuals who were tested, and all initial detections of HIV antibodies, through U.S. military medical testing programs were ascertained from the Department of Defense Serum Repository (DODSR) specimens accessioned to the Defense Medical Surveillance System (DMSS).

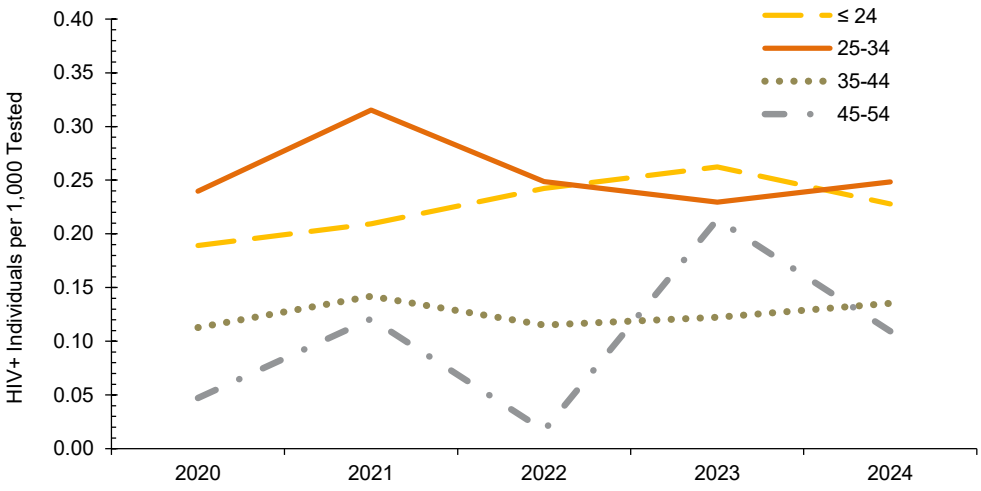
An incident case of HIV-antibody seropositivity was defined as an individual with positive HIV test results on 2 different, serial specimens. Individuals who had just 1 positive result without a subsequent negative result were also defined as positive, to capture those who had yet to test positive for a second time. The total number of HIV-positive tests were acquired from DMSS to calculate seropositivity rates as a standardized methodology for all services.

Annual rates of HIV seropositivity among service members were calculated by dividing the number of incident cases of HIV-antibody seropositivity during each calendar year by the number of individuals tested at least once during the relevant calendar year. Rates were further stratified by service, component, and sex. Overall rates by age category were calculated for all services for the complete annual years 2020 through 2024.

Results

From January 2020 through June 2025, approximately 7 million service members (active component, Guard, reserve) were tested for antibodies to HIV, and 1,463 were identified as HIV-antibody-positive (seropositivity 0.21 per 1,000 tested) (data not shown). The male rate (0.26 per 1,000 tested) persisted above the female rate (0.03 per 1,000 tested) throughout the surveillance period, as only 40 women were identified as newly HIV-antibody-positive during this time. Age-specific HIV seropositivity rates are presented for complete annual years in **Figure 1**; service members 25 to 34 years continually represented the highest age-specific rates from 2020 to 2024. In 2023, the seropositivity rate for service members ages 45-54 years increased to 0.21 per 1,000 tested, corresponding to an increase from 1 HIV seropositive cases identified in 2022 to 12 cases in 2023 (data not shown).

FIGURE 1. HIV Antibody Seropositivity Rates by Age[a], U.S. Armed Forces[b], 2020–2024



Abbreviation: HIV, human immunodeficiency virus.
[a] Rates are not represented for service members aged 55 years and older due to rate instability, as only 3 service members of this age group were identified as HIV seropositive, 2020–2024.
[b] Includes all components (active, Guard, reserve) for service members of the Army, Navy, Air Force, Marine Corps, Space Force, and Coast Guard.

U.S. Army, active component

From January 2024 through June 2025, a total of 445,309 U.S. Army active component soldiers were tested for HIV antibodies, and 77 were identified as HIV-antibody-positive (seropositivity 0.17 per 1,000 tested) **(Table 1)**. During the surveillance period, annual seropositivity rates fluctuated between a low of 0.15 per 1,000 tested in 2024 and a high of 0.28 per 1,000 tested in 2021 **(Table 1**, **Figure 2)**. Annual seropositivity rates for male active component soldiers were considerably higher than the seropositivity rates of female active component soldiers **(Figure 2)**. In 2024, 1 new HIV infection on average was detected among active component soldiers per 8,051 screening tests **(Table 1)**. Of the 389 active component soldiers diagnosed since 2020 with HIV infection, 242 (62.2%) were still in military service in 2025.

TABLE 1. New Diagnoses of HIV Infections, by Sex, U.S. Army, Active Component, January 2020–June 2025

Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	398,322	322,343	269,973	52,370	65	63	2	0.20	0.23	0.04	26
2021	403,660	323,463	270,828	52,635	90	89	1	0.28	0.33	0.02	40
2022	373,983	306,689	256,691	49,998	74	72	2	0.24	0.28	0.04	46
2023	374,734	303,704	254,159	49,545	83	79	4	0.27	0.31	0.08	60
2024	378,383	303,701	251,934	51,767	47	46	1	0.15	0.18	0.02	40
2025[a]	151,416	141,608	116,781	24,827	30	29	1	0.21	0.25	0.04	30
Total	2,080,498	1,701,508	1,420,366	281,142	389	378	11	0.23	0.27	0.04	242

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

Army National Guard

From January 2024 through June 2025, a total of 286,365 U.S. Army National Guard members were tested for HIV antibodies, and 102 soldiers were identified as HIV-antibody-positive (seropositivity 0.36 per 1,000 tested) **(Table 2)**. On average, 1 new HIV infection was detected in 2024 among Army National Guard soldiers per 3,309 screening tests. Of the 301 National Guard soldiers diagnosed since 2020 with HIV infection, 214 (71.1%) were still in service in 2025.

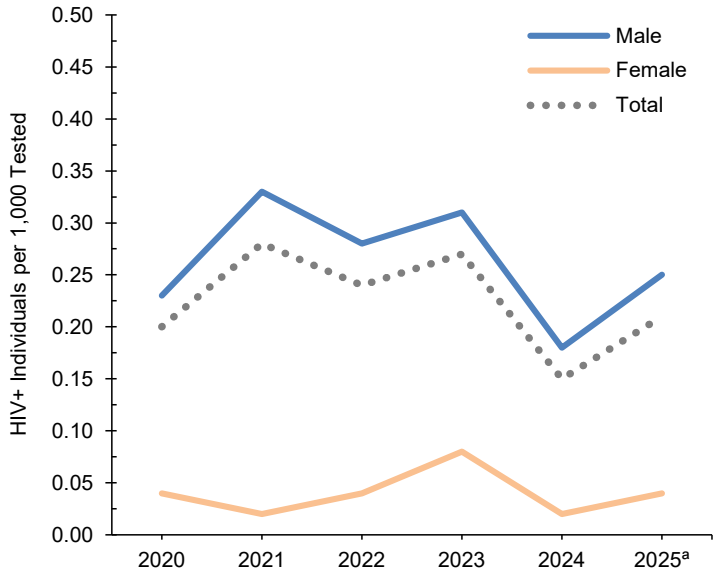
Army Reserve

From January 2024 through June 2025, a total of 127,024 U.S. Army Reserve members were tested for HIV antibodies, and 42 were identified as HIV-antibody-positive (seropositivity 0.33 per 1,000 tested) **(Table 3)**. During 2024, on average 1 new HIV infection was detected among Army reservists per 3,965 screening tests. Of the 153 Army reservists diagnosed since 2020 with HIV infection, 105 (68.6%) were still in service in 2025.

U.S. Navy, active component

A total of 282,755 members of the U.S. Navy active component were tested for HIV antibodies from January 2024 through June 2025, and 65 sailors were identified as HIV-antibody-positive (seropositivity 0.23 per 1,000 tested) **(Table 4)**. During the surveillance period, annual seropositivity rates fluctuated between a low of 0.16 per 1,000 tested in 2020 and a high of 0.29 per 1,000 tested in 2023 **(Table 4**, **Figure 3)**. Annual seropositivity rates for male active component sailors were considerably higher than the seropositivity rates of female active component soldiers **(Figure 3)**. During 2024, on average, 1 new HIV infection was detected among active component sailors per 4,990 screening tests. Of the 256 active component sailors diagnosed since 2020 with HIV infection, 181 (70.7%) were still in service in 2025.

FIGURE 2. HIV Antibody Seropositivity Rates by Sex, Active Component, U.S. Army, January 2020–June 2025



Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

Navy Reserve

From January 2024 through June 2025, a total of 45,073 members of the U.S. Navy Reserve were tested for HIV antibodies, with 9 sailors identified as HIV-antibody-positive (seropositivity 0.20 per 1,000 tested) **(Table 5)**. On average, 1 new HIV infection was detected in 2024 among Navy reservists per 4,468 screening tests. Of the 33 reserve component sailors diagnosed since 2020 with HIV infection, 19 (57.6%) were still in service in 2025.

TABLE 2. New Diagnoses of HIV Infections, by Sex, U.S. Army National Guard, January 2020–June 2025

Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	215,699	189,937	153,399	36,538	61	58	3	0.32	0.38	0.08	28
2021	218,060	190,121	154,006	36,115	50	48	2	0.26	0.31	0.06	28
2022	207,651	179,212	143,905	35,307	40	37	3	0.22	0.26	0.08	28
2023	214,471	186,821	149,597	37,224	48	47	1	0.26	0.31	0.03	37
2024	208,449	182,088	144,057	38,031	63	61	2	0.35	0.42	0.05	54
2025[a]	107,289	104,277	81,762	22,515	39	38	1	0.37	0.46	0.04	39
Total	1,171,619	1,032,456	826,726	205,730	301	289	12	0.29	0.35	0.06	214

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

TABLE 3. New Diagnoses of HIV Infections, by Sex, U.S. Army Reserve, January 2020–June 2025

Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	115,380	101,138	75,246	25,892	24	23	1	0.24	0.31	0.04	9
2021	119,108	101,434	75,562	25,872	29	29	0	0.29	0.38	0.00	17
2022	104,384	90,597	67,120	23,477	34	34	0	0.38	0.51	0.00	19
2023	79,437	69,082	50,640	18,442	24	23	1	0.35	0.45	0.05	18
2024	99,128	87,639	64,225	23,414	25	25	0	0.29	0.39	0.00	25
2025[a]	40,566	39,385	28,577	10,808	17	16	1	0.43	0.56	0.09	17
Total	558,003	489,275	361,370	127,905	153	150	3	0.31	0.42	0.02	105

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

TABLE 4. New Diagnoses of HIV Infections, by Sex, U.S. Navy, Active Component, January 2020–June 2025

Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	224,613	199,496	156,084	43,412	32	32	0	0.16	0.21	0.00	15
2021	242,438	215,079	168,997	46,082	54	51	3	0.25	0.30	0.07	30
2022	226,495	195,721	152,747	42,974	50	49	1	0.26	0.32	0.02	33
2023	223,122	191,930	149,570	42,360	55	55	0	0.29	0.37	0.00	47
2024	224,561	193,754	151,042	42,712	45	44	1	0.23	0.29	0.02	36
2025[a]	92,457	89,001	68,739	20,262	20	20	0	0.22	0.29	0.00	20
Total	1,233,686	1,084,981	847,179	237,802	256	251	5	0.24	0.30	0.02	181

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

TABLE 5. New Diagnoses of HIV Infections, by Sex, U.S. Navy Reserve, January 2020–June 2025

Year	Total HIV Tests	Total persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	30,252	27,847	21,137	6,710	6	6	0	0.22	0.28	0.00	3
2021	36,499	33,185	25,041	8,144	11	9	2	0.33	0.36	0.25	3
2022	32,234	28,762	21,567	7,195	7	5	2	0.24	0.23	0.28	6
2023	32,650	29,757	22,144	7,613	0	0	0	0.00	0.00	0.00	0
2024	31,278	28,411	20,995	7,416	7	7	0	0.25	0.33	0.00	6
2025[a]	17,260	16,662	12,391	4,271	2	2	0	0.12	0.16	0.00	1
Total	180,173	164,624	123,275	41,349	33	29	4	0.20	0.24	0.10	19

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2024.

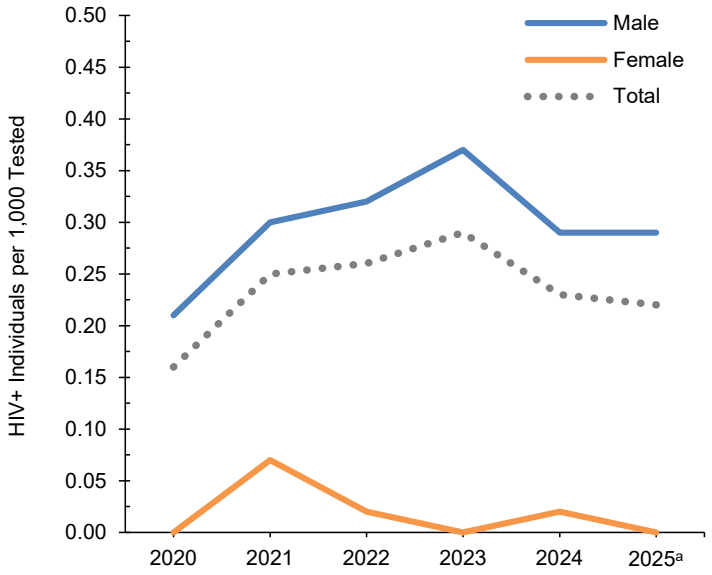
U.S. Air Force, active component

From January 2024 through June 2025, a total of 274,169 active component members of the U.S. Air Force were tested for HIV antibodies, and 37 Air Force members were diagnosed with HIV infection (seropositivity 0.13 per 1,000 tested) **(Table 6)**. On average, 1 new HIV infection was detected in 2024 among active component Air Force members per 8,692 screening tests. Of the 143 active component Air Force members diagnosed since 2020 with HIV infection, 91 (63.6%) were still in service in 2025. During the surveillance period, seropositivity rates among male members ranged from a low of 0.08 per 1,000 tested in 2020 to a high of 0.16 per 1,000 tested in 2022 **(Figure 4)**.

Air National Guard

From January 2024 through June 2025, a total of 85,121 members of the Air National Guard were tested for HIV antibodies, and 8 Air National Guard members were diagnosed with HIV infection (seropositivity 0.09 per 1,000 airmen tested) **(Table 7)**. During 2024, on average 1 new HIV infection was detected among Air National Guard members per 13,930 screening tests. Of the 32 Air National Guard members diagnosed since 2020 with HIV infection, 24 (75.0%) were still in service in 2025.

FIGURE 3. HIV Antibody Seropositivity Rates by Sex, Active Component, U.S. Navy, January 2020–June 2025



Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

Air Force Reserve

From January 2024 through June 2025, a total of 51,770 members of the Air Force Reserve were tested for HIV antibodies, with 9 Air Force reservists diagnosed with HIV infection (seropositivity 0.17 per 1,000 tested) **(Table 8)**. On average, in 2024 1 new HIV infection was detected among Air Force reservists per 7,749 screening tests. Of the 38 Air Force reservists diagnosed since 2020 with HIV infection, 26 (68.4%) were still in service in 2025.

U.S. Marine Corps, active component

From January 2024 through June 2025, a total of 154,093 active component members of the U.S. Marine Corps were tested for HIV antibodies, and 34 were identified as HIV-antibody-positive (seropositivity 0.22 per 1,000 tested) **(Table 9)**. Annual seropositivity rates rose from a low of 0.11 per 1,000 tested in 2021 to a high of 0.23 per 1,000 tested in 2024 **(Table 9, Figure 5)**. In 2024, on average, 1 new HIV infection per 5,031 screening tests was detected

TABLE 6. New Diagnoses of HIV Infections, U.S. Air Force, by Sex, Active Component, January 2020–June 2025

Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	243,703	194,471	152,318	42,153	16	16	0	0.08	0.11	0.00	9
2021	256,751	208,332	162,305	46,027	31	30	1	0.15	0.18	0.02	14
2022	238,720	190,564	148,666	41,898	31	31	0	0.16	0.21	0.00	16
2023	254,519	193,510	151,182	42,328	28	28	0	0.14	0.19	0.00	19
2024	234,672	174,910	136,596	38,314	27	27	0	0.15	0.20	0.00	23
2025[a]	117,031	99,259	77,542	21,717	10	10	0	0.10	0.13	0.00	10
Total	1,345,396	1,061,046	828,609	232,437	143	142	1	0.13	0.17	0.00	91

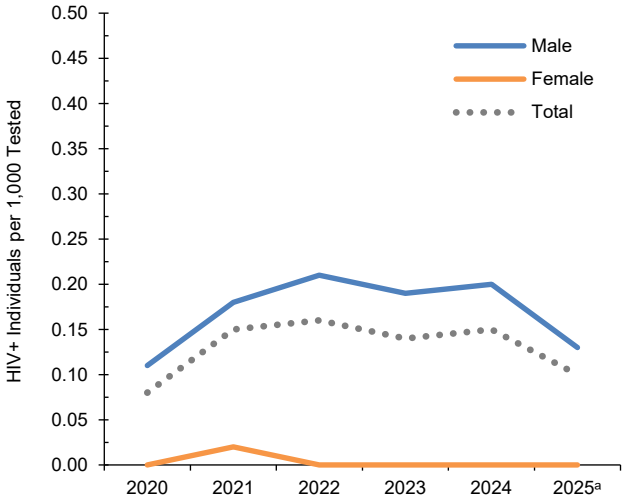
Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

among active component marines. Of the 100 active component marines diagnosed since 2020 with HIV infection, 58 (58.0%) were still in service in 2025.

Marine Corps Reserve

From January 2024 through June 2025, a total of 28,972 Marine Corps Reserve members were tested for antibodies to HIV, and 2 reservists were identified as HIV-antibody-positive (seropositivity 0.07 per 1,000 tested) **(Table 10)**. During 2024, on average, 1 new HIV infection was detected among Marine Corps reservists per 10,730 screening tests. Of the 12 active component marine reservists diagnosed since 2020 with HIV infection, 5 (41.7%) were still in service in 2025.

FIGURE 4. HIV Antibody Seropositivity Rates by Sex, Active Component, U.S. Air Force, January 2020–June 2025



Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

TABLE 7. New Diagnoses of HIV Infections, by Sex, U.S. Air National Guard, January 2020–June 2025

Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	67,949	58,974	46,171	12,803	6	5	1	0.10	0.11	0.08	3
2021	68,112	60,311	47,168	13,143	8	8	0	0.13	0.17	0.00	5
2022	61,356	54,829	42,790	12,039	4	3	1	0.07	0.07	0.08	2
2023	70,837	56,978	44,647	12,331	6	6	0	0.11	0.13	0.00	6
2024	69,651	52,553	41,057	11,496	5	5	0	0.10	0.12	0.00	5
2025[a]	38,829	32,568	25,588	6,980	3	3	0	0.09	0.12	0.00	3
Total	376,734	316,213	247,421	68,792	32	30	2	0.10	0.12	0.03	24

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

TABLE 8. New Diagnoses of HIV Infections, by Sex, U.S. Air Force Reserve, January 2020–June 2025

Year	Total HIV Tests	Total persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	38,943	33,947	24,604	9,343	6	6	0	0.18	0.24	0.00	3
2021	41,589	37,431	27,022	10,409	15	14	1	0.40	0.52	0.10	8
2022	37,274	33,460	24,185	9,275	4	4	0	0.12	0.17	0.00	4
2023	39,003	33,710	24,383	9,327	4	4	0	0.12	0.16	0.00	3
2024	38,743	31,854	22,645	9,209	5	5	0	0.16	0.22	0.00	4
2025[a]	22,173	19,916	14,405	5,511	4	4	0	0.20	0.28	0.00	4
Total	217,725	190,318	137,244	53,074	38	37	1	0.20	0.27	0.02	26

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

TABLE 9. New Diagnoses of HIV Infections, by Sex, U.S. Marine Corps, Active Component, January 2020–June 2025

Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	140,663	123,760	112,634	11,126	19	19	0	0.15	0.17	0.00	5
2021	148,034	129,763	117,790	11,973	14	14	0	0.11	0.12	0.00	4
2022	129,465	112,850	101,857	10,993	13	12	1	0.12	0.12	0.09	6
2023	129,606	112,505	101,138	11,367	20	20	0	0.18	0.20	0.00	14
2024	125,782	107,279	96,195	11,084	25	25	0	0.23	0.26	0.00	20
2025[a]	48,642	46,814	42,121	4,693	9	9	0	0.19	0.21	0.00	9
Total	722,192	632,971	571,735	61,236	100	99	1	0.16	0.17	0.02	58

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

TABLE 10. New Diagnoses of HIV Infections, by Sex, U.S. Marine Corps Reserve, January 2020–June 2025

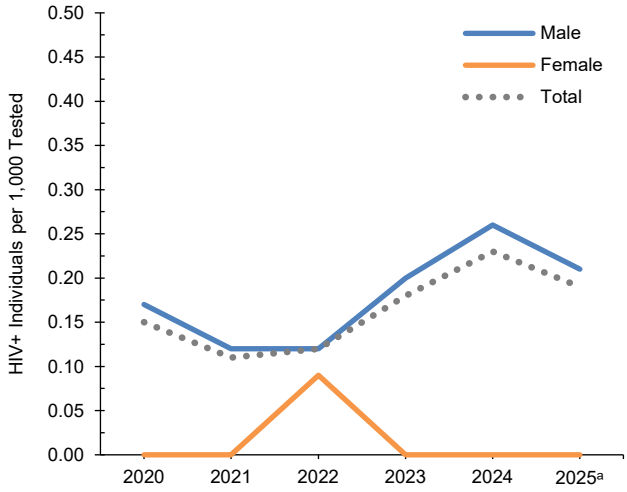
Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	19,371	17,874	17,141	733	2	2	0	0.11	0.12	0.00	1
2021	26,095	22,700	21,840	860	6	6	0	0.26	0.27	0.00	2
2022	19,963	17,747	17,024	723	2	2	0	0.11	0.12	0.00	0
2023	21,580	19,194	18,310	884	0	0	0	0.00	0.00	0.00	0
2024	21,460	18,533	17,626	907	2	2	0	0.11	0.11	0.00	2
2025[a]	10,660	10,439	9,872	567	0	0	0	0.00	0.00	0.00	0
Total	119,129	106,487	101,813	4,674	12	12	0	0.11	0.12	0.00	5

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

U.S. Coast Guard, active component

From January 2024 through June 2025, a total of 28,188 active component members of the U.S. Coast Guard were tested for antibodies to HIV, and 3 were identified as HIV-antibody-positive (seropositivity 0.11 per 1,000 tested) **(Table 11)**. During 2024, on average, 1 new HIV infection was detected among active component members of the U.S Coast Guard per 9,920 screening tests. Of the 5 active component Coast Guard service members diagnosed since 2020 with HIV infection, all 5 were still in service in 2025.

FIGURE 5. HIV Antibody Seropositivity Rates by Sex, Active Component, U.S. Marine Corps, January 2020–June 2025



Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

Coast Guard Reserve

From January 2024 through June 2025, a total of 5,307 U.S. Coast Guard Reserve members were tested for HIV antibodies, with none identified as HIV-antibody-positive **(Table 12)**.

Discussion

The most current seropositivity rate (0.21 per 1,000 tested) reported for January 1, 2024 through June 30, 2025 remains consistent with the seropositivity rate reported in the prior annual report (0.22 per 1,000 tested from January 1, 2023 to June 30, 2025).[4] The U.S. military has conducted routine screening for antibodies to HIV among all civilian applicants for service and all service members for more than 30 years.[5-8] In 1995, the U.S. Army tested approximately 1.1 million specimens annually, demonstrating an economically efficient, large-scale model for HIV testing.[9] The first *MSMR* article to publish results from HIV screening programs indicates that antibody seropositivity rates in 1994 for the Army active duty (0.19 per 1,000 soldiers) and reserve component (0.23 per 1,000 soldiers) remain comparable to rates presented in 2025.[10]

A review of archived surveillance data also reflects improved retention of HIV-positive service members, in alignment with recent DOD policy that recognizes significant advances in the diagnosis, prevention, and treatment of the disease. From 1990 to 1994, a total of 889 active and reserve component soldiers were diagnosed with HIV-1 infection. By 1995, only 234 (26.0%) were still in service.[10] Today, a comparative retention figure for active component Army service members has increased to 66.4%.

The 2022-2025 National HIV/AIDS strategy identifies youth ages 13-24 years as a priority population, based on increased risk for HIV transmission.[11] While the seropositivity results presented in this report do partially represent this priority population, as over 43% of all new HIV infections were identified in service members younger than age 25 years, these results should not be generalized to the U.S. population. Data from HIV screening in U.S. military populations are based on a negative test prior

TABLE 11. New Diagnoses of HIV Infections, by Sex, U.S. Coast Guard, Active Component, January 2020–June 2025

Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	17,269	16,748	14,133	2,615	1	1	0	0.06	0.07	0.00	1
2021	20,463	19,800	16,632	3,168	1	1	0	0.05	0.06	0.00	1
2022	19,578	18,934	15,930	3,004	0	0	0	0.00	0.00	0.00	0
2023	19,290	18,495	15,480	3,015	0	0	0	0.00	0.00	0.00	0
2024	19,839	18,890	15,786	3,104	2	2	0	0.11	0.13	0.00	2
2025[a]	9,497	9,298	7,752	1,546	1	1	0	0.11	0.13	0.00	1
Total	105,936	102,165	85,713	16,452	5	5	0	0.05	0.06	0.00	5

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

TABLE 12. New Diagnoses of HIV Infections, by Sex, U.S. Coast Guard Reserve, January 2020–June 2025

Year	Total HIV Tests	Total Persons Tested	Males Tested	Females Tested	Total New HIV(+)	New HIV(+) Males	New HIV(+) Females	Overall Rate per 1,000 Tested	Male Rate per 1,000 Tested	Female Rate per 1,000 Tested	HIV(+) Still in Military Service in 2025
2020	2,846	2,756	2,284	472	1	1	0	0.36	0.44	0.00	1
2021	3,233	3,027	2,514	513	0	0	0	0.00	0.00	0.00	0
2022	2,918	2,826	2,332	494	0	0	0	0.00	0.00	0.00	0
2023	2,907	2,788	2,275	513	0	0	0	0.00	0.00	0.00	0
2024	3,218	3,059	2,530	529	0	0	0	0.00	0.00	0.00	0
2025[a]	2,268	2,248	1,865	383	0	0	0	0.00	0.00	0.00	0
Total	17,390	16,704	13,800	2,904	1	1	0	0.06	0.07	0.00	1

Abbreviation: HIV, human immunodeficiency virus.
[a] Through Jun. 30, 2025.

to entry, as well as voluntary service. Previous *MSMR* reports presented HIV screening results for civilian applicants to the military service; however, those data are no longer available in the Defense Medical Surveillance System (DMSS), as the U.S. Military Entrance Processing Command stopped reporting data to the DMSS at the end of calendar year 2020. Thus, the data presented in this report reflect service members who had a negative HIV test upon entry to military service, followed by a positive test during uniformed service.

Routine screening of civilian applicants for service and periodic testing of all active and reserve component members have been fundamental components of the military's HIV control and clinical management efforts.[1,2] The most current HIV annual seropositivity rates indicate the HIV-antibody screening program remains an important element of force health protection, particularly for men younger than age 35 years, for all branches of service and components of the U.S. Armed Forces.

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Brief Report

Lyme Disease Forecasting in the U.S. Department of Defense: Summary of One- to Three-Month Forecasts, January–October 2024

Mark L. Bova, PhD; Sneha P. Cherukuri, MS; Shaylee P. Mehta, MPH; Christian T. Bautista, PhD

Lyme disease incidence has been increasing among U.S. Department of Defense (DOD) service members over the past 20 years, threatening the health and readiness of the force.[1] Syndromic surveillance of tick bite visits can provide timely information that might predict changes in tick-borne disease incidence and geographic spread.[2] Tick and tick-borne illness surveillance programs in the U.S. face many barriers, however, including inconsistent funding and limited capacities.[3]

Epidemic forecasting models can be used to enhance routine surveillance and inform public health policy.[4] Previous research on Lyme disease forecasting has focused on general time series and machine-learning models; however, these models have demonstrated high percentage errors and limited predictive accuracy.[5,6] Further research is needed to explore alternative modeling approaches that may improve forecasting performance.

Since 2019, the Armed Forces Health Surveillance Division, Integrated Biosurveillance (AFHSD-IB) Branch, within the Defense Health Agency's Public Health Directorate, has been conducting respiratory disease forecasting using syndromic surveillance data.[7] Since 2024, AFHSD-IB has integrated vector-borne disease forecasting to provide situational awareness and inform public health responses from DOD senior leaders. This report aims to predict the number of future Lyme disease and tick bite encounters among U.S Military Health System (MHS) beneficiaries using outpatient encounter data and multiple forecasting methods.

Methods

Tick bite encounters were used as a proxy for tick exposure, while Lyme disease encounters served as a proxy for Lyme disease diagnoses in the absence of trusted case reporting. Encounter definitions were developed using internal criteria.

A single instance of a Lyme disease encounter was defined using the International Classification of Diseases, 10th Revision (ICD-10), discharge diagnosis code 'A69.2' and chief complaint terms "Lyme disease," "erythema migrans," or "bulls-eye rash," or their misspellings, in the chief complaint field; any mention of a history of Lyme disease was excluded. Similarly, tick bite encounters were defined as health records mentioning "tick bite" and associated misspellings (including "tic" or "tik" for tick and "bit" for bite) in the chief complaint field. Monthly direct-sourced outpatient encounter data for each military treatment facility were obtained from the DOD's Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE). Data were then aggregated into 4 U.S. surveillance regions, selected based on their high volume of Lyme disease encounters in 2024: National Capital Region, New England, Tidewater, and West Point. Surveillance regions are collections of neighboring military installations, clinics, and hospitals used for disease surveillance and reporting. (Information about each surveillance region is shown in **Supplementary Table 1**.)

Monthly encounter data from January 2021 through October 2024 were collected and used to generate 1- through 3-month forecasts for each outcome metric and surveillance region for the period January through October 2024. Models were trained each month, using data from January 2021 through the most recent month.

Several time series and machine-learning models were used for forecasting. The seasonal autoregressive integrated moving average (SARIMA) model is based on the widely used Box-Jenkins method for univariate time series forecasting.[8] The error, trend, seasonal (ETS) model is another time series model that belongs to a special class of exponential smoothing models known as state-space models.[8] The exponentially weighted moving average (EWMA) model is a highly sensitive model that effectively identifies subtle data pattern changes due to its weighting scheme, which is of particular importance when assessing rare outcomes.[9] The vector autoregressive (VAR) model is a forecasting algorithm that can be used when 2 or more time series influence each other.[10] The neural network (NNET) model is a machine-learning model that can adapt to changing inputs, generating the best possible results without needing to redesign the output criteria.[11] Prophet is open-source forecasting model created by Facebook that allows users to easily customize and produce high quality forecasts.[12] Finally, a baseline naïve model was created using data from the previous tickborne season. An ensemble (ENS) model was also calculated as the average of all individual model forecasts.

A log-transformed weighted interval score (WIS) was used to measure accuracy of the model forecasts. WIS was previously established as a scoring method for respiratory disease forecasts,[13] with lower values indicating more accurate forecasts. The median absolute percentage error (MAPE), another common metric for forecasting error, was also calculated. All analyses were performed in R software 4.4 (R Foundation for Statistical Computing, Vienna, Austria), including the *fable*[14] and *fabletools*[15] packages.

Results

Our analyses indicated that observed Lyme disease encounters increased from late winter to early spring, peaking during the summer months, except for West Point, which peaked in April. West Point also had the highest peak (34.5 per 100,000 MHS beneficiaries), followed by New England (31.4 in July), National Capital Region (13.9, June), and Tidewater (4.2, June) **(Figure 1)**. Observed tick bite encounters increased from February until spring for each surveillance region. The National Capital Region had the highest peak (50.0 per 100,000 MHS beneficiaries in June), followed by West Point (39.5, April), New England (29.1, April), and Tidewater (18.9, May). **Figure 1** also shows 1- through 3-month ahead horizon forecasts for the ENS model.

For Lyme disease encounter forecasts, the NNET model had the lowest median log-WIS across the 2-month (0.6) and 3-month (0.8) ahead horizons, while the ENS model had the lowest median log-WIS for the 1-month ahead horizon (0.7) **(Figure 2)**. The ETS model had the lowest MAPE for Lyme disease encounters for the 1-month ahead horizon (33%), while the NNET model had the lowest MAPE for the 2-month ahead horizon (37%), and the ENS model had the lowest MAPE for the 3-month ahead horizon (28%) ahead horizon **(Supplementary Figure 2)**. During the months with the highest activity (March–October), MAPE for the ENS model improved to 29% and 27%, respectively, for the 1-month and 3-month ahead horizons, while the MAPE for the NNET model improved to 29% for the 2-month ahead horizon, indicating greater forecasting accuracy during high activity periods when compared to the total surveillance time **(Supplementary Table 2)**.

For tick bite encounter forecasts, the ETS model had the lowest score (1.0) for all horizons, as well as for the 1- (0.8), 2- (1.0), and 3-month (1.2) ahead horizons, followed by the NNET model (1.2, all horizons; 1.2, 1-month; 1.1, 2-month; and 1.2, 3-month) **(Figure 2)**. The ETS model had the lowest MAPE across all 1-month (25%), 2-month (23%), and 3-month (24%) ahead horizons **(Supplementary Figure 2)**. During the months of highest activity, MAPE for the ETS model improved to 21%, 22%, and 24% respectively for the 1-month, 2-month, and 3-month ahead horizons **(Supplementary Table 2)**.

Discussion

This study produced 2 major findings. First, among all the time series and machine-learning models mentioned in our analysis, 3 models—ENS, ETS, NNET—provided the most accurate forecasts of Lyme disease and tick bite activity in MHS beneficiaries, with increased accuracy during peak activity periods. This finding suggests that these 3 models would be valuable as early warning signals for public health surveillance and preparedness. It is important to note, however, that model accuracy decreased at longer horizons. Second, MAPE estimates were higher than those reported in previous studies using SARIMA models, although accuracy was improved by focusing on periods of higher activity. Individual surveillance regions aligned with the findings of the aforementioned study.[6]

Limitations of this study must be considered. First, data lags and inconsistent reporting of Lyme disease cases within the MHS prevented validation of encounter data against confirmed case data. Consequently, sensitivity analysis of encounter definition robustness could not be performed, and therefore, results may not be representative of overall disease incidence. The training data set was derived from a 3-year period of encounter data, but additional historical data may be needed to properly train some of the models. Due to limited technology capacity, particularly hardware, this study also did not utilize more computationally intensive machine-learning models, such as long short-term memory and random forest models, potentially limiting the accuracy of the forecasts. In addition, these models are susceptible to over-fitting when there is insufficient training data.

Despite these limitations, this study provided the first quantitative evidence of the use of outpatient encounter syndromic surveillance data for forecasting Lyme disease and tick bite encounters in the MHS population. Lyme disease forecasting can provide vital information for anticipating the impact on military health and readiness, as well as informing effective public health responses and mitigation efforts within the DOD. Further research is required to explore additional models, more robust training data, and other covariates, including incident Lyme disease cases and other key predictors, such as host species, geographic factors, climate, and weather.

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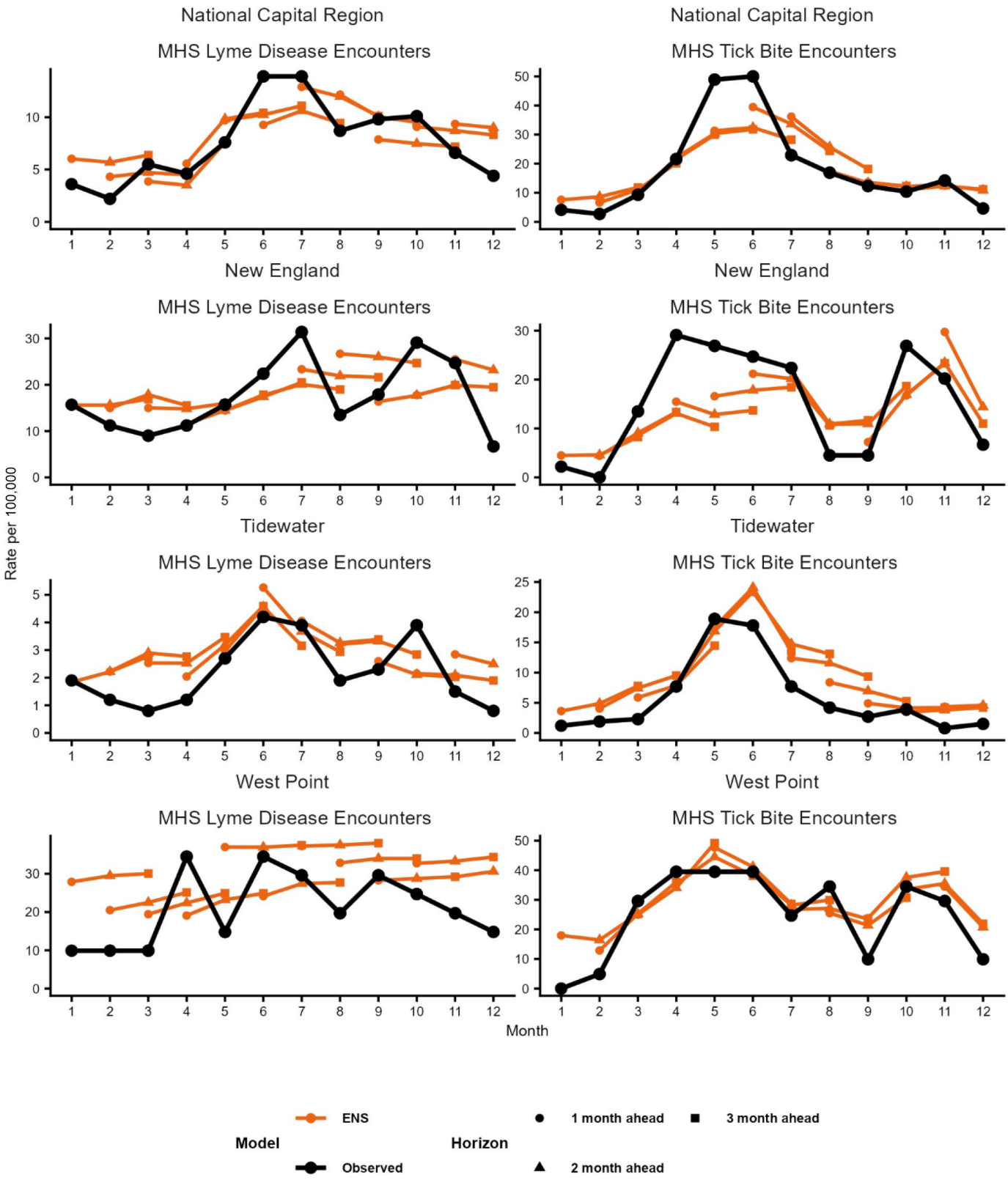
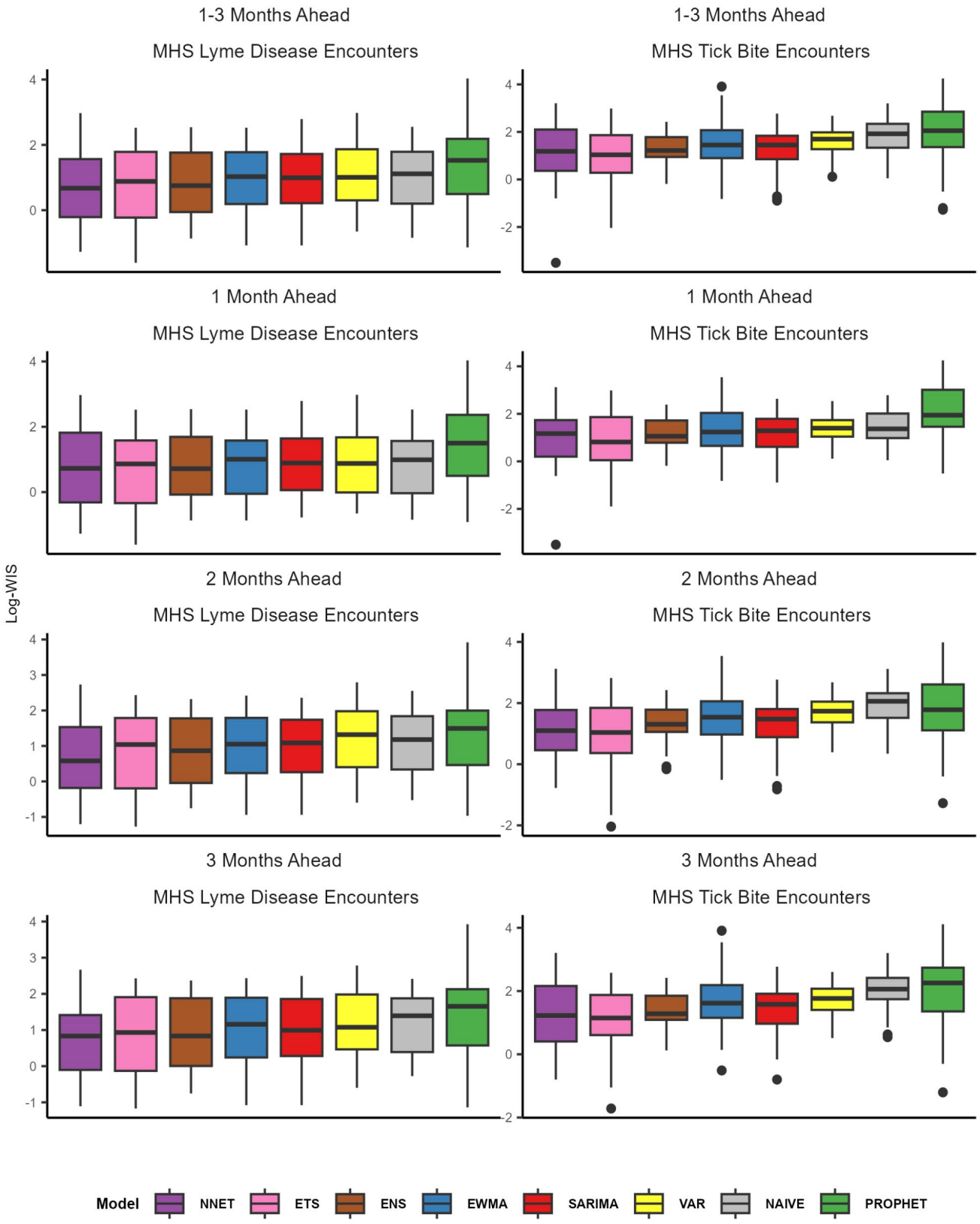
FIGURE 1. Ensemble Model Observed and Predicted Values, by Surveillance Region and Outcome Metric, 2024



Note: Y-axes scales may be different for each subplot.
Abbreviations: MHS, Military Health System; ENS, ensemble model.

FIGURE 2. Median Log-Weighted Interval Score by Forecasting Horizon, Outcome Metric and Model, 2024



Abbreviations: MHS, Military Health System; WIS, weighted interval score; NNET, neural network; ETS, error, trend, seasonal; ENS, ensemble; EWMA, exponentially weighted moving average; SARIMA, seasonal autoregressive integrated moving average; VAR, vector autoregressive.

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SUPPLEMENTARY TABLE 1. Summary Information for Lyme Disease and Tick Bite Encounters, by Selected Surveillance Regions, 2024

Region	States Included	Approximate MHS Beneficiaries	Lyme Disease Encounters	Tick Bite Encounters
		No.	No.	No.
National Capital Region	VA, DC, MD, DE, PA, NJ	366,146	333	798
New England	CT, RI, MA, NH	44,598	93	81
Tidewater	VA, NC	259,084	68	183
West Point	NJ, NY, PA	20,277	51	60

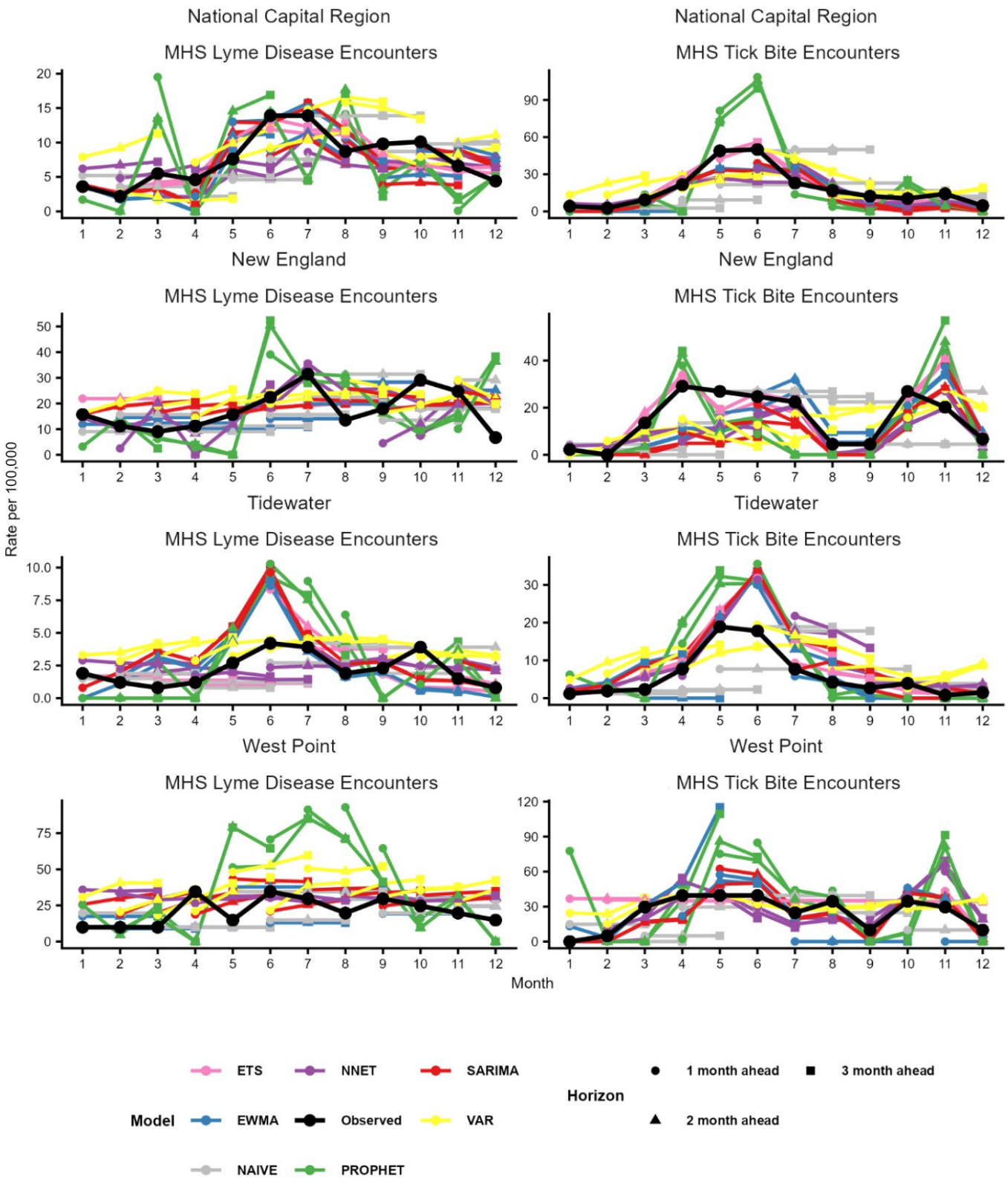
Abbreviations: MHS, Military Health System; No., number; VA, Virginia; DC, District of Columbia; MD, Maryland; DE, Delaware; PA, Pennsylvania; NJ, New Jersey; CT, Connecticut; RI, Rhode Island; MA, Massachusetts; NH, New Hampshire; VA, Virginia; NC, North Carolina; NY, New York.

SUPPLEMENTARY TABLE 2. Median Absolute Percentage Error, by Forecasting Model, Horizon and Outcome Metric, March–October 2024

Model	Lyme Disease			Tick Bites		
	1 Month Ahead	2 Months Ahead	3 Months Ahead	1 Month Ahead	2 Months Ahead	3 Months Ahead
	%	%	%	%	%	%
ENS	29	31	27	21	30	33
ETS	35	40	29	21	22	24
EWMA	37	46	31	43	45	71
Naïve	33	50	41	55	82	86
NNET	37	29	33	34	39	46
Prophet	90	100	92	97	79	87
SARIMA	40	39	36	41	48	54
VAR	34	50	67	31	47	46

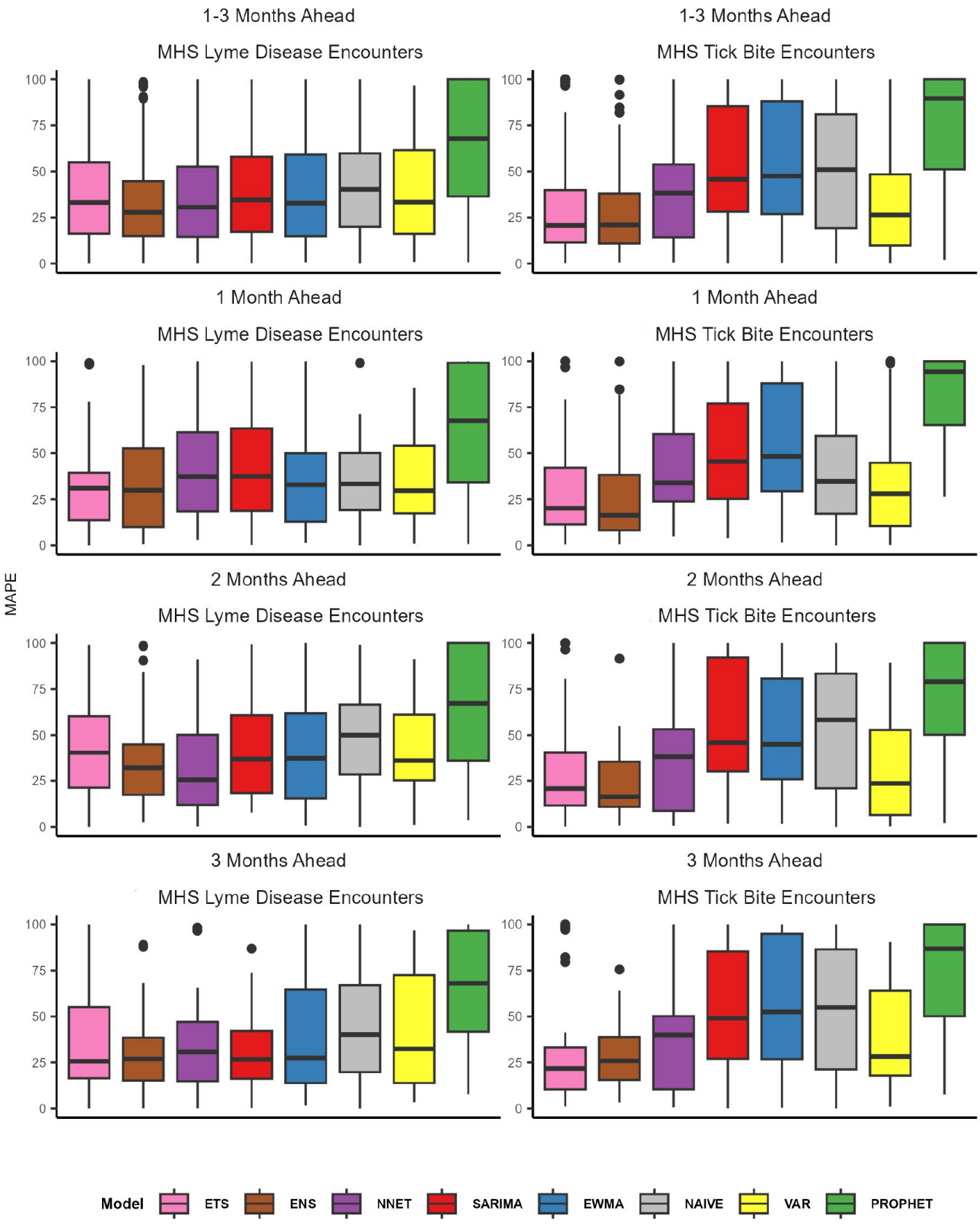
Abbreviations: ENS, ensemble; ETS, error, trend, seasonal; EWMA, exponentially weighted moving average; NNET, neural network; SARIMA, seasonal autoregressive integrated moving average; VAR, vector autoregressive.

SUPPLEMENTARY FIGURE 1. Observed and Predicted Values Not Shown in FIGURE 1, by Surveillance Region, Outcome Metric and Forecasting Model, 2024



Abbreviations: Military Health System; ETS, error, trend, seasonal; NNET, neural network; SARIMA, seasonal autoregressive integrated moving average; EWMA, exponentially weighted moving average; VAR, vector autoregressive.

SUPPLEMENTARY FIGURE 2. Median Absolute Percentage Error by Forecasting Horizon, Outcome Metric and Model, 2024



Abbreviations: MHS, Military Health System; MAPE, median absolute percentage error; ETS, error, trend, seasonal; ENS, ensemble; NNET, neural network; SARIMA, seasonal autoregressive integrated moving average; EWMA, exponentially weighted moving average; VAR, vector autoregressive.

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