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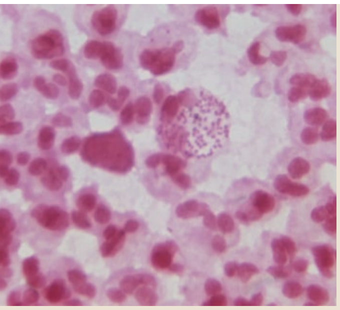

CDC/Dr. David Cox



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# Update: Sexually Transmitted Infections, Active Component, U.S. Armed Forces, 2011–2019

This report summarizes incidence rates of the 5 most common sexually transmitted infections (STIs) among active component service members of the U.S. Armed Forces during 2011–2019. Infections with chlamydia were the most common, followed in decreasing order of frequency by infections with genital human papillomavirus (HPV), gonorrhea, genital herpes simplex virus (HSV), and syphilis. Compared to men, women had higher rates of all STIs except for syphilis. In general, compared to their respective counterparts, younger service members, non-Hispanic black service members, soldiers, and enlisted members had higher incidence rates of STIs. The incidence of chlamydia and gonorrhea generally increased among both male and female service members in the latter half of the surveillance period but may have begun to level off or decrease in 2019. Rates of syphilis increased for male service members through 2018 but decreased slightly in 2019; the rate among female service members increased from 2011 to 2014 but leveled off through 2018 before increasing in 2019. The incidence of genital HPV generally decreased among both male and female service member but rose slightly among women in 2019; HSV incidence decreased among both male and female service members. Similarities to and differences from the findings of the last *MSMR* update on STIs are discussed.

**WHAT ARE THE NEW FINDINGS?**

The incidence of chlamydia and gonorrhea generally increased among male and female service members in the latter half of the surveillance period; however, the rates may have begun to decrease in 2019. The incidence of genital HPV and HSV continued to decrease. The incidence of syphilis increased among female service members in 2019.

**WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?**

STIs can adversely impact service members' availability and ability to perform their duties and can result in serious medical sequelae if untreated. Establishing standards for screening, testing, treatment, and reporting would likely improve efforts to detect STI-related health threats. Continued behavioral risk-reduction interventions are needed to counter the increasing incidence of some STIs and maintain any decreases.

Sexually transmitted infections (STIs) are relevant to the U.S. military because of their relatively high incidence, adverse impact on service members' availability and ability to perform their duties, and potential for serious medical sequelae if untreated.[1] Two of the most common bacterial STIs are caused by *Chlamydia trachomatis* (chlamydia) and *Neisseria gonorrhoeae* (gonorrhea). Rates of chlamydia and gonorrhea have been steadily increasing in the general U.S. population among both men and women since 2000.[2] A March 2019 *MSMR* report documented more than 212,000 incident infections of chlamydia and more than 32,000 incident infections of gonorrhea among active component U.S. military members between 2010 and 2018, with increasing incidence rates among both males and females in the latter half of the surveillance period, mirroring trends in the general U.S. population.[3]

Another important bacterial STI is syphilis, which is caused by the bacterium *Treponema pallidum*. Rates of primary and secondary syphilis in the U.S. have risen steadily from a historic low in 2001 and increased 71.4%, from 6.3 cases per 100,000 persons in 2014 to 10.8 cases per 100,000 persons in 2018.[2] This upward trend is mirrored in the active component of the U.S. Armed Forces, in which the incidence of syphilis (of any type) increased steadily between 2010 and 2018, with most of the increase occurring among men.[3] Although these 3 relatively common bacterial STIs are curable with antibiotics, there is continued concern regarding the threat of multidrug resistance.[4–6]

Common viral STIs in the U.S. include infections caused by human papillomavirus (HPV) and genital herpes simplex virus (HSV). HPVs are DNA viruses that infect basal epithelial (skin or mucosal) cells. HPV genotypes 6 and 11 are responsible for 90% of all genital wart infections,[7] while genotypes 16 and 18 cause most HPV-related cancers.[8] HSV can cause genital or oral herpes infections that are characterized by the appearance of 1 or more vesicles that can break and leave painful ulcers. Most genital herpes infections are caused by type 2 (HSV-2); however, type 1 (HSV-1), which is most often associated with oral herpes infection, is estimated to be responsible for 50% of new genital herpes infections.[9] Neither HPV nor HSV viral infections are curable with antibiotics; however, suppression of recurrent herpes manifestations is attainable using antiviral medication, and there is a vaccine to prevent infection with 4 of the most common HPV serotypes as well as 5 additional cancer-causing types.[7] From 2010 through 2018, the overall incidence rates of genital HPV and HSV in the active component were 61.1 and 23.7 cases per 10,000 person-years (p-yrs), respectively.[3]

The current analysis updates the findings of previous *MSMR* articles on STIs among active component service members.[1,3] Specifically, this report summarizes incident cases and incidence rates of 5 of the most common STIs during 2011–2019 and their distribution by demographic and military characteristics.

## METHODS

The surveillance period was 1 January 2011 through 31 December 2019. The surveillance population consisted of all active component service members of the U.S. Army, Navy, Air Force, or Marine Corps who served at any time during the period. Diagnoses of STIs were ascertained from medical administrative data and reports of notifiable medical events routinely provided to the Armed Forces Health Surveillance Branch and maintained in the Defense Medical Surveillance System (DMSS) for surveillance purposes. STI cases were also derived from positive laboratory test results recorded in the Health Level 7 (HL7) chemistry and microbiology databases maintained by the Navy and Marine Corps Public Health Center at the EpiData Center.

For each service member, the number of days in active military service was ascertained and then aggregated into a total for all service members during each calendar year. The resultant annual totals were expressed as p-yrs of service and used as the denominators for the calculation of annual incidence rates. Person-time that was not considered to be time at risk for each STI was excluded (i.e., the 30 days following each incident chlamydia or gonorrhea infection and all person-time following the first diagnosis, medical event report, or positive laboratory test of HSV, HPV, or syphilis).

An incident case of chlamydia was defined by any of the following: 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 for chlamydia, or 3) a positive laboratory test for chlamydia (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 a record of an inpatient or outpatient or in-theater encounter, 2) a confirmed notifiable disease report for gonorrhea, or 3) a positive laboratory test for gonorrhea (any specimen source or test type). For both chlamydia and gonorrhea, an individual could be counted as having a subsequent case only if there were more than 30 days between the dates on which the case-defining diagnoses were recorded.

**TABLE 1.** ICD-9 and ICD-10 diagnostic codes used to identify cases of STIs in electronic healthcare records

| | ICD-9[a] | ICD-10[a] |
|---|---|---|
| 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 |

[a]An asterisk (*) indicates that any subsequent digit/character is included.
ICD, International Classification of Diseases; STIs, sexually transmitted infections; HPV, human papillomavirus; HSV, herpes simplex virus.

Incident cases of HSV were identified by 1) the presence of the requisite International Classification of Diseases, 9th or 10th Revision (ICD-9 or ICD-10, respectively) codes in either the first or second diagnostic positions of a record of an outpatient or in-theater encounter or 2) a positive laboratory test from a genital specimen source. Antibody tests were excluded because they do not allow for distinction between genital and oral infections. Incident cases of HPV were similarly identified by 1) the presence of the requisite ICD-9 or ICD-10 codes in either the first or second diagnostic positions of a record of an outpatient or in-theater encounter or 2) a positive laboratory test from any specimen source or test type. Outpatient encounters for HPV with evidence of an immunization for HPV within 7 days before or after the 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 the vaccination administration. An individual could be counted as an incident case of HSV or HPV only once during the surveillance period. Individuals who had diagnoses of HSV or HPV infection before the surveillance period were excluded from the analysis.

An incident case of syphilis was defined by 1) a qualifying ICD-9 or ICD-10 code in the first, second, or third diagnostic position of a hospitalization, 2) at least 2 outpatient or in-theater encounters within 30 days of each other with a qualifying ICD-9 or 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 the HL7 laboratory data do not allow for differentiation of stages and because there is a high degree of misclassification associated with the use of ICD diagnosis codes for stage determination.[10,11] 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 from the analysis.

## RESULTS

Between 2011 and 2019, the number of incident chlamydia infections among active component service members was greater than the sum of the other 4 STIs combined and 3.4 times the total number of genital HPV infections—the next most frequently identified STI during this period **(Table 2)**. With the exception of syphilis, the overall incidence rates of all STIs were markedly higher among women than men. For chlamydia, gonorrhea, and syphilis, overall incidence rates were highest among those aged 24 years or younger and decreased with advancing age. However, overall rates of genital HSV and HPV infections were highest among those aged 20–24 years

**TABLE 2.** Incident counts and incidence rates of STIs, active component, U.S. Armed Forces, 2011–2019

| | Chlamydia | | Gonorrhea | | Syphilis | | Genital HSV | | Genital HPV | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Rate[a] | No. | Rate[a] | No. | Rate[a] | No. | Rate[a] | No. | Rate[a] |
| Total | 221,263 | 184.6 | 34,107 | 28.4 | 5,180 | 4.3 | 27,522 | 23.3 | 64,997 | 56.4 |
| Sex | | | | | | | | | | |
| Male | 139,723 | 137.9 | 26,827 | 26.5 | 4,540 | 4.5 | 15,226 | 15.2 | 28,065 | 28.2 |
| Female | 81,540 | 440.4 | 7,280 | 39.2 | 640 | 3.4 | 12,296 | 68.9 | 36,932 | 231.6 |
| Age group (years) | | | | | | | | | | |
| <20 | 29,548 | 366.5 | 3,407 | 42.2 | 448 | 5.5 | 1,916 | 23.7 | 1,406 | 17.4 |
| 20–24 | 128,245 | 338.2 | 18,258 | 48.0 | 1,977 | 5.2 | 11,396 | 30.2 | 26,645 | 71.3 |
| 25–29 | 43,712 | 152.9 | 7,582 | 26.5 | 1,391 | 4.9 | 7,348 | 26.0 | 17,767 | 65.1 |
| 30–34 | 13,048 | 68.1 | 3,042 | 15.9 | 693 | 3.6 | 3,644 | 19.4 | 11,065 | 61.9 |
| 35–39 | 4,620 | 33.8 | 1,169 | 8.5 | 322 | 2.4 | 1,847 | 13.9 | 4,955 | 38.7 |
| 40+ | 2,090 | 16.8 | 649 | 5.2 | 349 | 2.8 | 1,371 | 11.3 | 3,159 | 26.6 |
| Race/ethnicity group | | | | | | | | | | |
| Non-Hispanic white | 89,096 | 126.7 | 9,250 | 13.1 | 1,804 | 2.6 | 12,807 | 18.4 | 33,852 | 49.8 |
| Non-Hispanic black | 72,790 | 378.0 | 17,782 | 92.1 | 1,832 | 9.5 | 8,130 | 43.3 | 13,461 | 73.6 |
| Hispanic | 37,035 | 218.5 | 4,252 | 25.1 | 979 | 5.8 | 4,054 | 24.2 | 10,066 | 61.8 |
| Asian/Pacific Islander | 7,056 | 151.4 | 862 | 18.5 | 186 | 4.0 | 643 | 13.9 | 2,193 | 48.5 |
| Other/unknown | 15,286 | 176.3 | 1,961 | 22.6 | 379 | 4.4 | 1,888 | 22.1 | 5,425 | 65.4 |
| Service | | | | | | | | | | |
| Army | 94,799 | 210.4 | 17,700 | 39.2 | 2,042 | 4.5 | 12,044 | 27.1 | 24,257 | 55.8 |
| Navy | 51,256 | 177.4 | 7,800 | 27.0 | 1,765 | 6.1 | 6,443 | 22.6 | 16,669 | 60.0 |
| Air Force | 44,078 | 152.8 | 4,786 | 16.6 | 913 | 3.2 | 6,119 | 21.6 | 17,730 | 64.8 |
| Marine Corps | 31,130 | 182.8 | 3,821 | 22.4 | 460 | 2.7 | 2,916 | 17.2 | 6,341 | 38.0 |
| Rank/grade | | | | | | | | | | |
| Junior enlisted (E1–E4) | 166,738 | 320.1 | 24,171 | 46.3 | 3,105 | 6.0 | 15,061 | 29.0 | 33,506 | 65.2 |
| Senior enlisted (E5–E9) | 46,105 | 98.6 | 8,522 | 18.2 | 1,648 | 3.5 | 9,406 | 20.6 | 21,975 | 50.1 |
| Junior officer (O1–O3) | 7,163 | 61.5 | 1,078 | 9.3 | 261 | 2.2 | 2,084 | 18.1 | 7,070 | 63.2 |
| Senior officer (O4–O10) | 709 | 9.3 | 221 | 2.9 | 132 | 1.7 | 707 | 9.4 | 1,954 | 26.8 |
| Warrant officer (W01–W05) | 548 | 32.2 | 115 | 6.8 | 34 | 2.0 | 264 | 16.0 | 492 | 30.7 |
| Education level | | | | | | | | | | |
| High school or less | 192,651 | 247.0 | 29,070 | 37.2 | 3,794 | 4.9 | 19,744 | 25.5 | 42,996 | 56.7 |
| Some college | 14,007 | 97.5 | 2,470 | 17.2 | 595 | 4.1 | 3,320 | 23.7 | 8,267 | 62.0 |
| Bachelor's or advanced degree | 12,052 | 48.7 | 2,194 | 8.9 | 717 | 2.9 | 3,992 | 16.4 | 12,215 | 52.0 |
| Other/unknown | 2,553 | 93.8 | 373 | 13.7 | 74 | 2.7 | 466 | 17.3 | 1,519 | 57.6 |
| Marital status | | | | | | | | | | |
| Single, never married | 149,311 | 303.5 | 22,151 | 44.9 | 3,211 | 6.5 | 14,010 | 28.7 | 32,050 | 66.7 |
| Married | 58,507 | 89.8 | 9,954 | 15.3 | 1,665 | 2.6 | 10,776 | 16.8 | 26,564 | 42.6 |
| Other/unknown | 13,445 | 244.9 | 2,002 | 36.4 | 304 | 5.5 | 2,736 | 52.0 | 6,383 | 130.2 |
| Military occupation | | | | | | | | | | |
| Combat-specific[b] | 25,457 | 148.1 | 4,229 | 24.6 | 455 | 2.6 | 2,796 | 16.4 | 5,841 | 34.7 |
| Motor transport | 9,866 | 283.5 | 1,810 | 51.9 | 277 | 8.0 | 957 | 27.8 | 2,377 | 70.3 |
| Pilot/air crew | 2,221 | 49.6 | 267 | 6.0 | 69 | 1.5 | 528 | 11.9 | 1,474 | 34.2 |
| Repair/engineering | 63,054 | 179.7 | 9,323 | 26.5 | 1,241 | 3.5 | 7,327 | 21.1 | 16,367 | 48.1 |
| Communications/intelligence | 54,994 | 211.5 | 9,445 | 36.3 | 1,271 | 4.9 | 7,701 | 30.2 | 17,778 | 72.4 |
| Healthcare | 16,368 | 154.8 | 2,391 | 22.6 | 523 | 4.9 | 2,946 | 28.4 | 8,779 | 88.7 |
| Other/unknown | 49,303 | 214.1 | 6,642 | 28.8 | 1,344 | 5.8 | 5,267 | 23.1 | 12,381 | 55.5 |

[a]Incidence rate per 10,000 person-years.
[b]Infantry/artillery/combat engineering/armor.
STIs, sexually transmitted infections; HSV, herpes simplex virus; HPV, human papillomavirus; No., number.

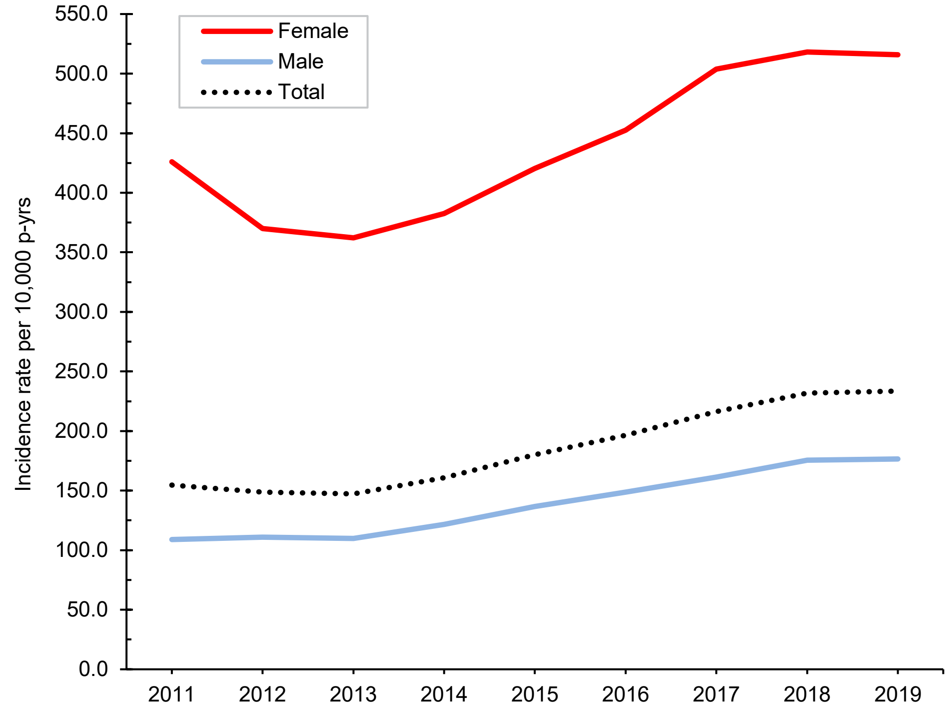
and those aged 25–29 years. Rates of all STIs were highest among non-Hispanic black service members compared to other race/ethnicity groups. For chlamydia, gonorrhea, and genital HSV infections, overall rates were highest among members of the Army. The overall incidence rate of syphilis was highest among Navy members, and the overall rate of genital HPV infections was highest among Air Force members. Compared to their respective counterparts, enlisted service members and those with lower levels of educational achievement tended to have higher overall rates for all STIs. Married service members had the lowest incidence rates of all 5 STIs compared to service members who were single and never married or of other/unknown marital status. Overall rates of chlamydia, gonorrhea, and syphilis were highest among those working in motor transport. In contrast, genital HPV infection rates were highest among those in healthcare occupations, and the highest rates of genital HSV infections were among those working in communications/intelligence, health care, or motor transport **(Table 2)**. Patterns of incidence for each specific STI are described in the subsections below.

## Chlamydia

During the surveillance period, annual incidence rates of chlamydia among service women were generally 3 to 4 times the rates among men. Annual rates among men and women combined increased 58.6% between 2013 and 2019, with rates among women peaking in 2018 (518.2 per 10,000 p-yrs) and rates for men peaking in 2019 (176.5 per 10,000 p-yrs) **(Figure 1)**. In both sexes, the increase was primarily attributed to service members in the youngest age groups (less than 25 years among women; less than 30 years among men) **(data not shown)**.

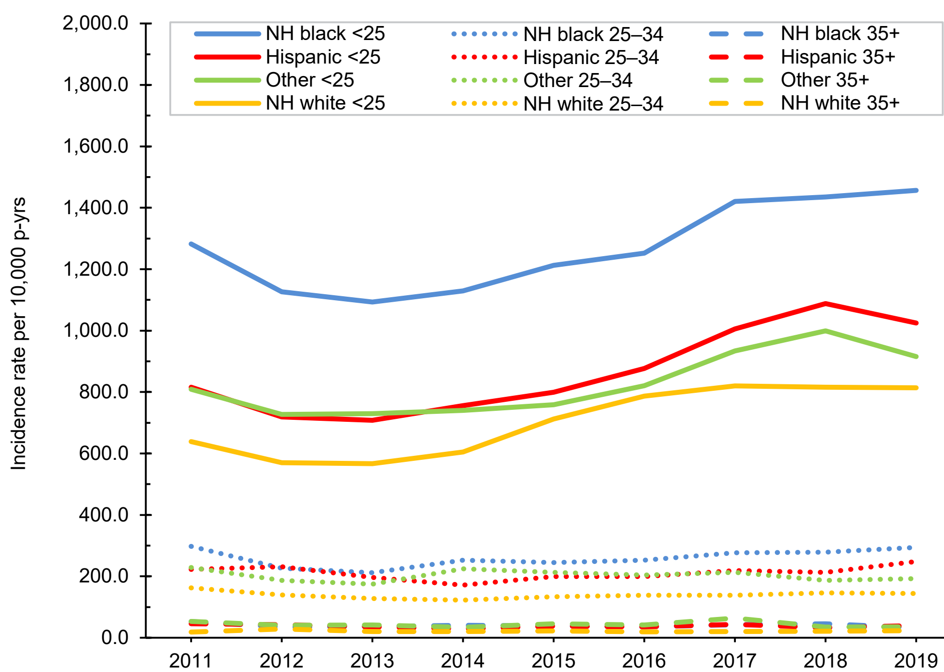
Among service women in each race/ethnicity group, annual rates of chlamydia generally increased among those under 25 years of age during 2013–2018 but leveled off or decreased slightly in 2019. Rates remained relatively stable among those aged 25–34 years and among those aged 35 years or older **(Figure 2)**. Among service men, annual rates of chlamydia increased

**FIGURE 1.** Incidence rates of *Chlamydia trachomatis* infections, by sex, active component, U.S. Armed Forces, 2011–2019




P-yrs, person-years.

**FIGURE 2.** Incidence rates of *Chlamydia trachomatis* infections among females, by age group (years) and race/ethnicity group, active component, U.S. Armed Forces, 2011–2019




NH, non-Hispanic; p-yrs, person-years.

between 2013 and 2018 in all age and race/ethnicity groups less than 35 years old but remained relatively stable among those in older age groups **(Figure 3)**. However, in 2019, rates stabilized for many age and race/ethnicity groups less than 35 years old, particularly among non-Hispanic black service members less than 25 years old **(Figure 3)**. Rates decreased for non-Hispanic white service members less than 25 years old but continued to rise for non-Hispanic black service members 25–34 years old, Hispanic service members less than 35 years old, and those in the other race/ethnicity group less than 25 years old **(Figure 3)**.

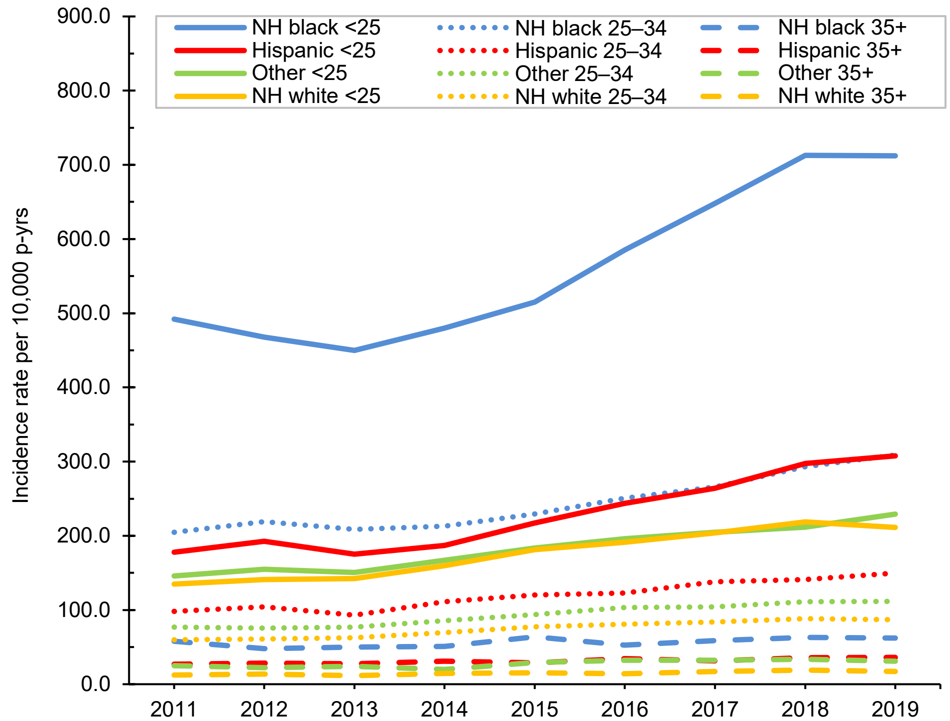
## Genital HPV

The crude annual incidence rates of genital HPV infections decreased 44.5% among all active component service members from the beginning to the end of the surveillance period, with the most dramatic decrease occurring among women **(Figure 4)**. There was a dip in the incidence of genital HPV infections among all active component service members in 2013 at 55.6 cases per 10,000 p-yrs, but the lowest points were reached in 2018 and 2019 at 43.5 and 43.8 cases per 10,000 p-yrs, respectively. Incidence rates among female service members declined by a little more than 35% during the surveillance period, from a high of 313.2 cases per 10,000 p-yrs in 2011 to a low of 198.1 cases per 10,000 p-yrs in 2018 **(Figure 4)**; rates increased slightly to 199.6 per 10,000 p-yrs in 2019. Rates among men decreased from 44.6 per 10,000 p-yrs in 2011 to 16.0 per 10,000 p-yrs in 2019. The slight increase in rates of genital HPV infections among women overall was attributable to small increases in the rates among women in each of the age groups younger than 35 years old **(Figure 5)**. The decrease in the genital HPV infection rates among men overall was driven by decreases in the rates in the youngest age groups (less than 30 years) **(Figure 6)**.

## Gonorrhea

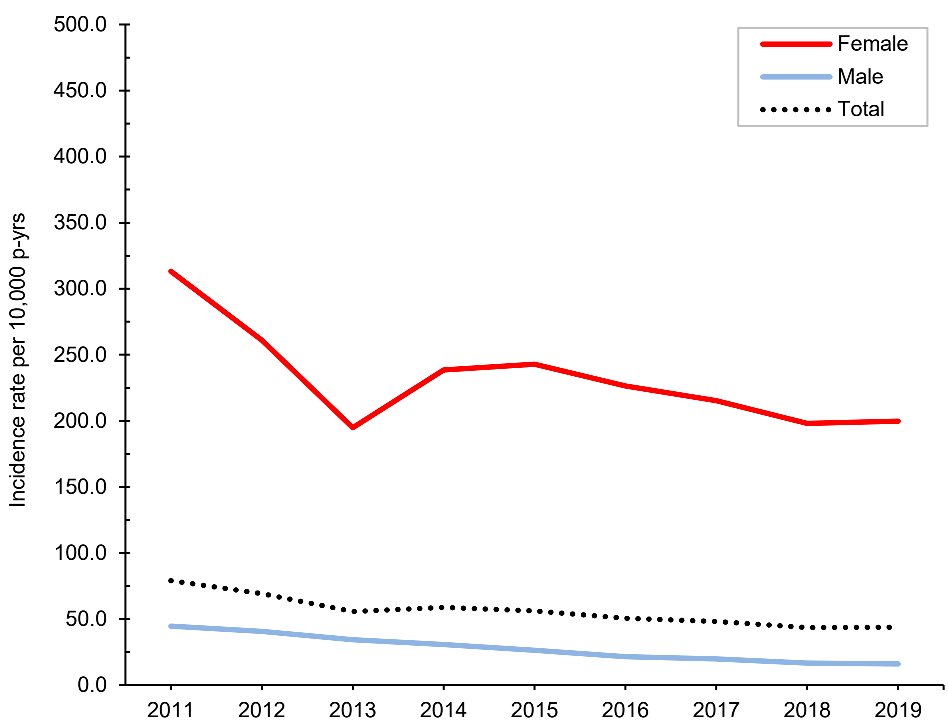
Between 2011 and 2019, the crude annual incidence rate of gonorrhea increased by 49.2%; however, after increasing steadily from 2011 through 2018, the

**FIGURE 3.** Incidence rates of *Chlamydia trachomatis* infections among males, by age group (years) and race/ethnicity group, active component, U.S. Armed Forces, 2011–2019




NH, non-Hispanic; p-yrs, person-years.

**FIGURE 4.** Incidence rates of genital HPV infections, by sex, active component, U.S. Armed Forces, 2011–2019




HPV, human papillomavirus; p-yrs, person-years.

rate decreased in 2019 (by 4.6%). The annual rates among women declined between 2011 and 2015 then increased through 2018 before decreasing in 2019 (by 3.1%). After increasing steadily between 2011 and 2018, the rate among men also decreased in 2019 (by 5.3%) **(Figure 7)**. These trends in gonorrhea incidence were primarily driven by similar trends among women less than 25 years of age and among men less than 30 years of age **(Figures 8, 9)**. The ratio of the incidence rate for women compared to men was 2.1 in 2011 but dropped to 1.4 in 2019. The annual rates of gonorrhea increased during the surveillance period among all race/ethnicity groups through 2018, but the rates fell in 2019 for all groups except non-Hispanic black service members, whose rate continued to increase **(data not shown)**.

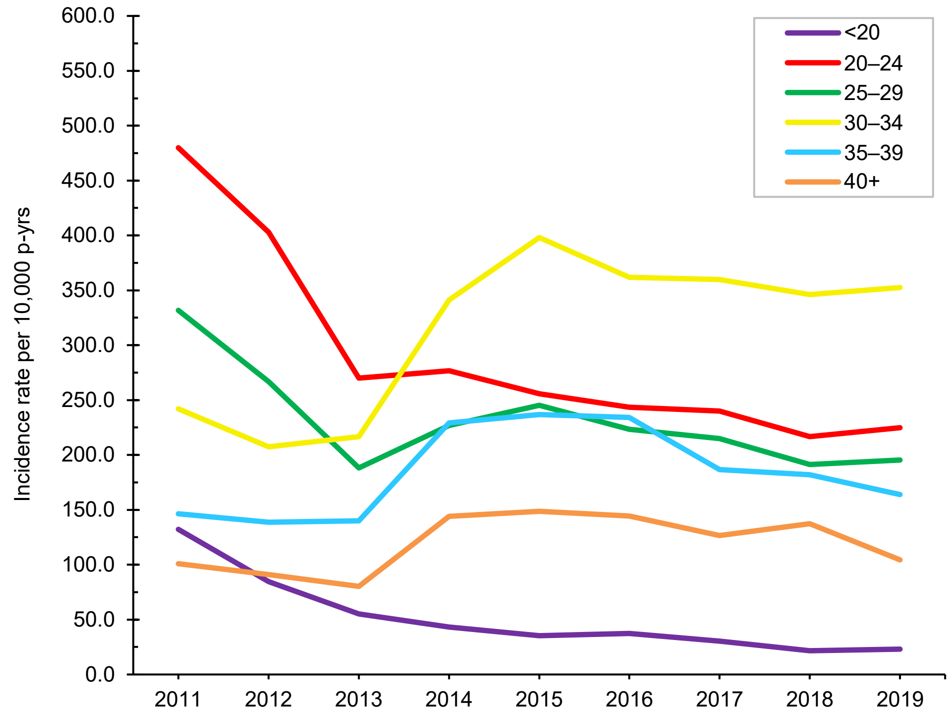
## Genital HSV

Crude annual incidence rates of genital HSV infections decreased from 25.2 to 20.2 per 10,000 p-yrs over the course of the surveillance period. Annual rates declined steadily among both men and women from 2011 to 2019 **(Figure 10)**; rates among female service members decreased from a high of 74.0 per 10,000 p-yrs in 2011 to a low of 60.8 per 10,000 p-yrs in 2019, and rates among men decreased from 17.2 per 10,000 p-yrs in 2011 to 12.2 per 10,000 p-yrs in 2019. The incidence rates of genital HSV infections decreased among all age groups over the course of the surveillance period **(data not shown)**. The rates decreased between 2018 and 2019 among women in all age groups and decreased or remained relatively stable among men in all age groups during the same period except among those 25–29 years old (increase of 4.8%) **(data not shown)**. In addition, the incidence rates decreased among all race/ethnicity groups during the surveillance period except for non-Hispanic black and Asian/Pacific Islander service members, whose rates increased slightly **(data not shown)**.

## Syphilis

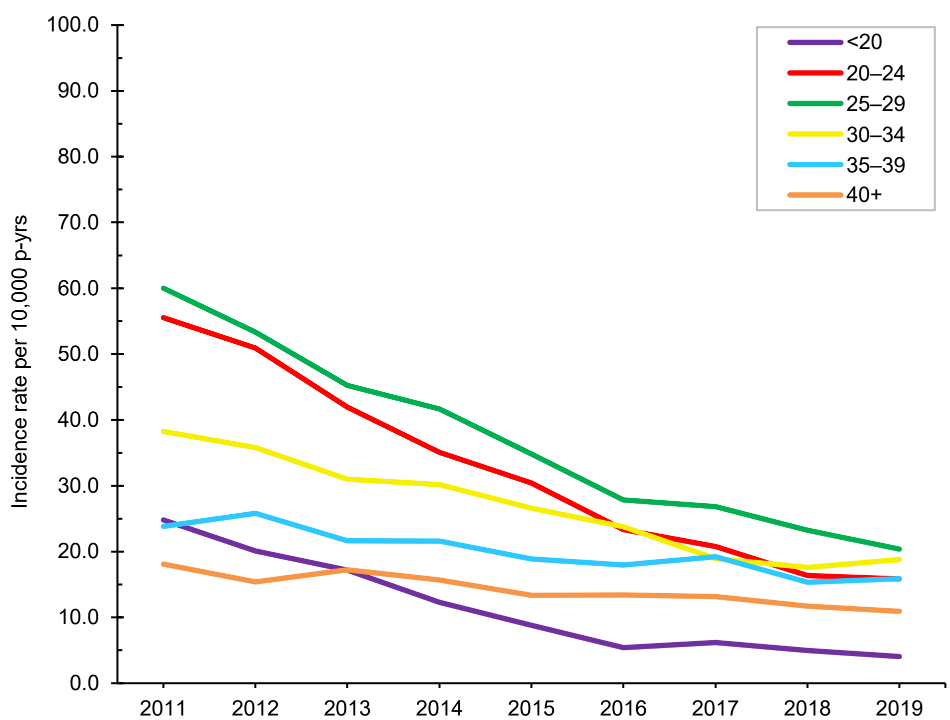
The crude incidence rate of syphilis in the last year of the surveillance period (6.1 per 10,000 p-yrs) was 2.7 times that

**FIGURE 5.** Incidence rates of genital HPV infections among females, by age group (years), active component, U.S. Armed Forces, 2011–2019




HPV, human papillomavirus; p-yrs, person-years.

**FIGURE 6.** Incidence rates of genital HPV infections among males, by age group (years), active component, U.S. Armed Forces, 2011–2019




HPV, human papillomavirus; p-yrs, person-years.

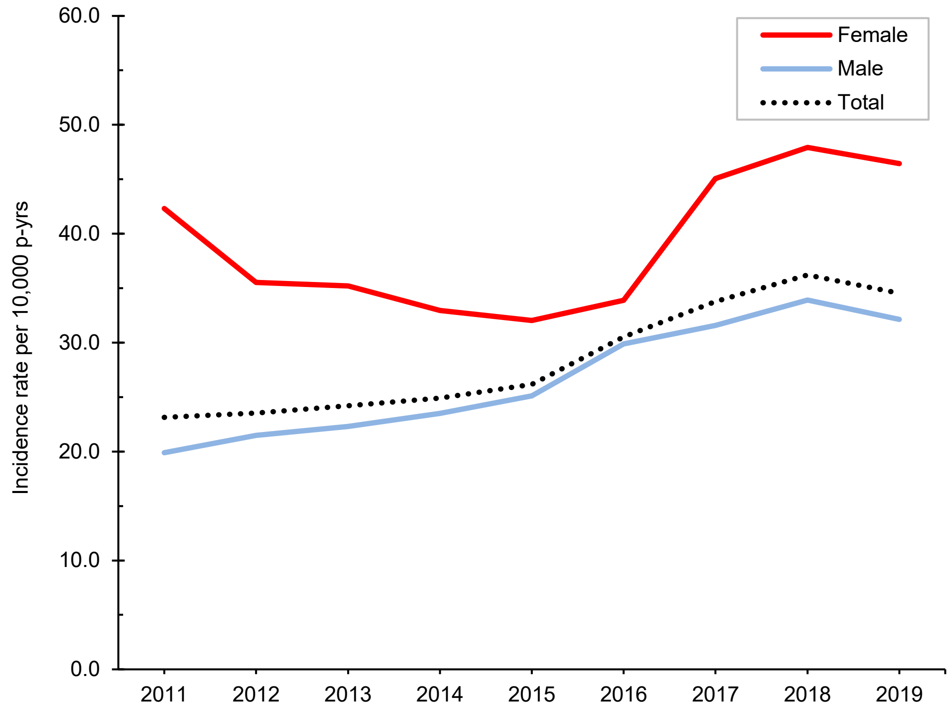
observed in 2011 (2.2 per 10,000 p-yrs). This increase in the rate was primarily driven by cases identified among male service members, though the rate among female service members increased sharply (43.1%) between 2018 and 2019 **(Figure 11)**. Rates of syphilis steadily increased among men until 2018 and then decreased slightly in 2019. Among women, rates increased between 2011 and 2014, leveled off through 2018, and then increased in 2019. Among men, the pattern of decreasing overall incidence with increasing age was consistent among all race/ethnicity groups; there were not enough cases to evaluate associations between age and race/ethnicity group among women **(data not shown)**.

## EDITORIAL COMMENT

As in previous reports, the crude annual incidence rates of chlamydia, gonorrhea, and syphilis generally increased during the surveillance period. However, from 2018 through 2019, the rate of chlamydia decreased slightly in women and the rates of gonorrhea decreased slightly in both men and women. From 2018 through 2019, the rate of syphilis remained relatively stable among male service members but increased in female service members. In contrast, the incidence rate of genital HSV continued to decrease through 2018 and 2019 among both male and female service members, and the rate of HPV continued to decrease in men and remained relatively stable, with a slight rise, for women. Overall incidence rates of STIs were higher among women when compared to men for HPV, HSV, gonorrhea, and chlamydia. Syphilis was the only STI in this analysis for which the incidence was, on average, higher among male compared to female service members.

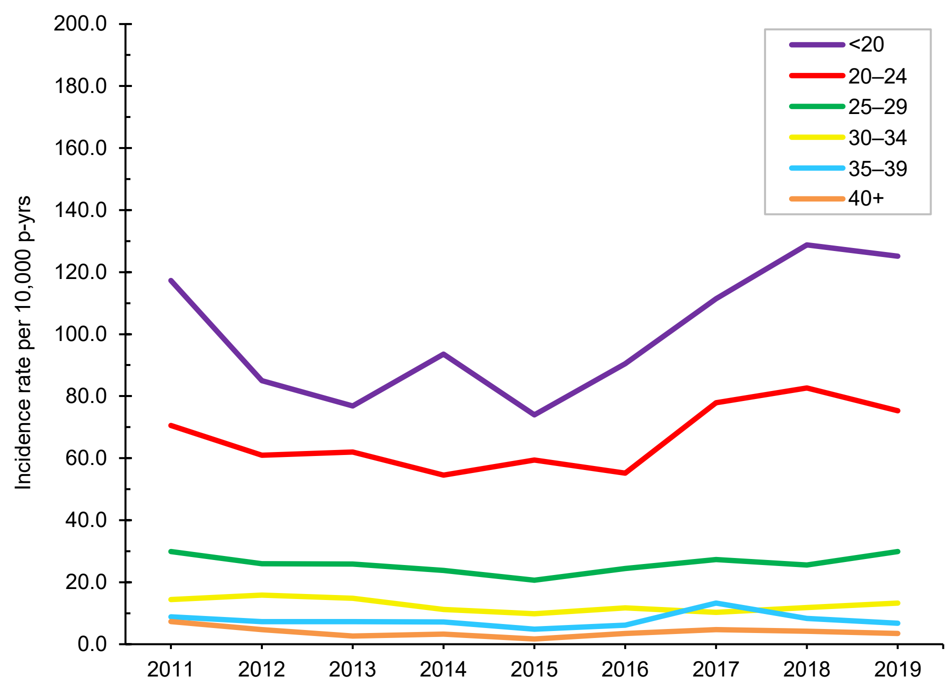
Higher incidence rates of most STIs among women compared to men can likely be attributed to implementation of the services' screening programs for STIs among female service members as they enter active service and during the subsequent annual screenings for women under age 26. Because asymptomatic infection with chlamydia, gonorrhea, or HPV is common

**FIGURE 7.** Incidence rates of gonorrhea infections, by sex, active component, U.S. Armed Forces, 2011–2019




P-yrs, person-years.

**FIGURE 8.** Incidence rates of gonorrhea infections among females, by age group (years), active component, U.S. Armed Forces, 2011–2019



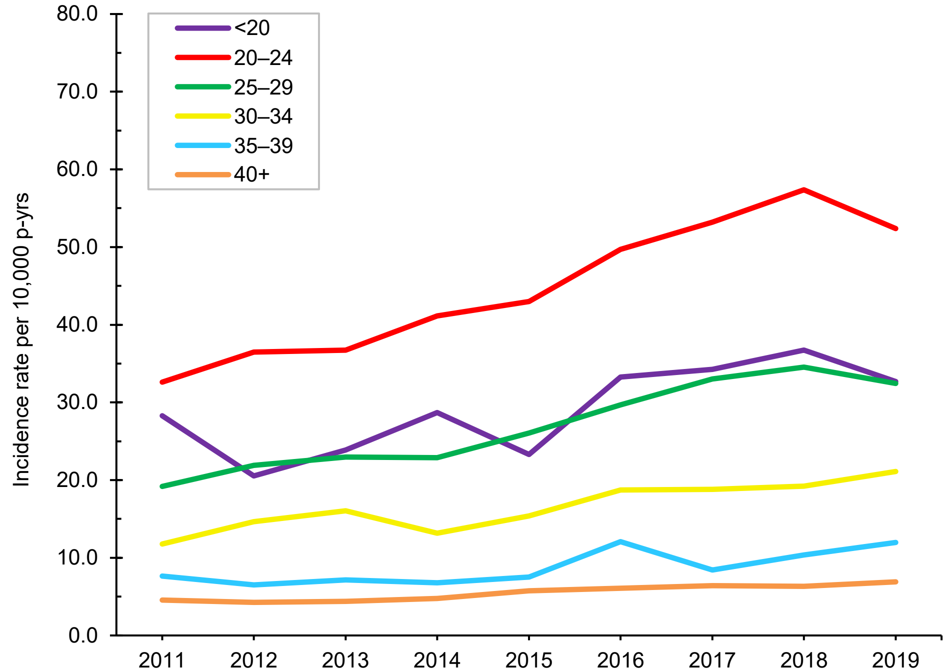

P-yrs, person-years.

among sexually active women, widespread screening may result in sustained high numbers of infections diagnosed among young women. Although rates of chlamydia and gonorrhea increased among both male and female service members during the latter half of the surveillance period, mirroring the increasing rates in the civilian population,[2] the rate of chlamydia decreased slightly for women and the rates of gonorrhea decreased slightly for both men and women between 2018 and 2019. In the U.S., rates of chlamydia have been increasing among both men and women since 2000, and rates of gonorrhea have been increasing among both sexes since 2013[2]; however, no 2019 data on the rates of chlamydia or gonorrhea in the civilian population were available for comparison at the time of this report. The increases seen through 2018 in both the civilian and military populations could reflect true increases in the incidence of infections as well as improved screening coverage in men, particularly extragenital screening in men who have sex with men.[12]

No data on sexual risk behaviors were available in this study, but prior surveys of military personnel have indicated high levels of such behaviors. The 2015 Department of Defense Health Related Behaviors Survey (HRBS) documented that 19.4% of respondents reported having more than 1 sex partner in the past year and that 36.7% reported sex with a new partner in the past year without using a condom; these percentages were almost double those reported from the previous survey in 2011.[13] Data from the 2018 HRBS were not available at the time of this report, precluding any comparisons.

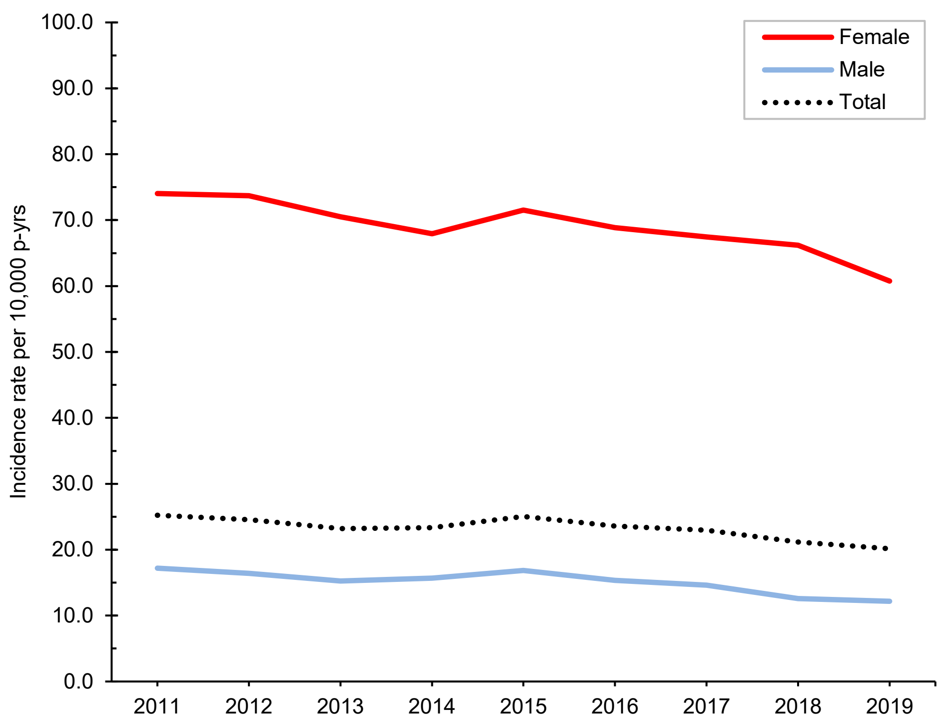
The general downward trend in incidence rates of genital HPV infections observed during the surveillance period may be related to the introduction of the HPV vaccine for women and girls in 2006 and for men in 2010. Among civilian women aged 14–24 years, cervical/vaginal prevalence of HPV types 6, 11, 16, and 18 decreased by approximately 6% from the period 2003–2006 to 2009–2012.[14] The HPV vaccine is currently not a mandatory vaccine for military service, but it is encouraged and offered to service members. Because the HPV vaccine (Gardasil) is approved for use among males and

**FIGURE 9.** Incidence rates of gonorrhea infections among males, by age group (years), active component, U.S. Armed Forces, 2011–2019




P-yrs, person-years.

**FIGURE 10.** Incidence rates of genital HSV infections, by sex, active component, U.S. Armed Forces, 2011–2019

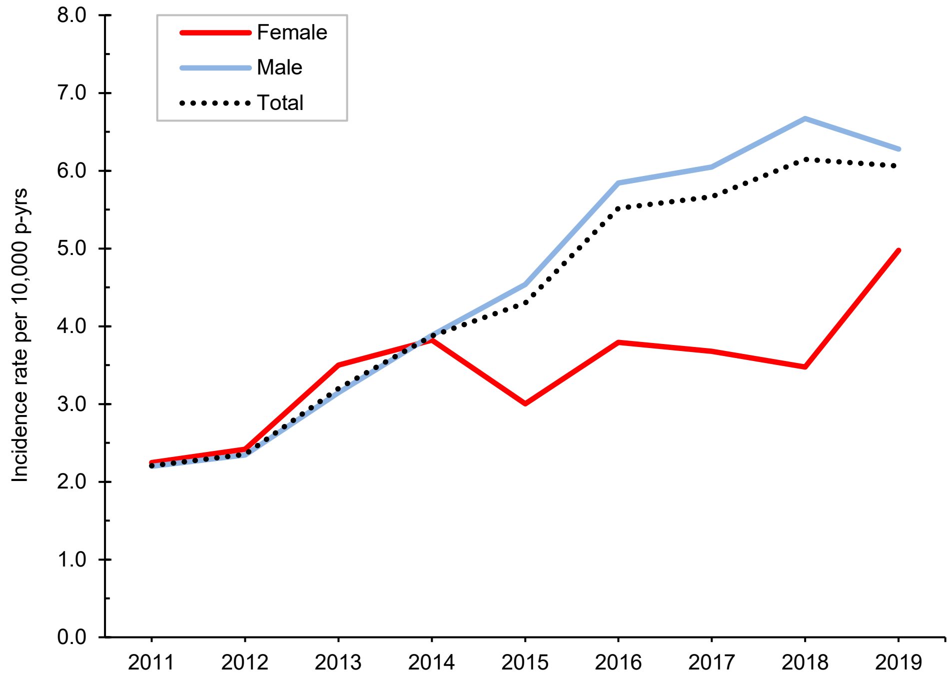



HSV, herpes simplex virus; p-yrs, person-years.

females beginning at age 9 years, it is possible that an increasing number of members who entered military service during the surveillance period may have been vaccinated for HPV before entering service. This prior vaccination may account for the decrease in the annual rates of genital HPV infections during the surveillance period. However, a recent study has shown that the number of service women initiating HPV vaccine is decreasing.[15] This decrease may partially explain the possible slight rate increase among women in 2019.

The trends in the incidence of HSV and syphilis in the U.S. military are also similar to what is observed in the civilian population. Data from the Centers for Disease Control and Prevention's (CDC's) National Health and Nutrition Examination Survey indicate that the seroprevalence of both HSV-1 and HSV-2 has decreased in the U.S. population since 1999.[2] In contrast, the incidence of primary and secondary syphilis reported to CDC has increased markedly since 2001, with men accounting for the majority of cases.[2,16]

**FIGURE 11.** Incidence rates of syphilis by sex, active component, U.S. Armed Forces, 2011–2019




P-yrs, person-years.

This report has several limitations that should be considered when interpreting the results. First, diagnoses of STIs may 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 an overestimate of STI incidence. Cases of syphilis, genital HSV, and genital HPV infections based solely on laboratory test results are considered "suspect" because the lab test results cannot distinguish between active and chronic infections. However, because incident cases of these STIs were identified based on the first qualifying encounter or laboratory result, the likelihood is high that most such cases are acute and not chronic.

STI cases may not be captured if coded in the medical record using symptom codes (e.g., urethritis) rather than STI-specific codes. In addition, the counts of STI diagnoses reported here may underestimate the actual numbers of diagnoses because some affected service members may be diagnosed and treated through nonreimbursed, non-military care providers (e.g., county health departments or family planning centers) or in deployed settings (e.g., overseas training exercises, combat operations, or aboard ships). Laboratory tests that are performed in a purchased care setting, a shipboard facility, a battalion aid station, or an in-theater facility were not captured in the current analysis. Finally, medical data from sites that were using the new electronic health record for the Military Health System, MHS GENESIS, are not available in the DMSS. These sites include Naval Hospital Oak Harbor, Naval Hospital Bremerton, Air Force Medical Services Fairchild, and Madigan Army Medical Center. Therefore, medical encounter data for individuals seeking care at any of these facilities during 2017–2019 were not included in the current analysis.

For some STIs, the detection of prevalent infections may occur long after the initial infections. As a result, changes in incidence rates reflect, at least in part, temporal changes in case ascertainment, such as a shift to more aggressive screening. The lack of standard practices across the services and their installations regarding screening, testing, treatment, and reporting complicate interpretations of differences between services, military and demographic subgroups, and locations. Establishing screening, testing, treatment, and reporting standards across the services and ensuring adherence to such standards would likely improve efforts to detect and characterize STI-related health threats. In addition, continued behavioral risk-reduction interventions are needed to counter the increasing incidence of STIs among military service members.

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# Incidence of Sexually Transmitted Infections Before and After Insertion of an Intrauterine Device or Contraceptive Implant, Active Component Service Women, U.S. Armed Forces, 2014–2019

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Long-acting reversible contraceptive (LARC) use has been increasing for almost 2 decades; however, while LARC methods are highly effective at preventing pregnancies, they do not prevent sexually transmitted infections (STIs). As a result, there is concern that the increased use of LARCs could lead to increased risk for STIs through sexual risk behaviors such as reduced condom use. Between 1 January 2015 and 31 December 2018, 18,691 service women in the study population received an intrauterine device (IUD) and 17,723 received an implant. Among active component service women who received an IUD or implant and maintained the same marital status during the study period, there was no notable increase in incidence of STIs in the 12 months after LARC insertion when compared to the 12 months before insertion. However, findings did show that rates of STIs increased from the LARC pre-insertion period to the post-insertion period among women in the youngest age category, suggesting that risk-reduction counseling and educational efforts should be focused on the youngest service members who receive LARC.

**WHAT ARE THE NEW FINDINGS?**

In general, among service women who began using LARC (an IUD or a contraceptive implant), incidence rates of STIs did not increase from the year before to the year after insertion. However, rates of STIs did increase after LARC insertion among women who were less than 20 years of age at the time of insertion.

**WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?**

Because STIs can negatively affect service members' readiness and cause serious medical sequelae, the results of the study suggest that providers should emphasize to younger service women that LARC methods do not protect against STIs. Sexually active service members should be counseled that, for the prevention of STIs, condoms should be used along with LARCs.

Long-acting reversible contraceptive (LARC) use, including subdermal hormonal implants and intrauterine devices (IUDs), has been increasing for almost 2 decades, from 1.5–2.5% of U.S. women of childbearing age in the early 2000s[1,2] to 10.3–14.3% between 2009 and 2015.[3–6] IUDs initially fell out of favor when a design flaw in an early brand resulted in the deaths of 6 women and infections in thousands more,[7] but newer types have been found to be long-lasting, efficacious, and safe.[1,8] Rates of use vary by subgroup, with women in their 20s and 30s[1,3–5] and those with a higher parity[1,2] more likely to use a LARC method than their respective counterparts.

Among active component service women, a prior *MSMR* analysis indicated that LARC use increased from 17.2% to 21.7% between 2012 and 2016, mirroring the increasing trend observed in the general population.[9] LARC use among active component service women was most common among those aged 25–29 years,[9,10] although an increase was seen across all age groups.[9] As in the civilian population, this increase is most likely related to the efficacy, longevity, and ease of use of LARCs. However, LARCs may have an additional appeal to female service members because of the ability of some LARCs to suppress menstruation,[7,8,11] which may be advantageous in military operational environments.

While LARC methods are highly effective at preventing pregnancies, they do not prevent sexually transmitted infections (STIs). The increasing use of LARCs as an effective pregnancy prevention method has generated concern that their increased use both in U.S. civilian and military populations could increase risk for STIs through reduced use of condoms and increased high-risk behaviors, such as increased number of sexual partners. While some studies have reported lower rates of condom use among LARC users compared to women using other non-barrier contraceptive methods[12–16] (particularly oral contraceptives[15]) and higher rates of STIs,[13] others studies showed no difference in condom use between LARC users and users of the Depo-Provera injection, the patch, or the ring.[17] Factors such as relationship status and number of partners may be related to dual-method use (i.e., use of both condoms and hormonal methods),[16,18] as LARC users with a new partner[19] and those with multiple partners[18] have been shown to be more likely to report condom use than those without. Data from the contraceptive CHOICE project, a prospective cohort study of over 9,000 women who were offered the contraceptive method of their choice at no cost for 2–3 years, indicated that there was no difference in condom use or the number of partners before and after uptake of LARC.[13,20] In addition, a recent systematic review reported no evidence of an association between LARC use and STIs, although the review noted a lack of prospective studies analyzing the relationship between contraceptive use and STI risk.[21]

A recent *MSMR* study showed that although the incidence of human papillomavirus (HPV) and genital herpes simplex virus (HSV) infections decreased among female service members during 2010–2018, the incidence of chlamydia and gonorrhea, the 2 most common bacterial STIs, increased,[22] mirroring overall trends in the general U.S. population.[23] STIs can negatively affect service members' readiness and cause serious medical sequelae if untreated. Given the high, sustained burden of STIs and the uncertainty regarding the association between LARC use and STI risk among military service members, the objective of this analysis was to determine whether LARC initiation was associated with increased incidence of STIs among active component service women between 1 January 2015 and 31 December 2018.

## METHODS

The surveillance population consisted of all active component service women of the Army, Navy, Marine Corps, or Air Force who received an IUD or implant between 1 January 2015 and 31 December 2018. Data for this study were ascertained from medical administrative and pharmacy data, as well as reports of notifiable medical events, routinely provided to the Armed Forces Health Surveillance Branch and maintained in the Defense Medical Surveillance System (DMSS) for surveillance purposes. STI cases were also derived from positive laboratory records in the Health Level 7 (HL7) chemistry and microbiology databases maintained by the Navy and Marine Corps Public Health Center at the EpiData Center.

Service women who received an IUD were identified as those who met any of the following criteria: 1) received a prescription for Mirena, Kyleena, Skyla, Paragard, or Liletta; 2) had a qualifying International Classification of Diseases, 9th or 10th Revision (ICD-9 or ICD-10, respectively) diagnosis code for IUD insertion **(Table 1)** in any diagnostic position; or 3) had a qualifying inpatient procedure code or outpatient Current Procedural Terminology (CPT) code for IUD insertion **(Table 1)** in any recorded position. Similarly, women who received an implant were identified as those who 1) received a prescription for Nexplanon or Implanon, 2) had a qualifying ICD-9 or ICD-10 diagnosis code for implant insertion **(Table 1)** in any diagnostic position, or 3) had a qualifying outpatient CPT code for implant insertion **(Table 1)** in any recorded position. Only the first documented insertion of each contraceptive type during the surveillance period was retained. If a woman had both an IUD and implant insertion during the study period, she was included in both groups.

Women were excluded from the IUD study population if they had an ICD-9 or ICD-10 diagnosis code or outpatient CPT code indicating IUD removal in the 12 months before or after the IUD insertion date **(Table 2)**. Similarly, women were excluded from the implant study population if they had an outpatient CPT code indicating implant removal in the 12 months before or after the implant insertion date **(Table 2)**. Women were excluded from the study population if they did not have continuous active component service time during the 12 months before or after the IUD or implant insertion. In addition, women were excluded if they changed their marital status at any time during the 12 months before or after the IUD or implant insertion.

Time-varying demographic and military characteristics including age, grade, service, military occupation, marital status, and education were measured at the time of the IUD or implant insertion. Receipt of short-acting reversible contraceptives (SARCs) was measured separately during the 12-month period before IUD or implant insertion and the 12-month period after IUD or implant insertion. Oral contraceptives, patches, and vaginal rings were defined by having a prescription record with therapeutic class code 681200 and a corresponding drug form code.[24] Injectables were defined by having a prescription record for Depo-Provera or medroxyprogesterone acetate.

Incidence rates of STIs were measured during the period from 12 months to

**TABLE 1.** ICD-9 and ICD-10 diagnostic and procedure codes and CPT codes for LARC insertion and removal

| | ICD-9 diagnostic codes | | ICD-10 diagnostic codes | |
|---|---|---|---|---|
| | Insertion | Removal | Insertion | Removal |
| IUD | V25.11, V25.13 | V25.12 | Z30.014, Z30.430, Z30.433 | Z30.432 |
| Implant | V25.5 | --- | Z30.017 | |
| Inpatient PR codes | | | | |
| IUD | 69.7 | --- | 0UH97HZ, 0UH98HZ, 0UHC7HZ, 0UHC8HZ | --- |
| Outpatient CPT codes | | | | |
| IUD | 58300 | 58301 | 58300 | 58301 |
| Implant | | | 11975, 11981, 11983, 11977 | 11976, 11982 |

ICD, International Classification of Diseases; CPT, Current Procedural Terminology; LARC, long-acting reversible contraceptive; IUD, intrauterine device.

**TABLE 2.** STI case defining ICD-9 and ICD-10 codes

| | ICD-9 | ICD-10 |
|---|---|---|
| Chlamydia | 099.41, 099.5* | A56.* |
| Gonorrhea | 098.0, 098.1*, 098.4*–098.8* | A54.* |
| Trichomoniasis | 131.* | A59.* |

[a]An asterisk (*) indicates that any subsequent digit/character is included.
STI, sexually transmitted infection; ICD, International Classification of Diseases.

1 month before IUD or implant insertion and in the 1 month to 12 months following IUD or implant insertion (full surveillance period: 1 January 2014–31 December 2019). A 30-day washout period before and after the IUD or implant insertion was used to account for any additional STI testing or short-term behavioral change that may have occurred during that period. An incident case of chlamydia, gonorrhea, or trichomoniasis was defined by having any of the following: 1) a case-defining diagnosis **(Table 2)** in the first or second diagnostic position of a record of an outpatient or in-theater medical encounter, 2) a confirmed notifiable disease report (applies only to chlamydia and gonorrhea), or 3) a positive laboratory test for any specimen source or test type. An individual could be counted as having a subsequent case only if there were more than 30 days between the dates on which the case-defining diagnoses were recorded. Incidence rates of STIs during the pre- and post-insertion periods were calculated per 1,000 service women. Crude confidence intervals were calculated in SAS/STAT software, version 9.4 (2014, SAS Institute, Cary, NC) using PROC GENMOD.

## RESULTS

During the study period, 18,691 service women who met inclusion criteria received an IUD and 17,723 received an implant **(Table 3)**. Most of the women who received an IUD were aged 20–24 years (32.8%) or 25–29 years (26.2%). Half of the women who received an IUD were

**TABLE 3.** Demographic and military characteristics at the time of first-ever LARC placement, active component service women, U.S. Armed Forces,1 January 2015–31 December 2018

| | IUD | | Implant | |
|---|---|---|---|---|
| | No. | % | No. | % |
| Total | 18,691 | 100.0 | 17,723 | 100.0 |
| Age group (years) | | | | |
| <20 | 3,220 | 17.2 | 7,423 | 41.9 |
| 20–24 | 6,130 | 32.8 | 5,929 | 33.5 |
| 25–29 | 4,893 | 26.2 | 2,883 | 16.3 |
| 30–34 | 2,473 | 13.2 | 991 | 5.6 |
| 35–39 | 1,290 | 6.9 | 375 | 2.1 |
| 40–44 | 515 | 2.8 | 101 | 0.6 |
| 45+ | 170 | 0.9 | 21 | 0.1 |
| Race/ethnicity group | | | | |
| Non-Hispanic white | 9,345 | 50.0 | 7,174 | 40.5 |
| Non-Hispanic black | 3,712 | 19.9 | 4,171 | 23.5 |
| Hispanic | 3,167 | 16.9 | 3,898 | 22.0 |
| Asian/Pacific Islander | 691 | 3.7 | 849 | 4.8 |
| American Indian/Alaska Native | 201 | 1.1 | 208 | 1.2 |
| Other/unknown | 1,575 | 8.4 | 1,423 | 8.0 |
| Education level | | | | |
| High school or less | 11,025 | 59.0 | 14,180 | 80.0 |
| Some college | 2,256 | 12.1 | 1,357 | 7.7 |
| Bachelor's or advanced degree | 4,669 | 25.0 | 1751 | 9.9 |
| Other/unknown | 741 | 4.0 | 435 | 2.5 |
| Marital status | | | | |
| Single, never married | 10,102 | 54.0 | 13,177 | 74.3 |
| Married | 7,625 | 40.8 | 4,029 | 22.7 |
| Other/unknown | 964 | 5.2 | 517 | 2.9 |
| Rank/grade | | | | |
| Junior enlisted (E1–E4) | 9,725 | 52.0 | 13,935 | 78.6 |
| Senior enlisted (E5–E9) | 4,857 | 26.0 | 2,487 | 14.0 |
| Junior officer (O1–O3) | 3,240 | 17.3 | 1,168 | 6.6 |
| Senior officer (O4–O10) | 778 | 4.2 | 91 | 0.5 |
| Warrant officer (W1–W5) | 91 | 0.5 | 42 | 0.2 |
| Service | | | | |
| Army | 5,166 | 27.6 | 4,551 | 25.7 |
| Navy | 6,695 | 35.8 | 7,606 | 42.9 |
| Air Force | 5,263 | 28.2 | 3,515 | 19.8 |
| Marine Corps | 1,567 | 8.4 | 2,051 | 11.6 |
| Military occupation | | | | |
| Combat-specific[a] | 428 | 2.3 | 361 | 2.0 |
| Motor transport | 694 | 3.7 | 1,112 | 6.3 |
| Pilot/air crew | 391 | 2.1 | 119 | 0.7 |
| Repair/engineering | 3,586 | 19.2 | 3,504 | 19.8 |
| Communications/intelligence | 5,208 | 27.9 | 4,071 | 23.0 |
| Healthcare | 4,049 | 21.7 | 2,116 | 11.9 |
| Other/unknown | 4,335 | 23.2 | 6,440 | 36.3 |
| Receipt of SARC within 12 months before insertion | | | | |
| Oral contraceptive | 6,435 | 34.4 | 4,474 | 25.2 |
| Patch | 423 | 2.3 | 365 | 2.1 |
| Vaginal ring | 1,168 | 6.2 | 501 | 2.8 |
| Injectable | 848 | 4.5 | 1,322 | 7.5 |
| Any of the above | 8,266 | 44.2 | 6,157 | 34.7 |
| None of the above | 10,425 | 55.8 | 11,566 | 65.3 |
| Receipt of SARC within 12 months after insertion | | | | |
| Oral contraceptive | 1,876 | 10.0 | 2,081 | 11.7 |
| Patch | 110 | 0.6 | 96 | 0.5 |
| Vaginal ring | 260 | 1.4 | 103 | 0.6 |
| Injectable | 181 | 1.0 | 157 | 0.9 |
| Any of the above | 2,275 | 12.2 | 2,329 | 13.1 |
| None of the above | 16,416 | 87.8 | 15,394 | 86.9 |

[a]Infantry/artillery/combat engineering/armor.
Note that demographic characteristics were measured at the time of LARC placement.
LARC, long-acting reversible contraceptive; IUD, intrauterine device; No., number; SARC, short-acting reversible contraceptive.

non-Hispanic white, and more than half were single and never married (54.0%) and had a high school education or less (59.0%). Women who received an IUD were more likely to be in the Navy (35.8%), junior enlisted rank (52.0%), and in communications/intelligence occupations (27.9%). A little less than half (44.2%) of women were using any type of SARC before IUD insertion, which dropped to 12.2% after IUD insertion. The most commonly dispensed SARC in the pre- and post-IUD insertion periods were oral contraceptives (34.4% and 10.0%, respectively).

Most of the women who received an implant were aged 20 years or less (41.9%) or 20–24 years (33.5%). Women with implants were predominantly non-Hispanic white (40.5%), single and never married (74.3%), and had a high school education or less (80.0%). Similar to those who received an IUD, women who received an implant were more likely to be in the Navy (42.9%) and junior enlisted rank (78.6%). Before implant insertion, a little more than one-third (34.7%) of women used any type of SARC, which dropped to 13.1% after implant insertion. The most commonly dispensed SARC in the pre- and post-implant insertion periods were oral contraceptives (25.2% and 11.7%, respectively).

Among women in the study population who received an IUD, the incidence rates of chlamydia, gonorrhea, and trichomoniasis were generally similar before and after IUD insertion, although rates of chlamydia and gonorrhea increased slightly **(Table 4)**. Incidence rates of chlamydia were 42.5 per 1,000 women before IUD insertion (n=795) and 44.1 per 1,000 women after insertion (n=825). Incidence rates of gonorrhea were 3.3 per 1,000 women (n=62) before insertion and 4.4 per 1,000 women after insertion (n=82). Incidence rates of trichomoniasis remained the same before and after IUD insertion (2.8 per 1,000 [n=53] and 2.8 per 1,000 [n=52], respectively). Taken together, the incidence of any of the 3 STIs was 48.7 per 1,000 before IUD insertion and 51.3 per 1,000 after IUD insertion (incidence rate ratio [IRR]=1.05; 95% confidence interval [CI]: 0.95–1.16).

**TABLE 4.** Incidence of STIs during pre- and post-IUD placement, active component service women, U.S. Armed Forces, 1 January 2014–31 December 2019

| | Pre-IUD | | Post-IUD | | IRR | 95% CI |
|---|---|---|---|---|---|---|
| | No. | Rate[a] | No. | Rate[a] | (post/pre) | |
| Chlamydia | 795 | 42.5 | 825 | 44.1 | 1.04 | 0.94–1.15 |
| Gonorrhea | 62 | 3.3 | 82 | 4.4 | 1.32 | 0.92–1.89 |
| Trichomoniasis | 53 | 2.8 | 52 | 2.8 | 0.98 | 0.67–1.43 |
| Total | 910 | 48.7 | 959 | 51.3 | 1.05 | 0.95–1.16 |

[a]Rate per 1,000 service women.
STIs, sexually transmitted infections; IUD, intrauterine device; IRR, incidence rate ratio; CI, confidence interval; No., number.

**TABLE 5.** Incidence of STIs during pre- and post-implant placement, active component service women, U.S. Armed Forces, 1 January 2014–31 December 2019

| | Pre-implant | | Post-implant | | IRR | 95% CI |
|---|---|---|---|---|---|---|
| | No. | Rate[a] | No. | Rate[a] | (post/pre) | |
| Chlamydia | 1,155 | 65.2 | 1,209 | 68.2 | 1.05 | 0.96–1.14 |
| Gonorrhea | 97 | 5.5 | 78 | 4.4 | 0.80 | 0.59–1.09 |
| Trichomoniasis | 56 | 3.2 | 57 | 3.2 | 1.02 | 0.68–1.52 |
| Total | 1,308 | 73.8 | 1,344 | 75.8 | 1.03 | 0.95–1.12 |

[a]Rate per 1,000 service women.
STIs, sexually transmitted infections; IRR, incidence rate ratio; CI, confidence interval; No., number.

Among women in the study population who received an implant, the incidence rate of chlamydia increased slightly, the rate of gonorrhea decreased slightly, and the rate of trichomoniasis remained similar before and after implant insertion **(Table 5)**. Incidence rates of chlamydia were 65.2 per 1,000 before implant insertion (n=1,155) and 68.2 per 1,000 after insertion (n=1,209). Incidence rates of gonorrhea were 5.5 per 1,000 women (n=97) before insertion and 4.4 per 1,000 after insertion (n=78). Incidence rates of trichomoniasis were 3.2 per 1,000 before implant insertion (n=56) and 3.2 per 1,000 after implant insertion (n=57). Taken together, the incidence of any of the 3 STIs was 73.8 per 1,000 before implant insertion and 75.8 per 1,000 after implant insertion (IRR=1.03; 95% CI: 0.95–1.12).

The incidence rates of any STI after IUD or implant insertion compared to before insertion varied by subgroup. Among women who were less than 20 years of age at the time of IUD or implant insertion, there was an increase in the rate of STIs after insertion, while women in all other age groups showed a decrease or no change in rates. Women who were less than 20 years of age at the time of LARC insertion had 1.61 times the rate of any STI infection after IUD insertion compared to before insertion (95% CI: 1.37–1.89) and 1.38 times the rate of any STI infection after implant insertion compared to before insertion (95% CI: 1.24–1.54) **(Tables 6 and 7)**.

## EDITORIAL COMMENT

This study demonstrated that among active component service women who received an IUD or implant and maintained the same marital status during the study period, there was not a notable increase in incidence of STIs from the year before insertion to the year after insertion. This finding suggests that there is not a significant change in sexual risk behaviors among service women overall from before to after receiving an IUD or implant. While the current analysis is unable to ascertain the reasons for this finding, it could be that

**TABLE 6.** Incidence of any STI during pre- and post-IUD placement, active component service women, U.S. Armed Forces, 1 January 2014–31 December 2019

| | Pre-IUD | | Post-IUD | | IRR | 95% CI |
|---|---|---|---|---|---|---|
| | No. | Rate[a] | No. | Rate[a] | (post/pre) | |
| Total | 910 | 48.7 | 959 | 51.3 | 1.05 | 0.95–1.16 |
| Age group (years) | | | | | | |
| <20 | 283 | 87.9 | 455 | 141.3 | 1.61 | 1.37–1.89 |
| 20–24 | 445 | 72.6 | 359 | 58.6 | 0.81 | 0.69–0.94 |
| 25–29 | 137 | 28.0 | 119 | 24.3 | 0.87 | 0.66–1.14 |
| 30–34 | 29 | 11.7 | 19 | 7.7 | 0.66 | 0.36–1.20 |
| 35–39 | 13 | 10.1 | 6 | 4.7 | 0.46 | 0.18–1.15 |
| 40–44 | 2 | 3.9 | 1 | 1.9 | 0.50 | 0.05–5.51 |
| 45+ | 1 | 5.9 | 0 | 0.0 | 0.00 | -- |
| Race/ethnicity group | | | | | | |
| Non-Hispanic white | 344 | 36.8 | 392 | 41.9 | 1.14 | 0.98–1.33 |
| Non-Hispanic black | 284 | 76.5 | 243 | 65.5 | 0.86 | 0.71–1.04 |
| Hispanic | 164 | 51.8 | 203 | 64.1 | 1.24 | 0.99–1.56 |
| Asian/Pacific Islander | 47 | 68.0 | 35 | 50.7 | 0.74 | 0.45–1.22 |
| American Indian/Alaska Native | 7 | 34.8 | 13 | 64.7 | 1.86 | 0.79–4.36 |
| Other/unknown | 64 | 40.6 | 73 | 46.3 | 1.14 | 0.79–1.65 |
| Education level | | | | | | |
| High school or less | 787 | 71.4 | 847 | 76.8 | 1.08 | 0.97–1.20 |
| Some college | 49 | 21.7 | 42 | 18.6 | 0.86 | 0.56–1.30 |
| Bachelor's or advanced degree | 59 | 12.6 | 47 | 10.1 | 0.80 | 0.52–1.22 |
| Other/unknown | 15 | 20.2 | 23 | 31.0 | 1.53 | 0.69–3.42 |
| Marital status | | | | | | |
| Single, never married | 710 | 70.3 | 757 | 74.9 | 1.07 | 0.95–1.19 |
| Married | 160 | 21.0 | 173 | 22.7 | 1.08 | 0.85–1.37 |
| Other/unknown | 40 | 41.5 | 29 | 30.1 | 0.73 | 0.43–1.23 |
| Rank/grade | | | | | | |
| Junior enlisted (E1–E4) | 761 | 78.3 | 827 | 85.0 | 1.09 | 0.98–1.21 |
| Senior enlisted (E5–E9) | 113 | 23.3 | 90 | 18.5 | 0.80 | 0.59–1.08 |
| Junior officer (O1–O3) | 33 | 10.2 | 41 | 12.7 | 1.24 | 0.73–2.11 |
| Senior officer (O4–O10) | 2 | 2.6 | 0 | 0.0 | 0.00 | -- |
| Warrant officer (W1–W5) | 1 | 11.0 | 1 | 11.0 | 1.00 | 0.06–15.99 |
| Service | | | | | | |
| Army | 320 | 61.9 | 258 | 49.9 | 0.81 | 0.67–0.98 |
| Navy | 304 | 45.4 | 395 | 59.0 | 1.30 | 1.11–1.52 |
| Air Force | 161 | 30.6 | 179 | 34.0 | 1.11 | 0.88–1.40 |
| Marine Corps | 125 | 79.8 | 127 | 81.0 | 1.02 | 0.78–1.32 |
| Military occupation | | | | | | |
| Combat-specific[b] | 25 | 58.4 | 24 | 56.1 | 0.96 | 0.54–1.72 |
| Motor transport | 43 | 62.0 | 48 | 69.2 | 1.12 | 0.72–1.73 |
| Pilot/air crew | 3 | 7.7 | 5 | 12.8 | 1.67 | 0.40–6.97 |
| Repair/engineering | 213 | 59.4 | 186 | 51.9 | 0.87 | 0.71–1.08 |
| Communications/ intelligence | 266 | 51.1 | 246 | 47.2 | 0.92 | 0.76–1.12 |
| Healthcare | 145 | 35.8 | 126 | 31.1 | 0.87 | 0.67–1.13 |
| Other/unknown | 215 | 49.6 | 324 | 74.7 | 1.51 | 1.25–1.82 |

[a]Rate per 1,000 service women.
[b]Infantry/artillery/combat engineering/armor.
Note that demographic characteristics were measured at the time of LARC placement.
STI, sexually transmitted infection; IUD, intrauterine device; IRR, incidence rate ratio; CI, confidence interval; No., number; LARC, long-acting reversible contraceptive.

the number of partners for women choosing a LARC method did not change pre- and post-insertion and/or that LARC users with new or multiple partners increased or continued condom use, as suggested by some previous studies.[13,18–20] However, the finding that rates did increase from pre- to post-IUD and implant insertion among women in the youngest age category suggests that risk-reduction counseling and educational efforts should be focused on the youngest service members who receive LARC. This is particularly important given that service women in the youngest age categories have the highest numbers of self-reported sexual risk behaviors, including numbers of new and multiple sexual partners.[25] Providers who prescribe LARCs to young service women should emphasize that they do not protect against STIs and that condoms should continue to be used in addition to their contraceptive method of choice.

Overall rates of chlamydia and gonorrhea among women who received an IUD were approximately similar to rates observed in the overall female active component population.[22] In contrast, overall rates of chlamydia and gonorrhea among women who received an implant were somewhat higher; however, women who received an implant were more likely to be younger and single and never married as compared with women who received an IUD, and these are known risk factors for STIs in the overall active component female population.[22] It is worth mentioning that, historically, there has been concern regarding whether IUDs increase the risk of pelvic inflammatory disease (PID) among women with STIs; however, studies have indicated that the risk for PID among women who screened positive for chlamydia or gonorrhea and underwent concurrent IUD insertion is low,[8,14] and current guidelines from the Centers for Disease Control and Prevention and the American College of Obstetricians and Gynecologists state that insertion should not be delayed while awaiting STI screening results.[8,26]

When the barriers to access are removed, women tend to choose LARC methods over other methods.[13,20] LARC use has been shown to be increasing among service women and this trend will likely

**TABLE 7.** Incidence of any STI during pre- and post-implant placement, active component service women, U.S. Armed Forces, 1 January 2014–31 December 2019

| | Pre-implant | | Post-implant | | IRR | 95% CI |
|---|---|---|---|---|---|---|
| | No. | Rate[a] | No. | Rate[a] | (post/pre) | |
| Total | 1,308 | 73.8 | 1,344 | 75.8 | 1.03 | 0.95–1.12 |
| Age group (years) | | | | | | |
| <20 | 625 | 84.2 | 861 | 116.0 | 1.38 | 1.24–1.54 |
| 20–24 | 523 | 88.2 | 393 | 66.3 | 0.75 | 0.65–0.87 |
| 25–29 | 129 | 44.7 | 73 | 25.3 | 0.57 | 0.42–0.77 |
| 30–34 | 24 | 24.2 | 11 | 11.1 | 0.46 | 0.21–1.00 |
| 35–39 | 7 | 18.7 | 4 | 10.7 | 0.57 | 0.16–2.08 |
| 40–44 | 0 | 0.0 | 2 | 19.8 | 0.00 | -- |
| 45+ | 0 | 0.0 | 0 | 0.0 | 0.00 | -- |
| Race/ethnicity group | | | | | | |
| Non-Hispanic white | 389 | 54.2 | 475 | 66.2 | 1.22 | 1.06–1.41 |
| Non-Hispanic black | 486 | 116.5 | 381 | 91.3 | 0.78 | 0.68–0.91 |
| Hispanic | 273 | 70.0 | 318 | 81.6 | 1.16 | 0.98–1.38 |
| Asian/Pacific Islander | 57 | 67.1 | 65 | 76.6 | 1.14 | 0.78–1.67 |
| American Indian/Alaska Native | 21 | 101.0 | 16 | 76.9 | 0.76 | 0.40–1.46 |
| Other/unknown | 82 | 57.6 | 89 | 62.5 | 1.09 | 0.79–1.49 |
| Education level | | | | | | |
| High school or less | 1,198 | 84.5 | 1,254 | 88.4 | 1.05 | 0.96–1.14 |
| Some college | 58 | 42.7 | 34 | 25.1 | 0.59 | 0.37–0.92 |
| Bachelor's or advanced degree | 41 | 23.4 | 40 | 22.8 | 0.98 | 0.60–1.58 |
| Other/unknown | 11 | 25.3 | 16 | 36.8 | 1.45 | 0.69–3.06 |
| Marital status | | | | | | |
| Single, never married | 1,112 | 84.4 | 1,200 | 91.1 | 1.08 | 0.99–1.18 |
| Married | 168 | 41.7 | 129 | 32.0 | 0.77 | 0.59–1.00 |
| Other/unknown | 28 | 54.2 | 15 | 29.0 | 0.54 | 0.26–1.10 |
| Rank/grade | | | | | | |
| Junior enlisted (E1–E4) | 1,190 | 85.4 | 1,273 | 91.4 | 1.07 | 0.98–1.16 |
| Senior enlisted (E5–E9) | 101 | 40.6 | 50 | 20.1 | 0.50 | 0.34–0.71 |
| Junior officer (O1–O3) | 17 | 14.6 | 20 | 17.1 | 1.18 | 0.60–2.32 |
| Senior officer (O4–O10) | 0 | 0.0 | 0 | 0.0 | 0.00 | -- |
| Warrant officer (W1–W5) | 0 | 0.0 | 1 | 23.8 | 0.00 | -- |
| Service | | | | | | |
| Army | 467 | 102.6 | 410 | 90.1 | 0.88 | 0.76–1.02 |
| Navy | 460 | 60.5 | 535 | 70.3 | 1.16 | 1.02–1.32 |
| Air Force | 218 | 62.0 | 199 | 56.6 | 0.91 | 0.73–1.14 |
| Marine Corps | 163 | 79.5 | 200 | 97.5 | 1.23 | 0.99–1.52 |
| Military occupation | | | | | | |
| Combat-specific[b] | 27 | 74.8 | 46 | 127.4 | 1.70 | 0.97–3.00 |
| Motor transport | 96 | 86.3 | 70 | 62.9 | 0.73 | 0.52–1.02 |
| Pilot/air crew | 6 | 50.4 | 4 | 33.6 | 0.67 | 0.12–3.64 |
| Repair/engineering | 267 | 76.2 | 249 | 71.1 | 0.93 | 0.78–1.11 |
| Communications/ intelligence | 334 | 82.0 | 306 | 75.2 | 0.92 | 0.77–1.08 |
| Healthcare | 129 | 61.0 | 118 | 55.8 | 0.91 | 0.70–1.20 |
| Other/unknown | 449 | 69.7 | 551 | 85.6 | 1.23 | 1.07–1.40 |

[a]Rate per 1,000 service women.
[b]Infantry/artillery/combat engineering/armor.
Note that demographic characteristics were measured at the time of LARC placement.
STI, sexually transmitted infection; IRR, incidence rate ratio; CI, confidence interval; No., number; LARC, long-acting reversible contraceptive.

continue as both a method of pregnancy prevention and also potentially for menstrual suppression, which has operational benefits.[9,11] One survey-based study of 500 Army women indicated that the majority (85%) expressed a desire to learn more about contraceptive options for menstrual suppression.[27] Similarly, a recent article discussing menstrual suppression among female astronauts on longer missions also highlighted the benefits of some LARC methods in environments where menstrual suppression is beneficial.[28] One LARC option for menstrual suppression is the use of levonorgestrel-releasing IUDs for longer than 12 months, which has been shown to substantially reduce the volume of menstrual blood, with 20% of women achieving amenorrhea.[29]

There are several limitations of this analysis to consider. The study intended to measure whether risk for STIs changed after IUD or implant insertion as a result of a hypothesized increase in sexual risk behaviors such as reduced use of condoms. However, data on sexual risk behaviors including number and type of sexual partners and condom usage were unavailable. Women were excluded from the population if their marital status changed after IUD or implant insertion, which was done to eliminate the potential confounding effect of a significant change in sexual partner status during the observation periods. Because this study utilized a self-controlled case series design in which the same women comprised the "before" and "after" IUD or implant population, nontime-varying covariates such as race/ethnicity are controlled for in the study design.[30] However, changes in other demographic or military characteristics such as service branch, occupation, and rank in the year before and after IUD or implant insertion were not accounted for, although it is unlikely that these characteristics would change significantly to affect sexual risk behaviors over the course of the 2-year surveillance period for the majority of the study population.

Providers should continue to recommend LARCs to service women who ask for them. However, providers should also continue to emphasize that LARC methods do not protect against STIs and recommend that condoms be used along with

LARCs, especially for younger female service members. No additional STI screening is needed before IUD insertion, and IUDs can be inserted at the time of screening.[8,26] More information about sexual health and LARCs, including clinician training resources, is available through the Navy and Marine Corps Public Health Center's Sexual Health and Responsibility Program (SHARP) at https://www.med.navy.mil/sites/nmcphc/health-promotion/reproductive-sexual-health/Pages/larc.aspx.

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# Blood Lead Level Surveillance Among Pediatric Beneficiaries in the Military Health System, 2010–2017

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The EpiData Center (EDC) has provided routine blood lead level (BLL) surveillance for Department of Defense (DoD) pediatric beneficiaries since 2011. Data for this study were collected and compiled from raw laboratory test records obtained from the Composite Health Care System Health Level 7 (HL7)-formatted chemistry data, allowing an overview of the number of tests performed and the number of elevated results. Between 2010 and 2017, there were 177,061 tests performed among 162,238 pediatric beneficiaries tested. Using only the highest test result per year for each individual, 169,917 tests were retained for analysis, of which 1,334 (0.79%) test results were considered elevated. The percentage of children with elevated BLLs generally decreased over the time period for children of every service affiliation. All tests throughout this time frame were evaluated using current standards and the protocol followed by the Centers for Disease Control and Prevention and the Department of the Navy (DON). The adoption of a standardized BLL surveillance methodology across the DoD supports a cohesive approach to an evolving public health surveillance topic.

**WHAT ARE THE NEW FINDINGS?**

The EDC's BLL surveillance program established a methodology for lead exposure surveillance among DoD pediatric beneficiaries, providing critical data and valuable historical context for the interpretation of findings. Between 2010 and 2017, the percentage of children with elevated BLLs generally remained below 1.2%, and by 2017, the overall percentage was 0.5% for all children tested.

**WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?**

Blood lead surveillance of DON pediatric beneficiaries is required under Bureau of Medicine and Surgery instruction 6200.14D. The EDC's methodology for BLL surveillance may be leveraged for consistent BLL surveillance across the DoD.

Robust lead exposure surveillance is especially important in pediatric populations. There is no safe blood lead level (BLL) for children; even very low BLLs can increase the risk of harmful hematologic and neurologic effects.[1] The U.S. Preventive Services Task Force concluded there is currently insufficient evidence to recommend BLL screening of asymptomatic children 5 years of age and younger.[2] The Military Health System (MHS) does not require universal BLL screening for pediatric beneficiaries, but providers are directed to consider assessing the risk of lead exposure among children between 6 months and 6 years of age by parental questionnaire, in accordance with recommendations from the American Academy of Pediatrics.[3] Children who screen positive on this questionnaire should have their BLLs tested. Additionally, clinical suspicion of lead exposure or poisoning should prompt a blood lead test. Providers should ensure the performance of follow-up care for any child with an elevated BLL, and retesting is recommended to confirm an initial elevated BLL and to monitor the decline in BLLs following treatment.[4]

Before 2012, a BLL of 10 µg/dL or greater was considered to be an elevated test result.[5] In 2012, the Centers for Disease Control and Prevention (CDC) updated the guidelines for the blood lead reference value (BLRV) to 5 µg/dL or greater, based on National Health and Nutrition Examination Survey results showing declining BLLs in children.[6] For an elevated BLL (5 µg/dL or greater) to be considered "confirmed," CDC requires 1 elevated result from a venous blood test or 2 elevated results from capillary blood tests within 12 weeks.[7] Traditional blood lead laboratory test results are the preferred test for Department of the Navy (DON) BLL surveillance. Rapid testing results, like finger-stick tests obtained by MHS providers at the point of care, were used for BLL surveillance purposes until 30 August 2017 when the Bureau of Medicine and Surgery (BUMED) released an instruction stating point-of-care blood testing devices were no longer authorized for compliance with the childhood lead poisoning prevention program in the DON.[8]

Since 2011, the EpiData Center (EDC) at the Navy and Marine Corps Public Health Center (NMCPHC) has conducted routine BLL surveillance among Department of Defense (DoD) pediatric beneficiaries on a quarterly basis. An annual report based on data at the military treatment facility (MTF) level is also prepared on DON pediatric beneficiaries at the request of the Occupational and Environmental Medicine Department of NMCPHC. All surveillance reports are available to qualified DoD personnel upon request. The EDC's BLL surveillance program provides critical data and valuable historical context for evaluating lead exposure among DoD pediatric beneficiaries.

This article describes the EDC's methodology for BLL surveillance in DoD pediatric beneficiaries. This methodology represents a potential model for the development of a shared, standardized BLL surveillance method because it could be tailored to meet the unique needs of each DoD service while also maximizing the comparison, replication, and utility of findings. DON blood lead surveillance is modified from the CDC's standard blood lead surveillance definitions and classifications to best meet its needs using current capabilities. For every calendar year (CY), the EDC identifies elevated blood lead tests among DON pediatric beneficiaries and then verifies in the Armed Forces Health Longitudinal Technology Application (AHLTA) whether or not the provider followed up with the pediatric beneficiary. The EDC then provides a list of names of children that have not had follow-up testing to the Occupational and Environmental Medicine Department of NMCPHC.

## METHODS

Laboratory test records with a sample collection date in CYs 2010–2017 (01 January 2010 through 31 December 2017) were obtained from the Composite Health Care System (CHCS) Health Level 7 (HL7)-formatted chemistry laboratory data. The EDC receives a feed of CHCS HL7-formatted chemistry laboratory data and demographic information daily from the Defense Health Agency. These data include all records from MTFs using the CHCS across the DoD. Records were excluded if the sample was not blood, if the unit of measure or the test result could not be determined, or if the results indicated a test was not performed. For example, before CDC updated its BLRV, 122 test results were recorded as "<10." These results were removed from the final analysis, as it could not be determined if the results were less than the current BLRV of 5 µg/dL. Blood tests with the same sample collection date and date of certified results were excluded from the final sample, as these tests may have been unauthorized point of care tests[8]; moreover, it would have been highly unlikely for the laboratories to have been able to collect, analyze, and certify a sample on the same day. Zinc protoporphyrin (ZPP) tests, which measure the amount of ZPP in the blood (an indicator of chronic lead exposure) rather than BLL, were also excluded. If more than 1 BLL test result was identified for an individual in a single year, the highest BLL test result for that year was retained.

BLL tests administered to beneficiary children aged less than 18 years at the date and time of sample collection were included. Tests could either have been those completed within an MHS laboratory or those completed at an out-of-network laboratory, after which an MHS provider received and entered the results into AHLTA. Records were analyzed by sponsor service affiliation (Army, Air Force, Marine Corps, Navy, Other), age group (≤6 years and 7–17 years), BLL value (<5 µg/dL, 5–9 µg/dL, 10–19 µg/dL, and ≥20 µg/dL), and geographic region (outside of the U.S., New England, Mid-Atlantic, Eastern North Central, Western North Central, South Atlantic, Eastern South Central, Western South Central, Mountain, Pacific). For sponsor service affiliation and geographic region, the percentage of elevated BLL tests per year was determined.

## RESULTS

From 01 January 2010 through 31 December 2017, 169,917 BLL records were retained for analysis **(Table 1)**. The Army tested more pediatric beneficiaries than any other service affiliation during the reporting period. The majority of testing occurred among pediatric beneficiaries aged 6 years or younger across all branches of service.

Overall, the percentage of elevated BLLs among pediatric beneficiaries decreased from 2010 to 2017 **(Figure)**. Less than 1% of pediatric BLL tests in any service were elevated in 2016 and 2017, and no children in the "other" category had an elevated BLL test since 2014.

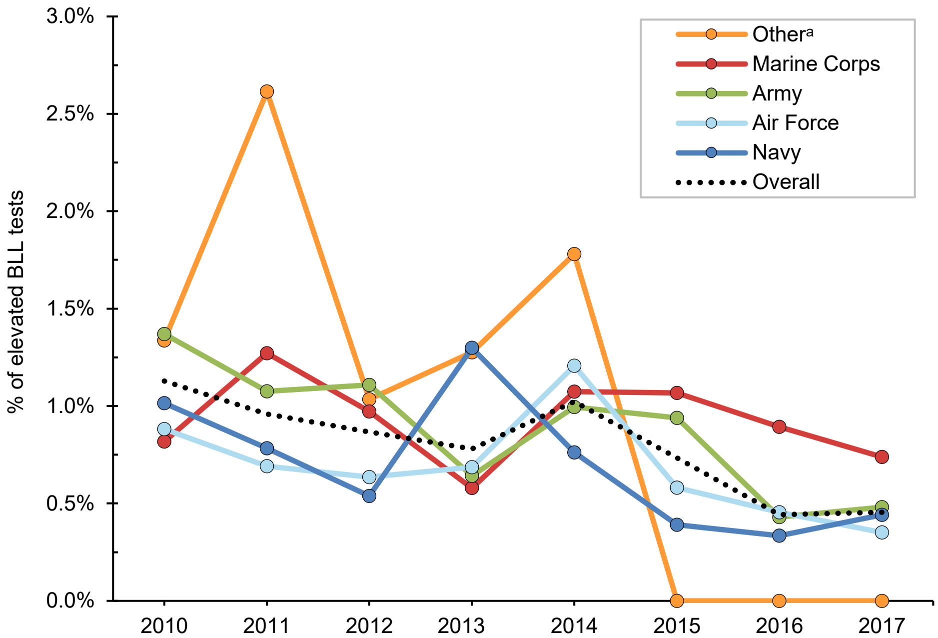
For CYs 2010–2017, 96.2% of all BLL tests among pediatric beneficiaries were performed in the U.S. and 3.8% were performed elsewhere **(Table 2)**. The percentages of elevated tests (0.8%) were equivalent for the 2 regions. Within the U.S., there were no tests performed in 9 states. Of all BLL tests in the U.S., 58.8% (n=96,089) were from the South Atlantic and Western South Central regions, which accounted for 54.8% (n=702) of all elevated BLLs. The New England region had the highest regional percentage of elevated BLLs (1.4%), but that percentage was based on just 22 elevated BLLs out of 1,561 tests, the lowest number of tests for any region. Among the states, Texas had the highest number of tests (n=29,340), followed by Virginia (n=25,852), but the percentages of tests with elevated BLLs were just 0.5% and 0.7%, respectively. The 5 states with the

**TABLE 1.** Pediatric BLLs, by sponsor service affiliation and age group, 2010–2017

| Sponsor service affiliation | BLL ranges | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | <5 µg/dL | | 5–9 µg/dL | | 10–19 µg/dL | | ≥20 µg/dL | | |
| | Age group (years) | | Age group (years) | | Age group (years) | | Age group (years) | | |
| | ≤6 | 7–17 | ≤6 | 7–17 | ≤6 | 7–17 | ≤6 | 7–17 | Total |
| Army | 76,183 | 2,634 | 560 | 20 | 85 | 3 | 18 | 2 | 79,505 |
| Air Force | 44,177 | 1,165 | 252 | 11 | 36 | 2 | 6 | 0 | 45,649 |
| Marine Corps | 10,957 | 267 | 91 | 4 | 6 | 1 | 4 | 0 | 11,330 |
| Navy | 29,408 | 1,195 | 151 | 3 | 40 | 2 | 12 | 0 | 30,811 |
| Other[a] | 2,447 | 150 | 21 | 0 | 3 | 0 | 1 | 0 | 2,622 |
| Total | 163,172 | 5,411 | 1,075 | 38 | 170 | 8 | 41 | 2 | 169,917 |

[a]Other branch of service includes beneficiaries of members of the Coast Guard, Public Health Service, National Oceanic and Atmospheric Administration, other civilian federal agencies, and foreign nationals of the North Atlantic Treaty Organization (NATO) military.
Data from CHCS HL7-formatted chemistry.
Prepared by the EDC, NMCPHC on 05 November 2019.
BLL, blood lead levels; CHCS, Composite Health Care System; HL7, Health Level 7; EDC, EpiData Center; NMCPHC, Navy and Marine Corps Public Health Center.

**FIGURE.** Percentage of elevated (≥5 µg/dL) pediatric BLL tests, by sponsor service affiliation, 2010–2017




[a]Other branch of service includes members of the Coast Guard, Public Health Service, National Oceanic and Atmospheric Administration, other civilian federal agencies, and foreign nationals of the North Atlantic Treaty Organization (NATO) military.
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highest percentages of elevated BLLs (Connecticut, Rhode Island, Pennsylvania, New Hampshire, and Tennessee) accounted for just 22 elevated levels out of only 268 tests performed **(Table 2)**. Among the remaining 37 states (including Washington, DC) that performed tests, the mean percentage positive was 0.9% and the values ranged from 0.3% (Arizona and Colorado) to 1.8% (Kansas and Mississippi).

## EDITORIAL COMMENT

Across the DoD, there were 177,061 tests performed between 2010 and 2017 among 162,238 pediatric beneficiaries. Some children may have had multiple tests occurring within the same year or during the totality of the reporting time frame because they had a positive lead questionnaire screen during a doctor's visit, exhibited clinical symptoms of lead poisoning per the provider's discretion, or had a prior elevated BLL test. For surveillance purposes, the highest BLL result per year per pediatric beneficiary was kept for analysis, leading to a final observation count of 169,917 BLL tests.

While the percentage of elevated BLL tests varied by sponsor service affiliation, the overall percentage of elevated BLL tests decreased from 2010 to 2017. The number of BLL tests among pediatric beneficiaries varied by state because of the location of fixed MTFs; however, in general, the percentage of elevated BLL tests did not differ between regions inside and outside of the U.S. The number of children tested within each branch of service likely varied because of the difference in the size of the service populations. Percentages of children with elevated BLLs could potentially be affected by the number of children tested within a branch of service or geographic region, whether the children tested were at a lower or higher risk of lead exposure, and the screening recommendations of the MHS.

To adequately identify and address lead exposure risks in their active duty and beneficiary populations, the DON and other DoD services might consider the adoption of a single, standardized method for BLL surveillance. A shared methodology would facilitate comparisons and reduce duplicative effort across the services. Ideally, a shared methodology would also be flexible and responsive to accommodate the challenges related to BLL surveillance in the DoD.

HL7-formatted data are routinely generated within the CHCS at fixed MTFs. HL7-formatted data do not include records from BLL tests without certified results. This may include specimens collected at an MTF that were sent to an out-of-network laboratory for testing. Data from purchased care providers also were not included. Records from MHS GENESIS, a new electronic health record that launched in February 2017 at select MHS facilities, were unavailable. Therefore, records from the following MTFs throughout the Pacific Northwest region were not included in this analysis after the launch of MHS GENESIS at their facilities: Fairchild Air Force Base, Madigan Army Medical Center, Naval Health Clinic Oak Harbor, and Naval Hospital Bremerton. Changes in civilian and military testing policies, updates to exposure thresholds, population- or service-specific practices, and data limitations complicate comparisons over time and across services and limit the generalizability of findings.

The HL7-formatted chemistry database consists of nonculture laboratory test results (e.g., polymerase chain reaction and antigen testing). Providers may order a panel when patients present with nonspecific symptoms. If the test name or test results within a panel are not disease-specific, these results may not be captured in search terms used to query the chemistry data. Classifying chemistry tests involves extensive searching of free-text test result fields. It is possible that some test results were misclassified, though validation steps were included to reduce error. Venous and capillary BLL specimen samples are unable to be distinguished in the HL7-formatted chemistry data. Capillary specimen samples for lead testing are generally viewed as

**TABLE 2.** Number and percentage of elevated (≥5 µg/dL) pediatric BLLs, by region and state, 2010–2017

| Region/state | No. BLL test performed | No. elevated BLLs | % elevated BLLs |
|---|---|---|---|
| Outside the U.S. | 6,383 | 52 | 0.8% |
| U.S. | 163,534 | 1,282 | 0.8% |
| Eastern North Central | 5,163 | 26 | 0.5% |
| Illinois | 1,445 | 10 | 0.7% |
| Indiana | 0 | 0 | 0.0% |
| Michigan | 0 | 0 | 0.0% |
| Ohio | 3,718 | 16 | 0.4% |
| Wisconsin | 0 | 0 | 0.0% |
| Eastern South Central | 7,697 | 75 | 1.0% |
| Alabama | 2,577 | 23 | 0.9% |
| Kentucky | 4,335 | 37 | 0.9% |
| Mississippi | 761 | 14 | 1.8% |
| Tennessee | 24 | 1 | 4.2% |
| Mid-Atlantic | 7,961 | 102 | 1.3% |
| New Jersey | 1,833 | 12 | 0.7% |
| New York | 6,032 | 85 | 1.4% |
| Pennsylvania | 96 | 5 | 5.2% |
| Mountain | 11,433 | 58 | 0.5% |
| Arizona | 2,059 | 6 | 0.3% |
| Colorado | 3,121 | 8 | 0.3% |
| Idaho | 826 | 4 | 0.5% |
| Montana | 273 | 4 | 1.5% |
| Nevada | 1,756 | 12 | 0.7% |
| New Mexico | 2,055 | 12 | 0.6% |
| Utah | 344 | 5 | 1.5% |
| Wyoming | 999 | 7 | 0.7% |
| New England | 1,561 | 22 | 1.4% |
| Connecticut | 36 | 6 | 16.7% |
| Maine | 0 | 0 | 0.0% |
| Massachusetts | 1,413 | 6 | 0.4% |
| New Hampshire | 20 | 1 | 5.0% |
| Rhode Island | 92 | 9 | 9.8% |
| Vermont | 0 | 0 | 0.0% |
| Pacific | 21,952 | 147 | 0.7% |
| Alaska | 1,570 | 10 | 0.6% |
| California | 11,739 | 66 | 0.6% |
| Hawaii | 7,152 | 58 | 0.8% |
| Oregon | 0 | 0 | 0.0% |
| Washington | 1,491 | 13 | 0.9% |
| South Atlantic | 59,497 | 493 | 0.8% |
| Delaware | 2,322 | 31 | 1.3% |
| District of Columbia | 389 | 4 | 1.0% |
| Florida | 4,534 | 33 | 0.7% |
| Georgia | 9,363 | 92 | 1.0% |
| Maryland | 2,688 | 28 | 1.0% |
| North Carolina | 12,514 | 100 | 0.8% |
| South Carolina | 1,835 | 31 | 1.7% |
| Virginia | 25,852 | 174 | 0.7% |
| West Virginia | 0 | 0 | 0.0% |
| Western North Central | 11,678 | 150 | 1.3% |
| Iowa | 0 | 0 | 0.0% |
| Kansas | 6,421 | 114 | 1.8% |
| Minnesota | 0 | 0 | 0.0% |
| Missouri | 3,071 | 16 | 0.5% |
| Nebraska | 1,355 | 9 | 0.7% |
| North Dakota | 639 | 9 | 1.4% |
| South Dakota | 192 | 2 | 1.0% |
| Western South Central | 36,592 | 209 | 0.6% |
| Arkansas | 1,016 | 8 | 0.8% |
| Louisiana | 3,874 | 30 | 0.8% |
| Oklahoma | 2,362 | 18 | 0.8% |
| Texas | 29,340 | 153 | 0.5% |
| Total | 169,917 | 1,334 | 0.8% |

Data from CHCS HL7-formatted chemistry.
Prepared by the EDC NMCPHC on 05 November 2019.
BLL, blood lead level; No., number; CHCS, Composite Health Care System; HL7, Health Level 7; EDC, EpiData Center; NMCPHC, Navy and Marine Corps Public Health Center.

less reliable than venous samples because of the potential for lead contamination of specimens during collection that could result in false positives. For surveillance purposes, the EDC reports the highest BLL result per year per pediatric beneficiary and ensures that there is follow-up regarding that elevated test regardless of specimen sample type.

Universal BLL screening is not required in the MHS but is based on the discretion of healthcare practitioners. As a result, the proportion of pediatric beneficiaries with high BLLs may not be a true representation of the BLLs in the pediatric beneficiary population. However, the EDC's pediatric BLL surveillance methods may provide a starting point for discussions on the value of developing a standardized blood lead surveillance program across all DoD services.

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