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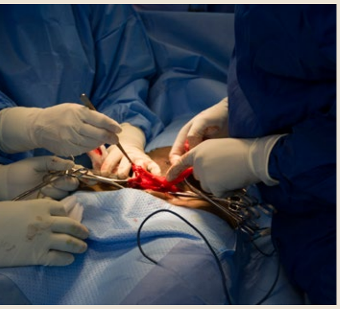

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Update: Routine Screening for Antibodies to Human Immunodeficiency Virus, Civilian Applicants for U.S. Military Service and U.S. Armed Forces, Active and Reserve Components, January 2015–June 2020

This report provides an update through June 2020 of the results of routine screening for antibodies to the human immunodeficiency virus (HIV) among civilian applicants for military service and among members of the active and reserve components of the U.S. Armed Forces. During January 2015–June 2020, full-year seroprevalences among applicants for service remained stable and ranged from 0.30 to 0.34 per 1,000 tested. Seroprevalences also peaked in 2015 for active component service members of the Army, Navy, and Air Force and among reservists of the Navy and Marine Corps. Overall, across the services, HIV antibody seroprevalences were highest among Army reservists, Army National Guard members, and Navy reservists and lowest among Air National Guard members, Marine Corps active component members, and Air Force reservists. Across active and reserve components of all services, HIV antibody seroprevalences continued to be higher among men than women.

WHAT ARE THE NEW FINDINGS?

From January 2015 through June 2020, the rates of HIV test positivity among civilian applicants for military service were stable at 0.32 per 1,000 tested. Among uniformed personnel (active component, Guard, and reserve), rates since 2015 decreased or remained relatively stable. Rates among female applicants and female service members have remained very low compared to those of males.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

The routine screening for antibodies to HIV for over 30 years has enabled the U.S. military to provide to infected service members adequate and timely medical evaluations, treatments, counseling to prevent unwitting transmission, and protection of the battlefield blood supply.

Since acquired immune deficiency syndrome (AIDS) was first recognized as a distinct clinical entity in 1981,[1] its spread has had major impacts on the health of populations and on healthcare systems worldwide. Human immunodeficiency virus type 1 (HIV-1) was identified as the cause of AIDS in 1983. For more than 30 years, the U.S. military has conducted routine screening for antibodies to HIV-1 to enable adequate and timely medical evaluations, treatment, and counseling; to prevent unwitting transmission; and to protect the battlefield blood supply.[2,3]

As part of the U.S. military's total-force HIV screening program, civilian applicants for military service are screened for antibodies to HIV during pre-accession medical examinations. Infection with HIV is medically disqualifying for entry into U.S. military service.[4] Since 1986, all members of the active and reserve components of the U.S. Armed Forces have been periodically screened to detect newly acquired HIV infections. In 2004, the Department of Defense (DoD) set a standard testing interval of 2 years for all service members.[5,6] All military personnel are periodically screened for HIV infection (at a minimum every 2 years or before deployment, on return from deployment, or after having received a diagnosis of various other conditions, such as a sexually transmitted infection).[6] Routine HIV screenings are usually performed during the Periodic Health Assessment, an annual evaluation of a service member's medical readiness status. Service members who are infected with HIV receive clinical assessments, treatments, and counseling; they may remain in service as long as they are able to fully perform their military duties.[2,3] HIV+ service members continue to be eligible for certain noncombat or noncontingency deployments and, as such, must meet the DoD's retention policy for non-deployable service members. The latest policy on retention determinations for non-deployable service members was implemented in October 2018 and requires service members who are in a non-deployable status for more than 12 consecutive months to be evaluated for a retention determination by their respective military departments or, as appropriate, be referred into the Disability Evaluation System, or be processed for administrative separation from the military.[7]

Before 2009, all of the aforementioned screening programs used laboratory techniques that detected only HIV-1–type infections. Starting in 2009, all programs adopted methods that allowed the detection of antibodies to both major HIV types (i.e., HIV-1 and HIV-2). Although HIV-2 infection is rare in the U.S. and no instances of HIV-2 infection have thus far been detected in civilian applicants or service members since 2009, HIV-2 is much more prevalent in other parts of the world where service members may be required to serve. To provide for the change in laboratory methods in the past and for the prospect of future detections of HIV-2 infection in the services' screening programs, this report will hereafter refer to the target of the screening programs as simply "HIV" without specifying the types.

This report summarizes numbers, seroprevalences, and trends of newly identified HIV antibody positivity among civilian applicants for military service and members of the active and reserve components of the U.S. Armed Forces from 1 January 2015 through 30 June 2020. Summaries of results of routine screening for antibodies to HIV among civilian applicants and active and reserve component members of the U.S. military since 1990 are available at www.health.mil/MSMRArchives.

METHODS

The surveillance period was 1 January 2015 through 30 June 2020. The surveillance population included all civilian applicants for U.S. military service and all individuals who were screened for antibodies to HIV while serving in the active or reserve component of the Army, Navy, Air Force, or Marine Corps during the surveillance period.

All individuals who were tested and all first-time detections of antibodies to HIV through U.S. military medical testing programs were ascertained by matching specimen numbers and serologic test results to the personal identifiers of providers of the specimens. With the exception of U.S. Air Force members, all results were accessed from records routinely maintained in the Defense Medical Surveillance System (DMSS). The U.S. Air Force provided summarized results of serologic screening for antibodies to HIV among its members.

An incident case of HIV antibody seropositivity was defined as 2 positive results from serologic testing of 2 different specimens from the same individual or 1 positive result from serologic testing of the most recent specimen provided by an individual.

Annual prevalences of HIV seropositivity among civilian applicants for service were calculated by dividing the number of applicants identified as HIV-antibody seropositive during each calendar year by the number of applicants tested during the corresponding year. For annual HIV seroprevalence summaries among U.S. service members, denominators were the numbers of individuals in each component of each service branch who were tested at least once during the relevant calendar year.

RESULTS

Civilian applicants

From January 2019 through June 2020, a total of 487,166 civilian applicants for U.S. military service were tested for antibodies to HIV, and 151 applicants were identified as HIV antibody positive (seroprevalence: 0.31 per 1,000 applicants tested) **(Table 1)**. During the surveillance period, full-year seroprevalences among applicants for service were highest in 2015 (0.34 per 1,000 tested) and then decreased during the subsequent 2 years (0.33 and 0.30 per 1,000 tested, respectively) **(Table 1, Figure 1).** In 2018, the seroprevalence increased slightly to 0.33 per 1,000 tested and then remained relatively stable at 0.32 per 1,000 tested in 2019.

Throughout the surveillance period, annual HIV antibody seroprevalences among male applicants were consistently higher than among female applicants **(Table 1, Figure 1)**. Seroprevalences were much higher among non-Hispanic blacks, compared with other race/ethnicity groups **(Table 2, Figure 2)**. During 2019, on average, 1 civilian applicant for service was detected with antibodies to HIV per 3,245 screening tests **(Table 1).**

U.S. Army

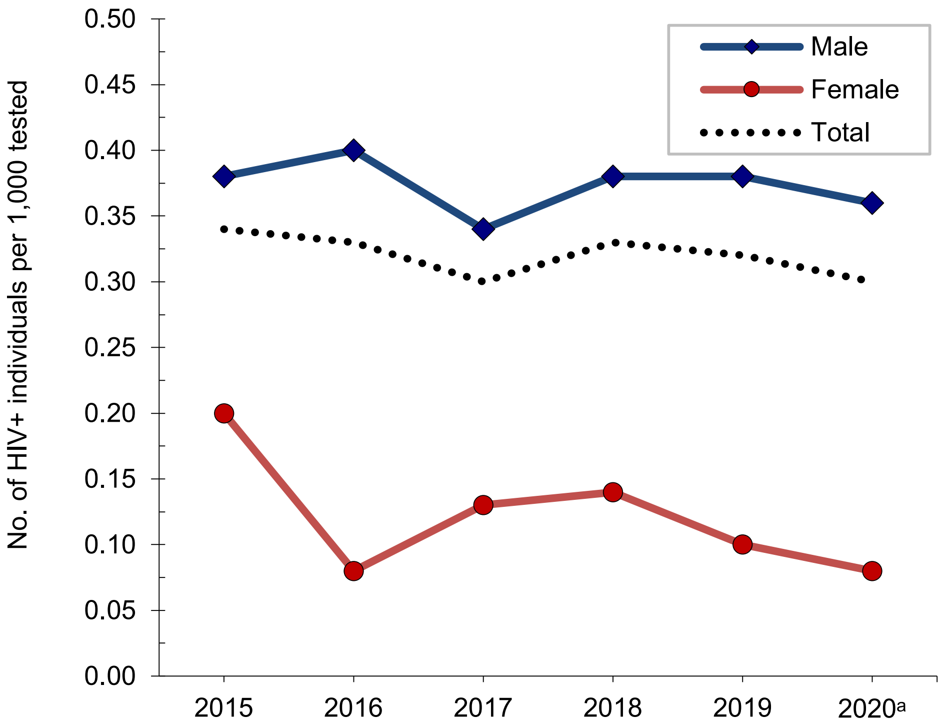
Active component: From January 2019 through June 2020, a total of 512,033 soldiers in the active component of the U.S. Army were tested for antibodies to HIV, and 113 soldiers were identified as HIV antibody positive (seroprevalence: 0.22 per 1,000 soldiers tested) **(Table 3)**. During the surveillance period, annual seroprevalences fluctuated between a low of 0.17 per 1,000 tested in 2017 and a high of 0.23 per 1,000 tested in 2015 **(Table 3, Figure 3)**. Annual seroprevalences for male active component Army members were considerably higher than those of females **(Figure 3)**. During 2019, on average, 1 new HIV infection was detected among active component

TABLE 1. New diagnoses of HIV infections, by sex, civilian applicants for U.S. military service, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total HIV(+)	HIV(+) male	HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested
2015	250,292	243,574	193,038	50,536	**83**	73	10	**0.34**	0.38	0.20
2016	251,602	245,487	194,333	51,154	**82**	78	4	**0.33**	0.40	0.08
2017	269,478	262,757	207,802	54,955	**78**	71	7	**0.30**	0.34	0.13
2018	269,505	261,276	203,747	57,529	**85**	77	8	**0.33**	0.38	0.14
2019	327,700	319,461	246,890	72,571	**101**	94	7	**0.32**	0.38	0.10
2020[a]	179,847	167,705	129,912	37,793	**50**	47	3	**0.30**	0.36	0.08
Total	1,548,424	1,500,260	1,175,722	324,538	**479**	440	39	**0.32**	0.37	0.12

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

FIGURE 1. Diagnoses of HIV infection by sex, civilian applicants for U.S. military service, January 2015–June 2020



[a]Through 30 June 2020.
HIV, human immunodeficiency virus; No., number.

Army soldiers per 5,710 screening tests **(Table 3)**. Of the 396 active component soldiers diagnosed with HIV infections since 2015, a total of 245 (61.9%) were still in military service in 2020.

Army National Guard: From January 2019 through June 2020, a total of 294,705 members of the U.S. Army National Guard were tested for antibodies to HIV, and 86 soldiers were identified as HIV antibody positive (seroprevalence: 0.29 per 1,000 soldiers tested) **(Table 4)**. Among Army National Guard soldiers, annual seroprevalences decreased markedly from 2016 through 2018 (seroprevalences: 0.38 and 0.24 per 1,000 soldiers tested, respectively), increased in 2019 (0.30 per 1,000 tested), and then decreased slightly in the first 6 months of 2020 (0.28 per 1,000 tested). On average, during 2019, 1 new HIV infection was detected among Army National Guard soldiers per 3,918 screening tests. Of the 349 National Guard soldiers who tested positive for HIV since 2015, a total of 183 (52.4%) were still in military service in 2020.

Army Reserve: From January 2019 through June 2020, a total of 156,308 members of the U.S. Army Reserve were tested for antibodies to HIV, and 47 soldiers were identified as HIV antibody positive (seroprevalence: 0.30 per 1,000 soldiers tested) **(Table 5)**. Among Army reservists during the surveillance period, seroprevalence was highest in 2016 at 0.40 per 1,000 tested, decreased slightly in 2017 to 0.38 per 1,000 tested, and then remained relatively stable through 2019. This pattern was followed by a considerable decrease in seroprevalence in the first 6 months of 2020 (0.11 tested per 1,000). During 2019, on average, 1 new HIV infection was detected among Army reservists per 2,997 screening tests **(Table 5)**. Of the 213 Army reservists diagnosed with HIV infections since 2015, a total of 132 (62.0%) were still in military service in 2020.

U.S. Navy

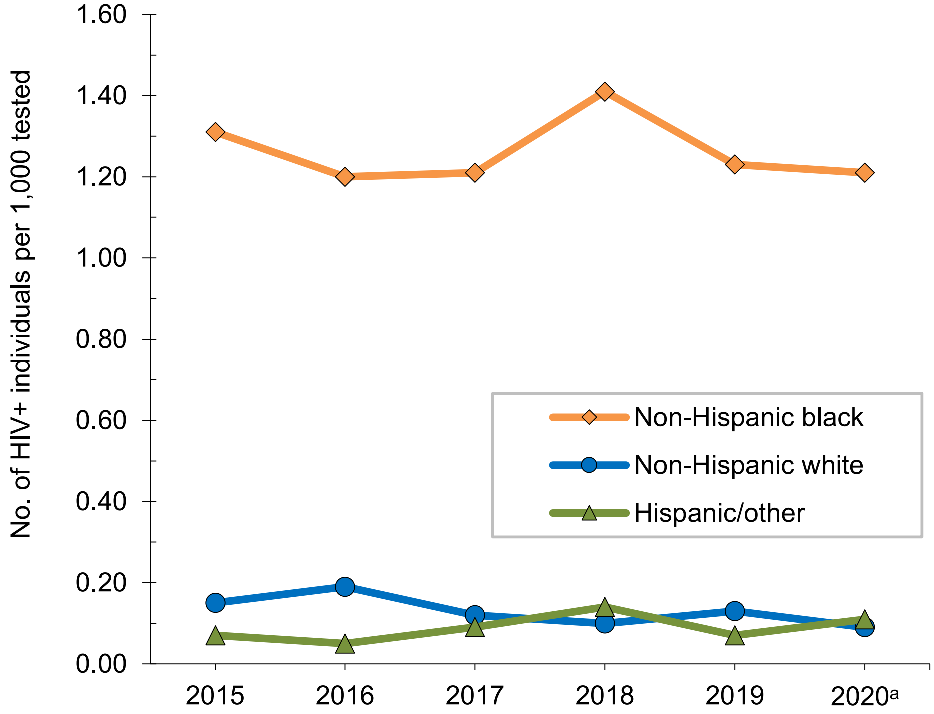
Active component: From January 2019 through June 2020, a total of 320,956 active component members of the U.S. Navy were

TABLE 2. New diagnoses of HIV infections, by race/ethnicity, civilian applicants for U.S. military service, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Non-Hispanic white tested	Non-Hispanic black tested	Hispanic/others tested	Total HIV(+)	Non-Hispanic white HIV(+)	Non-Hispanic black HIV(+)	Hispanic/others HIV(+)	Overall rate per 1,000 tested	Non-Hispanic white rate per 1,000 tested	Non-Hispanic black rate per 1,000 tested	Hispanic/others rate per 1,000 tested
2015	250,292	243,574	142,349	44,227	56,998	**83**	21	58	4	**0.34**	0.15	1.31	0.07
2016	251,602	245,487	141,827	43,214	60,446	**82**	27	52	3	**0.33**	0.19	1.20	0.05
2017	269,478	262,758	155,767	43,747	63,244	**78**	19	53	6	**0.30**	0.12	1.21	0.09
2018	269,505	261,279	154,638	43,412	63,229	**85**	15	61	9	**0.33**	0.10	1.41	0.14
2019	327,700	319,464	188,973	58,671	71,820	**101**	24	72	5	**0.32**	0.13	1.23	0.07
2020[a]	179,847	167,710	109,496	30,490	27,724	**50**	10	37	3	**0.30**	0.09	1.21	0.11
Total	1,548,424	1,500,272	893,050	263,761	343,461	**479**	116	333	30	**0.32**	0.13	1.26	0.09

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

FIGURE 2. Diagnoses of HIV infections by race/ethnicity, civilian applicants for U.S. military service, January 2015–June 2020



[a]Through 30 June 2020.
HIV, human immunodeficiency virus; No., number.

tested for antibodies to HIV, and 72 sailors were identified as HIV antibody positive (seroprevalence: 0.22 per 1,000 sailors tested) **(Table 6)**. Among tested male active component sailors, full-year annual HIV antibody seroprevalences decreased 30.0% between 2015 and 2019 **(Figure 4)**. Annual seroprevalences remained relatively low and stable among female sailors during the surveillance period. During 2019, on average, 1 new HIV infection was detected among active component sailors per 4,614 screening tests **(Table 6)**. Of the 319 active component sailors who tested positive for HIV since 2015, a total of 213 (66.8%) were still in military service in 2020.

Navy Reserve: From January 2019 through June 2020, a total of 46,046 members of the U.S. Navy Reserve were tested for antibodies to HIV, and 13 sailors were identified as HIV antibody positive (seroprevalence: 0.28 per 1,000 sailors tested) **(Table 7)**. The HIV antibody seroprevalence among Navy reservists in 2015 was more than 2 times that in 2016 (seroprevalences: 0.46 and 0.22 per 1,000 sailors tested, respectively). Since 2007, no female Navy reservist has been detected with antibodies to HIV during routine testing **(data not shown)**. On average, during 2019, 1 new HIV infection was detected among Navy reservists per 4,303 screening tests **(Table 7)**. Of the 55 reserve component sailors diagnosed with HIV infections since 2015, a total of 39 (70.9%) were still in military service in 2020.

U.S. Marine Corps

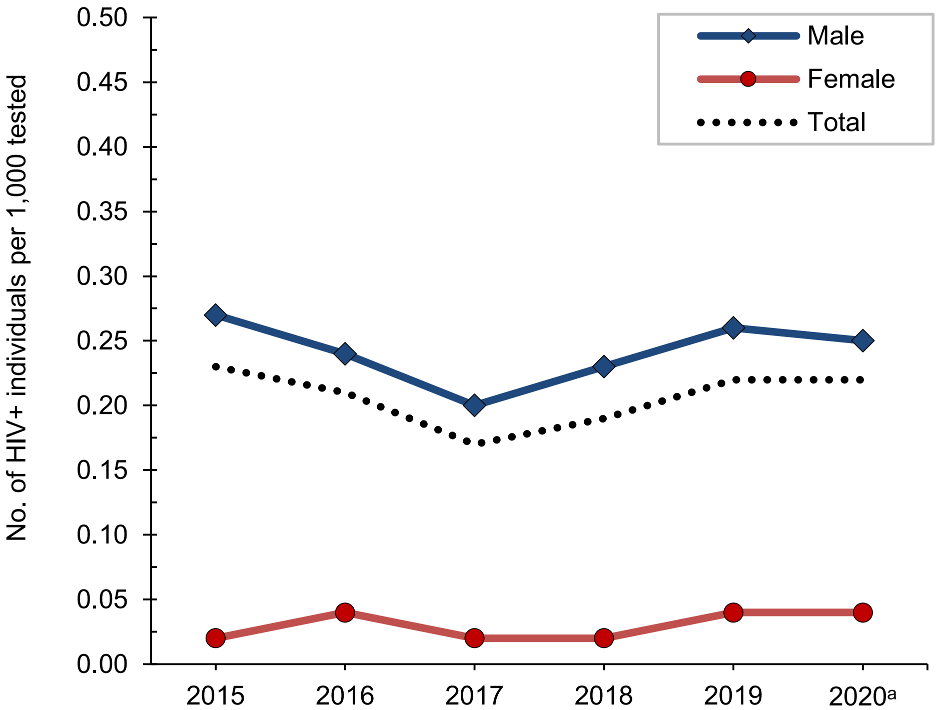
Active component: From January 2019 through June 2020, a total of 198,861 members of the active component of the U.S. Marine Corps were tested for antibodies to HIV, and 28 Marines were identified as HIV antibody positive (seroprevalence: 0.14 per 1,000 Marines tested) **(Table 8)**. From January 2015 through June 2020, seroprevalences of antibodies to HIV remained relatively low and stable among routinely tested Marines **(Figure 5)**. During 2019, on average, 1 new HIV infection was detected among active component Marines per 7,623 screening tests **(Table 8)**. Of the 113 active component Marines diagnosed

TABLE 3. New diagnoses of HIV infections, by sex, active component, U.S. Army, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	426,462	349,811	298,205	51,606	**82**	81	1	**0.23**	0.27	0.02	34
2016	428,275	349,748	297,394	52,354	**72**	70	2	**0.21**	0.24	0.04	38
2017	435,663	351,106	297,038	54,068	**61**	60	1	**0.17**	0.20	0.02	34
2018	450,608	351,344	296,744	54,600	**68**	67	1	**0.19**	0.23	0.02	41
2019	439,663	345,697	289,768	55,929	**77**	75	2	**0.22**	0.26	0.04	63
2020[a]	183,027	166,336	138,266	28,070	**36**	35	1	**0.22**	0.25	0.04	35
Total	2,363,698	1,914,042	1,617,415	296,627	**396**	388	8	**0.21**	0.24	0.03	245

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

FIGURE 3. New diagnoses of HIV infections by gender, active component, U.S. Army, January 2015–June 2020



[a]Through 30 June 2020.
HIV, human immunodeficiency virus; No., number.

with HIV infections since 2015, a total of 55 (48.7%) were still in military service in 2020.

Marine Corps Reserve: From January 2019 through June 2020, a total of 33,225 members of the U.S. Marine Corps Reserve were tested for antibodies to HIV, and 4 Marine Corps reservists were identified as HIV antibody positive (seroprevalence: 0.12 per 1,000 Marines tested) **(Table 9)**. During the surveillance period, seroprevalences among Marine Corps reservists peaked at 0.46 per 1,000 tested in 2015, and reached a low of 0.12 per 1,000 tested in 2019, and remained stable through June 2020. From 1990 through June 2020, only 1 female Marine Corps reservist was detected with antibodies to HIV during routine screening **(data not shown)**. During 2019, on average, 1 new HIV infection was detected among Marine Corps reservists per 9,400 screening tests **(Table 9)**. Of the 33 Marine Corps reservists diagnosed with HIV infection since 2015, a total of 11 (33.3%) were still in military service in 2020.

U.S. Air Force

Active component: From January 2019 through June 2020, a total of 308,303 active component members of the U.S. Air Force were tested for antibodies to HIV, and 42 airmen were diagnosed with HIV infections (seroprevalence: 0.14 per 1,000 airmen tested) **(Table 10)**. During the surveillance period, seroprevalences among males ranged from a high of 0.27 per 1,000 tested in 2015 to a low of 0.10 per 1,000 tested in the first 6 months of 2020 **(Figure 6)**. Among females during the surveillance period, annual seroprevalences remained relatively low and stable. During 2019, on average, 1 new HIV infection was detected among active component Air Force members per 7,733 screening tests **(Table 10)**. Of the 188 active component airmen diagnosed with HIV infections since 2015, 110 (58.5%) were still in military service in 2020.

Air National Guard: From January 2019 through June 2020, a total of 85,977 members of the Air National Guard were tested for antibodies to HIV, and 9 airmen were diagnosed with HIV infections (seroprevalence: 0.10 per 1,000 airmen tested) **(Table 11)**. In the first 6 months of 2020, 1 female Air National Guard member was detected with antibodies to HIV, the first since 2010 **(data not shown)**. During 2019, on average, 1 new HIV infection was detected among Air National Guard members

TABLE 4. New diagnoses of HIV infections, by sex, U.S. Army National Guard, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	205,549	181,785	151,147	30,638	**68**	66	2	**0.37**	0.44	0.07	16
2016	232,930	209,973	174,065	35,908	**80**	78	2	**0.38**	0.45	0.06	29
2017	235,671	205,401	170,172	35,229	**65**	63	2	**0.32**	0.37	0.06	28
2018	235,505	205,455	168,553	36,902	**50**	49	1	**0.24**	0.29	0.03	33
2019	235,066	202,964	165,335	37,629	**60**	60	0	**0.30**	0.36	0.00	51
2020[a]	97,962	91,741	73,847	17,894	**26**	24	2	**0.28**	0.32	0.11	26
Total	1,242,683	1,097,319	903,119	194,200	**349**	340	9	**0.32**	0.38	0.05	183

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

TABLE 5. New diagnoses of HIV infections, by sex, U.S. Army Reserve, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	121,897	110,161	84,786	25,375	**42**	42	0	**0.38**	0.50	0.00	17
2016	121,454	110,370	84,144	26,226	**44**	44	0	**0.40**	0.52	0.00	20
2017	119,373	108,249	82,686	25,563	**41**	40	1	**0.38**	0.48	0.04	23
2018	122,472	106,001	79,882	26,119	**39**	37	2	**0.37**	0.46	0.08	30
2019	125,893	109,317	81,948	27,369	**42**	40	2	**0.38**	0.49	0.07	37
2020[a]	50,035	46,991	34,858	12,133	**5**	4	1	**0.11**	0.11	0.08	5
Total	661,124	591,089	448,304	142,785	**213**	207	6	**0.36**	0.46	0.04	132

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

TABLE 6. New diagnoses of HIV infections, by sex, active component, U.S. Navy, January 2015–June 2020

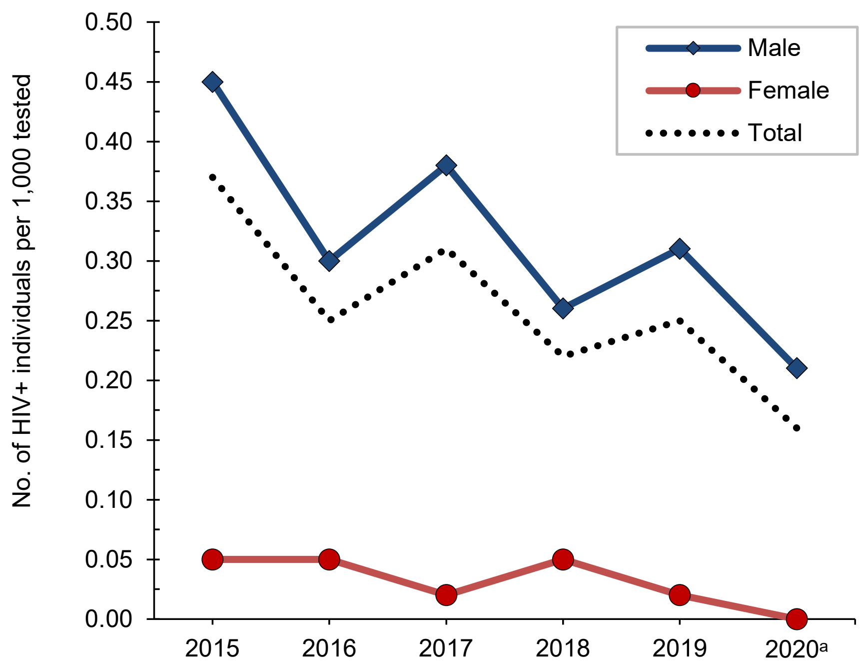
Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	241,711	214,218	172,632	41,586	**79**	77	2	**0.37**	0.45	0.05	38
2016	241,585	214,825	173,084	41,741	**54**	52	2	**0.25**	0.30	0.05	35
2017	249,270	219,408	174,722	44,686	**67**	66	1	**0.31**	0.38	0.02	41
2018	252,551	216,850	172,713	44,137	**47**	45	2	**0.22**	0.26	0.05	36
2019	258,388	223,012	176,071	46,941	**56**	55	1	**0.25**	0.31	0.02	47
2020[a]	104,086	97,944	76,295	21,649	**16**	16	0	**0.16**	0.21	0.00	16
Total	1,347,591	1,186,257	945,517	240,740	**319**	311	8	**0.27**	0.33	0.03	213

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

per 9,620 screening tests **(Table 11)**. Of the 30 Air National Guard members diagnosed with HIV infections since 2015, 22 (73.3%) were still in military service in 2020.

Air Force Reserve: From January 2019 through June 2020, a total of 51,243 members of the Air Force Reserve were tested for antibodies to HIV, and 7 airmen were diagnosed with HIV infections (seroprevalence: 0.14 per 1,000 airmen tested) **(Table 12)**. During 2019, on average, 1 new HIV infection was detected among Air Force reservists per 6,031 screening tests **(Table 12)**. Of the 30 reserve component airmen diagnosed with HIV infections since 2015, 22 (73.3%) were still in military service in 2020.

FIGURE 4. New diagnoses of HIV infections by gender, active component, U.S. Navy, January 2015–June 2020



[a]Through 30 June 2020.
HIV, human immunodeficiency virus; No., number.

EDITORIAL COMMENT

The U.S. military has conducted routine screening for antibodies to HIV among all

TABLE 7. New diagnoses of HIV infections, by sex, U.S. Navy Reserve, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	39,028	34,625	27,328	7,297	**16**	16	0	**0.46**	0.59	0.00	7
2016	41,693	35,990	28,170	7,820	**8**	8	0	**0.22**	0.28	0.00	6
2017	40,532	34,769	27,263	7,506	**8**	8	0	**0.23**	0.29	0.00	5
2018	37,855	33,385	25,750	7,635	**10**	10	0	**0.30**	0.39	0.00	10
2019	38,725	34,387	26,481	7,906	**9**	9	0	**0.26**	0.34	0.00	7
2020[a]	12,325	11,659	8,921	2,738	**4**	4	0	**0.34**	0.45	0.00	4
Total	210,158	184,815	143,913	40,902	**55**	55	0	**0.30**	0.38	0.00	39

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

TABLE 8. New diagnoses of HIV infections, by sex, active component, U.S. Marine Corps, January 2015–June 2020

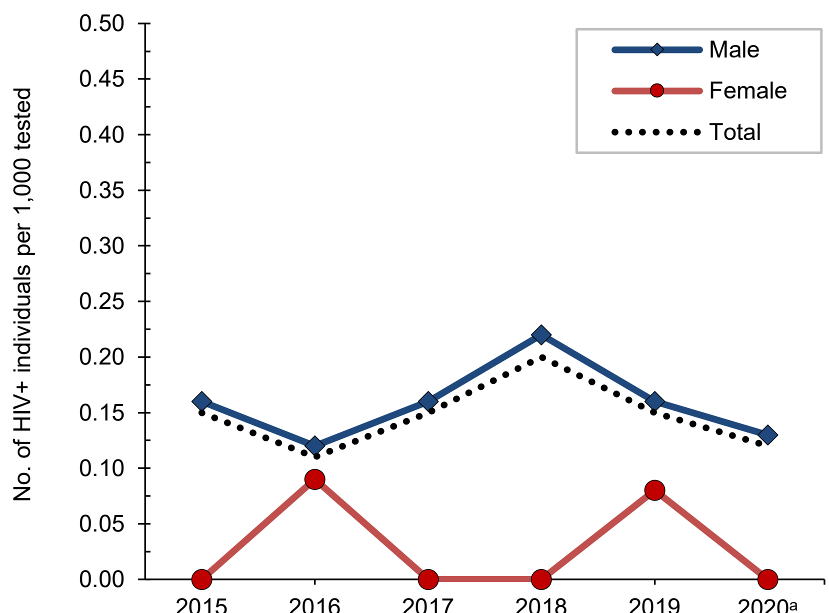
Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	162,065	140,440	129,494	10,946	**21**	21	0	**0.15**	0.16	0.00	5
2016	159,466	139,677	128,122	11,555	**16**	15	1	**0.11**	0.12	0.09	5
2017	164,599	140,973	129,134	11,839	**21**	21	0	**0.15**	0.16	0.00	5
2018	157,613	135,989	123,700	12,289	**27**	27	0	**0.20**	0.22	0.00	14
2019	160,073	138,215	125,684	12,531	**21**	20	1	**0.15**	0.16	0.08	19
2020[a]	64,833	60,646	54,616	6,030	**7**	7	0	**0.12**	0.13	0.00	7
Total	868,649	755,940	690,750	65,190	**113**	111	2	**0.15**	0.16	0.03	55

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

civilian applicants for service and all active and reserve component members of the services for more than 30 years.[2,3,5,6] Results of U.S. military HIV antibody testing programs have been summarized in the *MSMR* for more than 2 decades.[8]

This report documents that, since 2015, prevalences of HIV seropositivity among civilian applicants for military service have fluctuated between 0.30 per 1,000 tested in 2017 and 0.34 per 1,000 applicants tested in 2015. It is important to note that because applicants for military service are not randomly selected from the general population of U.S. young adults, seroprevalences among applicants are not directly indicative of HIV prevalences, infection rates, or trends in the U.S. civilian population. As such, relatively low prevalences of HIV among civilian applicants for military service do not necessarily indicate low prevalences or incidence rates of HIV among young adults in the U.S. in general.

FIGURE 5. New diagnoses of HIV infections by gender, active component, U.S. Marine Corps, January 2015–June 2020



[a]Through 30 June 2020.
HIV, human immunodeficiency virus; No., number.

TABLE 9. New diagnoses of HIV infections, by sex, U.S. Marine Corps Reserve, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	26,809	24,018	23,142	876	**11**	10	1	**0.46**	0.43	1.14	4
2016	26,760	23,505	22,652	853	**6**	6	0	**0.26**	0.26	0.00	1
2017	28,809	25,364	24,470	894	**8**	8	0	**0.32**	0.33	0.00	1
2018	27,009	22,987	22,214	773	**4**	4	0	**0.17**	0.18	0.00	2
2019	28,200	24,835	23,935	900	**3**	3	0	**0.12**	0.13	0.00	2
2020[a]	8,914	8,390	8,084	306	**1**	1	0	**0.12**	0.12	0.00	1
Total	146,501	129,099	124,497	4,602	**33**	32	1	**0.26**	0.26	0.22	11

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

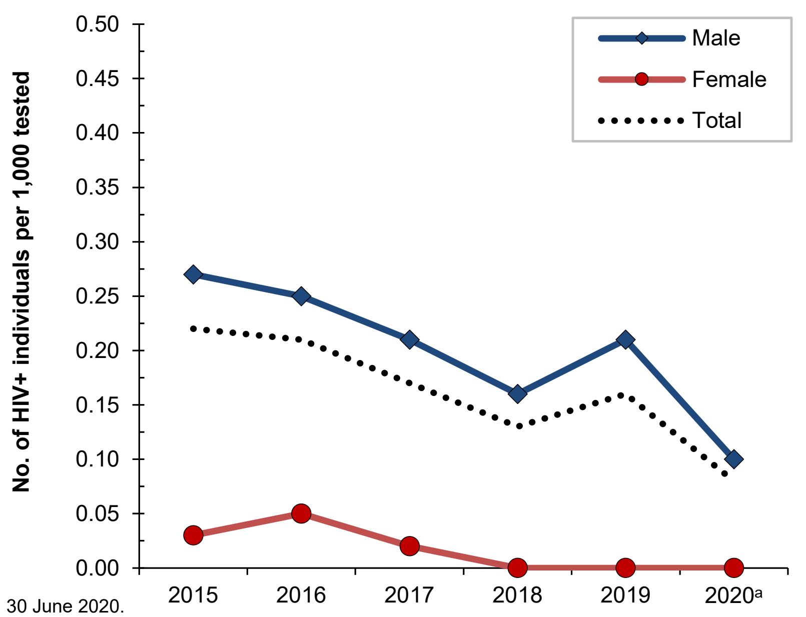
TABLE 10. New diagnoses of HIV infections, by sex, active component, U.S. Air Force, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	231,752	192,811	155,481	37,330	**43**	42	1	**0.22**	0.27	0.03	21
2016	242,827	196,486	157,836	38,650	**41**	39	2	**0.21**	0.25	0.05	21
2017	254,725	202,787	161,725	41,062	**35**	34	1	**0.17**	0.21	0.02	17
2018	258,664	207,702	164,676	43,026	**27**	27	0	**0.13**	0.16	0.00	15
2019	262,909	209,420	164,499	44,921	**34**	34	0	**0.16**	0.21	0.00	28
2020[a]	109,697	98,883	77,387	21,496	**8**	8	0	**0.08**	0.10	0.00	8
Total	1,360,574	1,108,089	881,604	226,485	**188**	184	4	**0.17**	0.21	0.02	110

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

This report also documents that full-year HIV antibody seroprevalences among members of the active components ranged from 0.11 per 1,000 tested (Marine Corps, 2016) to 0.37 per 1,000 tested (Navy, 2015). Full-year seroprevalences among the Reserve/Guard components fluctuated between 0.07 per 1,000 tested (Air National Guard, 2018) and 0.46 per 1,000 tested (Navy Reserve, 2015; Marine Corps Reserve, 2015); the greatest variations in full-year seroprevalences were observed among Marine Corps and Navy reservists. As was observed for total civilian applicants, annual seroprevalences among Army active component service members, Navy active component members, Air Force active component members, Navy reservists, and Marine Corps reservists were highest in 2015. Seroprevalences among the Navy Reserve exhibited a pronounced drop after 2015, while full-year seroprevalences among

FIGURE 6. New diagnoses of HIV infections by gender, active component, U.S. Air Force, January 2015–June 2020



[a]Through 30 June 2020.
HIV, human immunodeficiency virus; No., number.

TABLE 11. New diagnoses of HIV infections, by sex, U.S. Air National Guard, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	60,615	53,483	43,099	10,384	**6**	6	0	**0.11**	0.14	0.00	4
2016	70,691	60,709	48,731	11,978	**6**	6	0	**0.10**	0.12	0.00	3
2017	67,843	58,819	46,915	11,904	**5**	5	0	**0.09**	0.11	0.00	4
2018	71,244	61,315	48,882	12,433	**4**	4	0	**0.07**	0.08	0.00	3
2019	67,339	58,867	46,281	12,586	**7**	7	0	**0.12**	0.15	0.00	6
2020[a]	28,721	27,110	21,337	5,773	**2**	1	1	**0.07**	0.05	0.17	2
Total	366,453	320,303	255,245	65,058	**30**	29	1	**0.09**	0.11	0.02	22

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

TABLE 12. New diagnoses of HIV infections, by sex, U.S. Air Force Reserve, January 2015–June 2020

Year	Total HIV tests	Total persons tested	Males tested	Females tested	Total new HIV(+)	New HIV(+) male	New HIV(+) female	Overall rate per 1,000 tested	Male rate per 1,000 tested	Female rate per 1,000 tested	HIV(+) still in military service in 2020
2015	36,579	32,681	24,266	8,415	**3**	2	1	**0.09**	0.08	0.12	1
2016	41,176	36,453	26,796	9,657	**10**	10	0	**0.27**	0.37	0.00	8
2017	39,788	35,252	25,968	9,284	**6**	6	0	**0.17**	0.23	0.00	5
2018	41,402	36,816	26,972	9,844	**4**	4	0	**0.11**	0.15	0.00	2
2019	42,220	37,056	26,858	10,198	**7**	7	0	**0.19**	0.26	0.00	6
2020[a]	15,227	14,187	10,132	4,055	**0**	0	0	**0.00**	0.00	0.00	0
Total	216,392	192,445	140,992	51,453	**30**	29	1	**0.16**	0.21	0.02	22

[a]Through 30 June 2020.
HIV, human immunodeficiency virus.

the Army Reserve were relatively stable during the surveillance period. Overall (January 2015–June 2020), across the services, HIV antibody seroprevalences were highest among Army reservists, Army National Guard members, and Navy reservists. Across active and reserve components of all services, seroprevalences continued to be higher among males than females.

There are several limitations that should be considered when interpreting the results of the current analysis. For example, because of the frequency of screening in the military (as an applicant, routinely every 2 years, and before and after overseas deployments), routine screening now detects relatively recently acquired HIV infections (i.e., infections acquired since the most recent negative test of each affected individual). As such, annual HIV-antibody seroprevalences during routine screening of military populations are reflective of, but are not direct unbiased estimates of, incidence rates and trends of acquisitions of HIV infections among military members.

In summary, the U.S. military has conducted comprehensive HIV prevention, education, counseling, and treatment programs for more than 30 years. Since the beginning of these programs, routine screening of all civilian applicants for service and routine periodic testing of all active and reserve component members of the services have been fundamental components of the military's HIV control and clinical management efforts.[9] Summaries of results of screening programs such as those in this report provide insights into the current status and trends of HIV's impacts in various U.S. military populations.

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Incidence of Inguinal Hernia and Repair Procedures and Rate of Subsequent Pain Diagnoses, Active Component Service Members, U.S. Armed Forces, 2010–2019

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An inguinal hernia occurs when an internal organ protrudes through a tear or weak spot in the abdominal muscles. Among U.S. military service members, inguinal hernia is the fourth most prevalent digestive condition in terms of individuals affected and number of medical encounters. This study found that the overall incidence of inguinal hernia diagnoses between 2010 and 2019 among U.S. active component service members was 34.3 per 10,000 person-years. Older service members, males, non-Hispanic whites, and those in combat-specific occupations had comparatively higher incidence rates. Among the 44,898 incident inguinal hernia diagnoses during the surveillance period, 22,349 were followed by an open or laparoscopic inguinal hernia repair procedure. Of these, 12,210 (54.6%) were open and 10,139 (45.4%) were laparoscopic. Among the 22,349 inguinal hernia repair procedures, 6,276 (28.1%) were followed by pain diagnoses within 1 year after the repair procedures. Although the incidence of inguinal hernia diagnoses among active component service members decreased modestly during the surveillance period, the rate of hernia repair peaked in 2013, and the frequency of diagnoses of pain following hernia repair increased between 2010 and 2019.

WHAT ARE THE NEW FINDINGS?

The crude rate of incident inguinal hernia diagnoses between 2010 and 2019 among U.S. active component service members was 34.3 per 10,000 person-years, with a modest decline over the surveillance period. Among the 44,898 incident inguinal hernia diagnoses, 22,349 were followed by an open or laparoscopic repair and among these, 6,276 (28.1%) had a pain diagnosis within 1 year.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

For service members, inguinal hernias can result in reduced operational readiness due to lost duty time or medical evacuation from theater. Persistent pain from hernia repair surgeries can interfere with job duties and requirements for meeting standards of physical fitness. This study identifies subgroups of service members at higher risk for inguinal hernia and subsequent pain diagnosis.

An inguinal hernia occurs when an internal organ, usually part of the small intestine, protrudes into the inguinal canal through a tear or weak spot in the abdominal muscles. Inguinal hernias usually present as a lump in the groin that goes away with mild pressure or while lying down.[1] They can have many acquired causes, such as increased pressure on the abdomen due to strenuous activity, pregnancy, obesity, and chronic coughing or sneezing. Additional risk factors include being male, white, older, having a family history of inguinal hernia, and having a previous inguinal hernia or hernia repair (such as in childhood).[2]

Among U.S. military service members, inguinal hernia is the fourth most prevalent digestive condition in terms of individuals affected and number of medical encounters, exceeded in frequency only by diagnoses of esophageal disease, other gastroenteritis and colitis, and constipation.[3] In 2019, there were 10,853 encounters for inguinal hernia among 4,568 affected service members.[3] Inguinal hernias can also affect military readiness, particularly when they result in evacuations from theaters of operations. Among male service members, inguinal hernia was the second most common reason for medical evacuation from the Central Command Area of Responsibility (CENTCOM AOR) in 2019 (n=31).[4] The incidence of inguinal hernia among active component service members between 2005 and 2014 was 33.8 per 10,000 person-years (p-yrs), with rates being higher among males, non-Hispanic whites, older personnel, and those in combat-specific occupations.[5]

Inguinal hernia repair is one of the most common operations performed in the U.S., with more than 800,000 repairs done annually.[6] Options for surgical repair include open or laparoscopic repair. Open mesh repair is the preferred repair technique for primary inguinal hernia because it is reproducible by nonspecialist surgeons and is less likely to lead to recurrence, but primary suture repair can be performed when mesh is contraindicated.[1,6] Compared to open repair, laparoscopic repair is associated with longer operation times but less severe postoperative pain, fewer complications, and quicker return to normal physical activities.[6]

Pain persisting beyond the first few days following hernia repair is the primary complication of inguinal hernia repair and is reported in 3–39% of patients.[6–11] The relatively wide range of estimates for occurrence of pain following hernia repair can be attributed to the variation in patient populations studied, the severity of pain reported, and the time elapsed since hernia repair. In addition, there are varying definitions of chronic pain following hernia repair. Recent guidelines for prevention and management of postoperative pain following hernia repair recommend that chronic pain be defined as pain lasting at least 6 months after operation, as some patients may improve substantially between 3 and 6 months postoperation.[8,12] Chronic, disabling pain beyond 1 year is believed to occur in a small percentage of patients (<1%).[7] In hernia repairs, chronic pain can be caused by nerve injuries sustained during the surgery, inflammation, ischemia, or neuropathy; however, the true cause is often multifactorial and difficult to distinguish in a given patient.[6–8] Chronic pain has also been previously associated with high levels of preoperative pain, younger age, an anterior surgical approach, and a postoperative complication.[1]

The objective of this study was to examine the incidence of inguinal hernia diagnoses, the incidence of open and laparoscopic inguinal hernia repair procedures, and the proportion and rate of pain diagnoses (including both acute and chronic pain) following inguinal hernia repair, among active component service members between 2010 and 2019.

METHODS

The surveillance period was 1 January 2010 through 31 December 2019. The surveillance population included all active component service members of the U.S. Army, Navy, Air Force, and Marine Corps who served at any time during the surveillance period. Records of inpatient and outpatient encounters documented in the Defense Medical Surveillance System were used to ascertain cases of inguinal hernia, inguinal hernia repair procedures, and pain diagnoses.

An incident case of inguinal hernia was defined by having an inguinal hernia diagnosis (International Calssification of Diseases, 9th revision [ICD-9]: 550.*; 10th revision [ICD-10]: K40.*) in any diagnostic position of an inpatient or outpatient encounter. A service member could be counted only once per lifetime and the incident date was the date of the first qualifying encounter. Incident cases that occurred before the start of the surveillance period were excluded. For the purpose of measuring the incidence of inguinal hernia diagnoses, person-time was censored at the time of the incident inguinal hernia diagnosis, when the service member left service, or at the end of the surveillance period (whichever came first). Incidence rates were calculated per 10,000 p-yrs.

The incidence of inguinal hernia repair procedures was measured among the incident inguinal hernia cases identified during the surveillance period. Open and laparoscopic hernia repair procedures were defined by the presence of an inpatient or outpatient encounter with a qualifying ICD-9 or ICD-10 procedure code, or Current Procedural Terminology (CPT) code, in any procedural position **(Table 1)**. The first occurring repair procedure recorded on or after the incident inguinal hernia diagnosis was selected and an individual could be counted as having a repair procedure only once during the surveillance period. For the purpose of measuring incidence of inguinal hernia repair procedures, the person-time began to accrue at the time of the incident inguinal hernia diagnosis, and was censored at the time of the first inguinal hernia repair procedure, when the service member left service, or at the end of the surveillance period (whichever came first). Repair rates were calculated per 100 p-yrs.

The occurrence of post-procedural inguinal hernia repair pain was measured in the year following the first inguinal hernia repair procedure using ICD-9 and ICD-10 diagnoses for postoperative pain, abdominal pain, testicular pain, and mononeuritis of the lower limb **(Table 2)**. These ICD-9 and ICD-10 codes were selected in consultation with DoD pain medicine physicians, and were based on codes that would be most likely to represent the diagnosis of inguinal pain after hernia surgery. The first inpatient or outpatient encounter with a qualifying pain diagnosis in any diagnostic position, occurring within 1 year after the inguinal hernia repair procedure, was selected. For the purpose of measuring rates of pain diagnoses following inguinal hernia repair procedures, the person-time began to accrue at the time of the incident inguinal hernia repair procedure, and was censored at the time of the first pain diagnosis, when the service member left service, or at the end of the surveillance period (whichever came first). Rates of pain diagnoses were calculated per 100 p-yrs.

Covariates included age group, sex, race/ethnicity group, service branch, rank/grade, and military occupation. A prior pain diagnosis was defined by having an inpatient

TABLE 1. ICD-9/ICD-10 procedure codes and CPT codes used to identify inguinal hernia repair procedures

ICD-9 PR codes		ICD-10 PR codes[a]		CPT codes	
Open	Laparoscopic	Open	Laparoscopic	Open	Laparoscopic
53.00–53.05	17.11–17.13	0YQ50*	0YU54*	49505	49650
53.10–53.17	17.21–17.24	0YQ53*	0YU64*	49507	49651
		0YQ54*	0YUA4*	49520	
		0YQ60*		49521	
		0YQ63*		49525	
		0YQ64*			
		0YU50*			
		0YU60*			
		0YQA0*			
		0YQA3*			
		0YQA4*			
		0YUA0*			

[a]An asterisk (*) indicates that any subsequent digit/character is included.
ICD-9/ICD-10, International Classification of Diseases, 9th/10th revision; CPT, Common Procedural Terminology; PR, procedure.

TABLE 2. ICD-9/ICD-10 codes used to identify pain following inguinal hernia repair

ICD-9 code	Description	ICD-10 code[a]	Description
338.18	Other acute postoperative pain	G89.18	Other acute post procedural pain
338.28	Other chronic postoperative pain	G89.28	Other chronic post procedural pain
789.00	Abdominal pain unspecified	R10.9	Unspecified abdominal pain
789.03	Abdominal pain, right lower quadrant	R10.31	Right lower quadrant pain
789.04	Abdominal pain, left lower quadrant	R10.32	Left lower quadrant pain
789.09	Abdominal pain, other specified site	R10.30	Lower abdominal pain, unspecified
608.9	Unspecified disorder of male genital organs (testicular pain)	N50.81*	Testicular pain
355.8	Mononeuritis of lower limb, unspecified	R10.2	Pain in pelvic and perineal area
355.79	Other mononeuritis of lower limb	G57.9*	Unspecified mononeuropathy of lower limb

[a]An asterisk (*) indicates that any subsequent digit/character is included.
ICD-9/ICD-10, International Classification of Diseases, 9th/10th revision.

or outpatient encounter with a pain diagnosis **(Table 2)** in any diagnostic position on or before the inguinal hernia repair procedure.

RESULTS

During 2010–2019, the crude overall incidence of inguinal hernia diagnoses among active component service members was 34.3 per 10,000 p-yrs **(Table 3)**. Compared to their respective counterparts, males (39.5 per 10,000 p-yrs), non-Hispanic whites (39.8 per 10,000 p-yrs), senior officers (57.7 per 10,000 p-yrs), and those in combat-specific occupations (42.0 per 10,000 p-yrs) had higher overall rates. Overall rates of incident inguinal hernia diagnoses increased with increasing age, with service members aged 45 years or older having more than 3 times the rate of those less than 20 years of age. Crude annual incidence rates of inguinal hernia diagnoses decreased slightly over the course of the 10-year surveillance period, from 36.4 per 10,000 p-yrs in 2010 to 30.4 per 10,000 p-yrs in 2019 **(Figure 1)**.

Among the 44,898 incident inguinal hernia diagnoses during the surveillance period, 22,349 were followed by open or laparoscopic inguinal hernia repair procedures **(Table 4)**. Of these, 12,210 (54.6%) were open and 10,139 (45.4%) were laparoscopic. The proportion of incident inguinal hernia diagnoses with subsequent laparoscopic repairs increased annually over the course of the surveillance period, from 11.5% in 2010 to 28.4% in 2019 **(data not shown)**. In contrast, the proportion treated by open repairs peaked in 2013 at 32.5% and then decreased to 21.6% by 2019 **(data not shown)**. The overall incidence rate of repair among those with incident inguinal hernia diagnoses during the surveillance period, was 32.3 per 100 p-yrs **(Table 4)**. Compared to their respective counterparts, males (32.8 per 100 p-yrs), service members less than 20 years of age (158.2 per 100 p-yrs), non-Hispanic whites (34.2 per 100 p-yrs), Marine Corps members (49.3 per 100 p-yrs), junior enlisted personnel (59.2 per 100 p-yrs), and service members in combat-specific occupations (43.7 per 100 p-yrs) had higher overall rates of hernia repair.

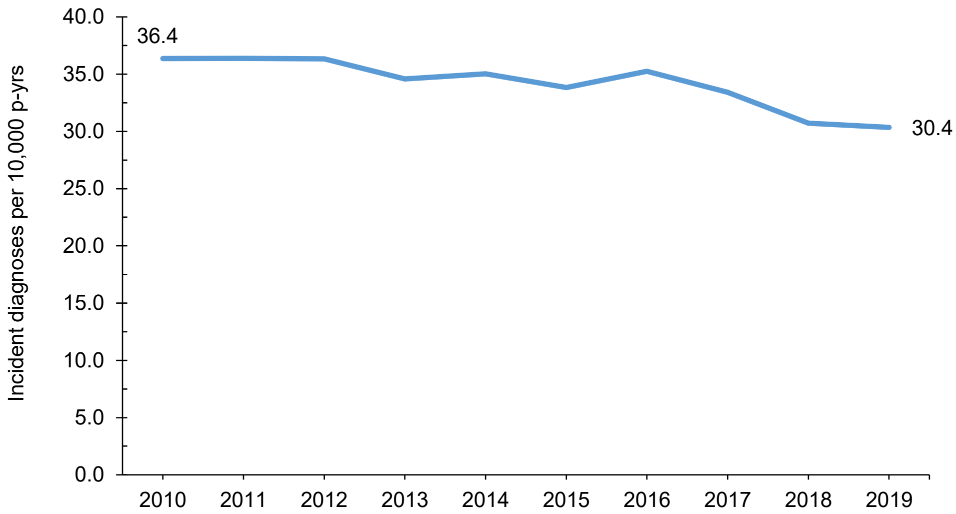
Among the 22,349 inguinal hernia repair procedures, 6,276 (28.1%) were followed by pain diagnoses within 1 year after the repair procedures **(Table 5, Figure 2)**. The proportions with pain diagnoses in the year following surgery were similar for those with laparoscopic (27.5%) and open (28.6%) repair procedures **(data not shown)**. The proportion with a pain diagnosis in the year following surgery increased from

TABLE 3. Incident cases and incidence rates of inguinal hernia, active component, U.S. Armed Forces, 2010–2019

	Total	
	No.	Rate[a]
Total	44,898	34.3
Encounter type		
Inpatient	581	0.4
Outpatient	44,317	33.8
Sex		
Male	43,580	39.5
Female	1,318	6.4
Age group (years)		
<20	2,140	24.0
20–24	11,547	27.2
25–29	9,394	29.8
30–34	7,111	34.5
35–39	6,419	44.0
40–44	4,759	57.5
45+	3,528	75.8
Males by age group (years)		
<20	2,085	28.3
20–24	11,201	31.4
25–29	9,042	34.2
30–34	6,892	39.6
35–39	6,254	50.1
40–44	4,646	64.7
45+	3,460	87.0
Females by age group (years)		
<20	55	3.5
20–24	346	5.1
25–29	352	6.9
30–34	219	6.8
35–39	165	7.8
40–44	113	10.3
45+	68	10.0
Race/ethnicity group		
Non-Hispanic white	30,661	39.8
Non-Hispanic black	5,585	26.4
Hispanic	5,405	29.6
Asian/Pacific Islander	808	15.9
American Indian/ Alaska Native	362	26.9
Other/unknown	2,077	25.6
Service		
Army	18,732	37.9
Navy	8,557	27.2
Air Force	10,570	33.7
Marine Corps	7,039	37.7
Rank/grade		
Junior enlisted (E01–E04)	16,596	28.6
Senior enlisted (E05–E09)	19,187	38.1
Junior officer/warrant officer (O01–O03; W1–W3)	4,295	30.4
Senior officer/warrant officer (O4–O10; W4–W5)	4,820	57.7
Military occupation		
Combat-specific[b]	7,937	42.0
Motor transport	1,247	32.3
Pilot/air crew	1,851	38.3
Repair/engineering	12,836	33.5
Communications/ intelligence	8,772	30.9
Healthcare	3,858	33.6
Other/unknown	8,397	33.3

[a]Incidence rate per 10,000 person-years.
[b]Infantry/artillery/combat engineering.
No., number.

FIGURE 1. Crude annual incidence rates of inguinal hernia diagoses, active component, U.S. Armed Forces, 2010–2019



P-yrs, person-years.

17.1% in 2010 to 31.5% in 2019 among males and from 25.0% in 2010 to 52.6% in 2019 among females **(data not shown)**. Overall, the percentages of inguinal hernia repairs with pain diagnoses in the following year were highest during the last 3 years of the surveillance period and ranged from 31.8% in 2017 to 32.3% in 2018 **(data not shown)**. Among those with an inguinal hernia repair procedure, the overall rate of pain in the subsequent year was 40.1 per 100 p-yrs **(Table 5)**.

Compared to their respective counterparts, females (67.3 per 100 p-yrs), service members less than 20 years of age (58.2 per 100 p-yrs), Hispanics (46.2 per 100 p-yrs), Army members (50.1 per 100 p-yrs), enlisted personnel (junior 49.1 per 100 p-yrs; senior 40.5 per 100 p-yrs), and those with a prior pain diagnosis (59.7 per 100 p-yrs) had higher overall rates of pain diagnoses. Among those with a pain diagnosis in the year following hernia repair, 30.7% (n=2,975) had a pain diagnosis within the first 3 months, 27.4% (n=2,658) had a diagnosis within 3-6 months after, 22.8% (n=2,214) within 6-9 months after, and 19.1% (n=1,855) had a pain diagnosis within 9-12 months following repair **(data not shown)**. Abdominal pain was the most frequently diagnosed type of pain, which occurred among 85.3% (n=5,352) of those with any pain diagnosis, followed by acute postoperative pain (19.5%, n=1,224), testicular pain (17.2%, n=1,079), chronic postoperative pain (7.5%, n=471), pelvic pain (3.8%, n=240), and mononeuritis (3.3%, n=209) **(data not shown)**.

EDITORIAL COMMENT

This study found that the overall incidence rate of inguinal hernia diagnoses among active component service members was 34.3 per 10,000 p-yrs between 2010 and 2019. In addition, older service members, males, non-Hispanic whites, and those in combat-specific occupations had comparatively higher rates of incident inguinal hernia diagnoses. These patterns are consistent with previously identified risk factors in the civilian population and are also similar to findings from a prior *MSMR* report.[2,5] Service members with pre-existing abdominal hernias would be screened and precluded from joining military service; however, results of this analysis indicate that a sizable proportion of service members develop hernias while in uniform. Of interest is the positive association between combat-specific occupations and incidence of inguinal hernia, which suggests that strenuous physical activity or traumatic injury could play a role

TABLE 4. Incidence of inguinal hernia repair following incident inguinal hernia diagnosis, active component, U.S. Armed Forces, 2010–2019

	Total	
	No.	Rate[a]
Total	22,349	32.3
Repair type		
Open	12,210	17.6
Laparoscopic	10,139	14.7
Sex		
Male	21,854	32.8
Female	495	19.5
Age group (years)		
<20	1,017	158.2
20–24	5,985	56.3
25–29	4,482	29.7
30–34	3,474	23.8
35–39	3,153	24.1
40–44	2,360	26.4
45+	1,878	30.4
Males by age group (years)		
<20	993	158.7
20–24	5,836	57.0
25–29	4,365	30.2
30–34	3,396	24.2
35–39	3,095	24.5
40–44	2,311	26.6
45+	1,858	31.1
Females by age group (years)		
<20	24	137.6
20–24	149	38.2
25–29	117	18.6
30–34	78	13.9
35–39	58	12.1
40–44	49	19.0
45+	20	9.9
Race/ethnicity group		
Non-Hispanic white	15,732	34.2
Non-Hispanic black	2,520	27.8
Hispanic	2,526	28.4
Asian/Pacific Islander	410	37.2
American Indian/ Alaska Native	175	29.9
Other/unknown	986	27.9
Service		
Army	9,582	36.0
Navy	4,291	31.2
Air Force	4,462	21.6
Marine Corps	4,014	49.3
Rank/grade		
Junior enlisted (E01–E04)	8,440	59.2
Senior enlisted (E05–E09)	9,147	23.5
Junior officer/warrant officer (O01–O03; W1–W3)	2,184	30.7
Senior officer/warrant officer (O4–O10; W4–W5)	2,578	29.0
Military occupation		
Combat-specific[b]	4,355	43.7
Motor transport	614	37.6
Pilot/air crew	932	27.6
Repair/engineering	6,318	30.4
Communications/ intelligence	4,281	29.0
Healthcare	2,012	32.3
Other/unknown	3,837	30.8

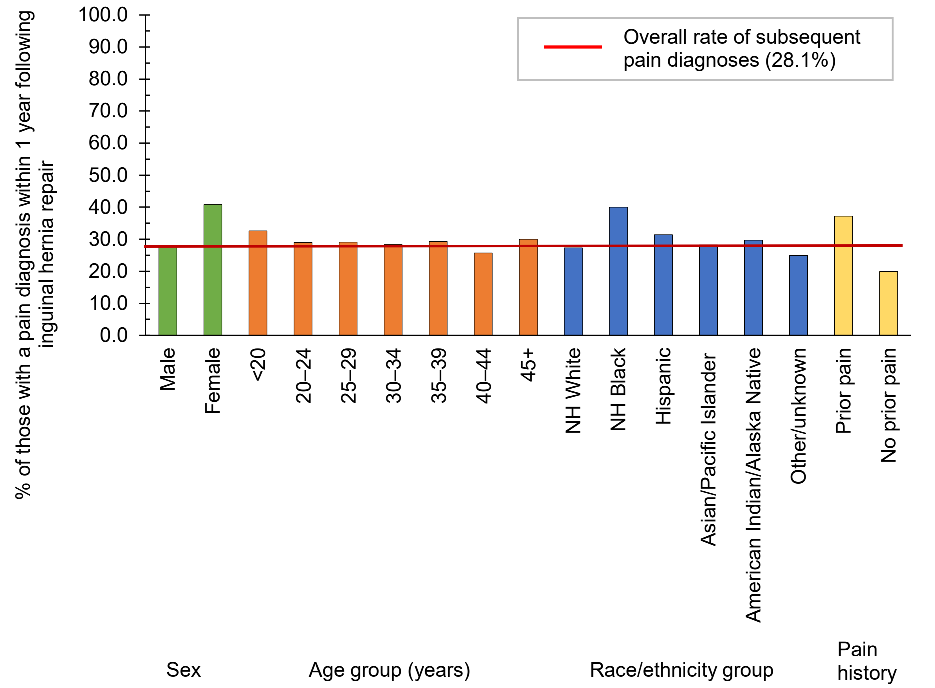
[a]Incidence rate per 100 person-years.
[b]Infantry/artillery/combat engineering.
No., number.

TABLE 5. Rate of pain diagnoses within 1 year following inguinal hernia repair, active component, U.S. Armed Forces, 2010–2019

	Total	
	No.	Rate[a]
Total	6,276	40.1
Sex		
Male	6,074	39.6
Female	202	67.3
Age group (years)		
<20	248	58.2
20–24	1,728	42.3
25–29	1,322	41.4
30–34	999	39.2
35–39	930	40.1
40–44	634	37.4
45+	415	30.2
Males by age group (years)		
<20	237	56.3
20–24	1,670	41.8
25–29	1,269	40.7
30–34	966	38.7
35–39	909	39.9
40–44	618	37.1
45+	405	29.7
Females by age group (years)		
<20	11	238.5
20–24	58	64.0
25–29	53	75.2
30–34	33	62.7
35–39	21	51.8
40–44	16	54.7
45+	10	82.7
Race/ethnicity group		
Non-Hispanic white	4,286	38.8
Non-Hispanic black	780	45.2
Hispanic	794	46.2
Asian/Pacific Islander	115	40.6
American Indian/ Alaska Native	54	41.1
Other/unknown	247	33.9
Service		
Army	3,196	50.1
Navy	778	23.7
Air Force	1,306	41.6
Marine Corps	996	35.2
Rank/grade		
Junior enlisted (E01–E04)	2,626	49.1
Senior enlisted (E05–E09)	2,703	40.5
Junior officer/warrant officer (O01–O03; W1–W3)	442	26.8
Senior officer/warrant officer (O4–O10; W4–W5)	505	25.7
Military occupation		
Combat-specific[b]	1,220	39.9
Motor transport	191	47.1
Pilot/air crew	165	23.4
Repair/engineering	1,761	38.6
Communications/intelligence	1,327	44.5
Healthcare	526	37.0
Other/unknown	1,086	43.3
Prior pain		
Yes	3,981	59.7
No	2,295	25.6

[a]Rate per 100 person-years.
[b]Infantry/artillery/combat engineering.
No., number.

FIGURE 2. Percentage of those with a pain diagnosis within 1 year following inguinal hernia repair, active component, U.S. Armed Forces, 2010–2019



in increasing risk among younger service members, although this could not be confirmed using the available data.

In addition, this study found that while the crude annual incidence rates of inguinal hernia diagnoses among active component service members decreased modestly during the surveillance period, the rate of hernia repair peaked in 2013, and the rates of pain following hernia repair increased between 2010 and 2019. The proportion of inguinal hernias treated by subsequent laparoscopic repair increased from 11.5% in 2010 to 28.4% in 2019. In contrast, the proportion treated by open repair peaked in 2013 at 32.5% and then decreased to 21.6% by 2019. This pattern of change is not surprising given that the laparoscopic technique has grown in popularity in the U.S., with estimates ranging from 16.8% to 41.0% of all inguinal hernia operations.[13] However, this did not correlate with decreased pain outcomes, as the percentages of inguinal hernia repairs with pain diagnoses in the following year were highest during the last 3 years of the surveillance period, ranging from 31.6% in 2017 to 32.2% in 2018, and the overall proportions of laparoscopic and open procedures with pain diagnoses in the following year were roughly similar (27.5% and 28.6%, respectively).

During the 10-year surveillance period, open repair remained the most common procedure type overall, and was performed at a rate of 17.6 per 100 p-yrs following inguinal hernia diagnosis, compared to 14.7 per 100 p-yrs for laparoscopic repair. However, by 2019, a greater proportion of inguinal hernias were being treated by laparascopy (28.4%) than by open repair (21.6%). Males, younger personnel, and those in combat-specific occupations were more likely than their respective counterparts to have repair procedures following incident inguinal hernia diagnoses. The reasons for these findings are unclear but may be related to the severity of the incident hernia. It is also possible that the nature of a service member's duties may precipitate the decision to undergo hernia repair.

For service members, persistent pain can interfere with job duties and requirements for meeting standards of physical fitness. This study indicated that pain following inguinal hernia repair was more common among women, younger personnel, and those with prior abdominal or groin pain diagnoses. These results are consistent with findings from international surveys of self-reported pain following hernia surgery.[11,14] Pain persisting after hernia repair can be treated using physical therapy, pharmacological analgesics, injections with local anesthetics, sensory stimulation or ablation of nerves, and surgery.[1,6,8] Anti-inflammatory agents are recommended as the first line of treatment, and if these are unsuccessful then nerve blocks (injection of anesthetic on or near the nerve/pain receptor) can be used.[6] When these treatments have failed, then neurectomy may be necessary.[6]

There are several limitations to this study. The primary limitation was that pain was ascertained using ICD-9 and ICD-10 codes for post-operative pain, abdominal pain, testicular pain, and mononeuritis. The lack of a specific ICD diagnosis code for post-inguinal herniorrhaphy pain likely led to the capture of incidents of pain unrelated to the hernia repair procedure; however, the surveillance period was restricted to the year following hernia repair in order to reduce the likelihood of this occurring. A further limitation to this approach is that pain persisting for longer than 1 year following hernia repair could not be assessed, as it was more likely that these pain diagnoses could be related to other conditions or procedures aside from hernia repair. In addition, data were not available for lost duty time or disability due to pain following hernia or hernia repair. Hernia diagnoses, repair procedures, and pain diagnoses occurring in deployed settings were not assessed. However, it is expected that most hernia repairs that occurring as a result of inguinal hernia sustained during deployment would be captured since service members would likely be medically evacuated out of theater for this procedure. Procedures and diagnoses that occurred after a service member left service, or were paid for out of pocket, were also not captured.

For service members, inguinal hernias can result in reduced operational readiness, and persistent pain from hernia repair surgeries can interfere with job duties and physical fitness requirements. Service members at higher risk for pain following hernia repair, such as female service members, younger personnel, those with prior abdominal or groin pain diagnoses, and those with prior repair procedures, should be monitored and treated according to best practice guidelines if the pain does not subside.[8]

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Surveillance of Spotted Fever Rickettsioses at Army Installations in the U.S. Central and Atlantic Regions, 2012–2018

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Spotted fever rickettsioses (SFR) are emerging in the Atlantic and Central regions of the U.S., though cases have been reported across the contiguous U.S. Military populations may be at increased risk for SFR because of residence in these regions and frequent field training in tick habitats. Surveillance for Rocky Mountain spotted fever in the Army began in 1998 and was expanded to include all SFR in 2017. Between 2016 and 2017, the rate of active component cases reported from Army installations in the Atlantic and Central regions of the U.S. increased nearly five-fold from 2016 (0.55 per 100,000 person-years [p-yrs]) to 2017 (2.65 per 100,000 p-yrs). The majority of SFR cases were reported from Fort Leonard Wood, MO, and Fort Bragg, NC. Most reported cases had no documented symptoms consistent with SFR and could not be confirmed as "cases" by standard case-defining methods. SFR surveillance and control efforts in military populations can be improved by better adherence to guidelines for SFR diagnosis and through the use of available advanced laboratory techniques.

WHAT ARE THE NEW FINDINGS?

Cases of SFR have been increasing in U.S. civilian and military populations since the mid-1990s. In 2017 and 2018, nearly 80% of military beneficiaries diagnosed with SFR received presumptive treatment despite a lack of symptoms consistent with SFR and only 4% had confirmed disease.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

Service members may be at increased risk of contracting SFR because of residence in regions with endemic rickettsial species and frequent field training in tick habitats. However, military health providers should adhere to national guidelines for diagnosis, treatment, and use of modern laboratory methods to confirm the diagnosis.

Spotted fever rickettsioses (SFR) can cause human infections ranging from asymptomatic or mild cases to severe, life-threatening disease.[1–3] SFR infections are caused by bacterial species of the genus *Rickettsia*. For example, SFR in the U.S. are caused by *R. rickettsii* (Rocky Mountain spotted fever [RMSF]), *R. parkeri (R. parkeri* rickettsiosis*)*, and *R.* species 364D (Pacific Coast tick fever).[2] These bacterial species are transmitted to humans through the bite of an infected tick, most commonly the American dog tick, Rocky Mountain wood tick, and brown dog tick.[2] These vectors have varying geographic distributions across the U.S. and can be found in regions where Army installations are present. Additionally, those traveling outside the U.S. may be at risk for other tick-borne rickettsial diseases, including African tick-bite fever, Mediterranean spotted fever (boutonneuse fever), Queensland tick typhus, Japanese spotted fever, and others.[4,5] Early treatment with doxycycline typically results in rapid recovery, but after the fifth day of illness, untreated cases have a higher risk of developing severe illness, including disseminated intravascular coagulopathy and multisystem organ failure, potentially leading to permanent disabilities or death.[1–3]

The incidence of tick-borne diseases, including SFR, has been increasing in the U.S.[1] The highest number of cases of tick-borne disease in the past 14 years was reported to the Centers for Disease Control and Prevention (CDC) in 2017.[6] Annual incidence of SFR in the U.S. increased from 1.7 cases per 1 million persons in 2000 to 13.2 cases per 1 million persons in 2016.[6] Cases have been reported from throughout the contiguous U.S.; SFR are not reportable conditions in Hawaii or Alaska.[6] From 2008–2012, 63% of cases were reported to CDC from 5 states: Arkansas, Missouri, North Carolina, Oklahoma, and Tennessee.[7,8] In Missouri, the state in which Fort Leonard Wood is located, the incidence rate of RMSF during 1 January 2019–2 July 2019 was 32.7 cases per 1 million persons.[9] An overall seasonality has been recognized throughout most of the U.S., with 68% of cases reporting symptom onset occurring between May and September and the highest number of cases in June.

CDC included RMSF as a notifiable condition in the National Notifiable Diseases Surveillance System from 1944 to 2009.[10] However, the SFR are antigenically related and serologic assays developed for the diagnosis of RMSF may react nonspecifically with antigens of less pathogenic species.[11] For this reason, the Council of State and Territorial Epidemiologists changed the case definition of RMSF to the broader category called SFR. This reporting change, implemented by the states and CDC in 2010, may account for some of the increase in SFR reported to CDC in recent years, although the upward trend in disease incidence began much earlier in the 1990s.[7] Because of limitations of laboratory diagnostic evidence used to identify cases, the epidemiology of all spotted fever group rickettsioses remains unclear.[1,2,11]

Military populations may be at increased risk for SFR because of residence in endemic regions and frequent field training in tick habitats.[12–14] Further, those in a military occupational specialty that included ground combat have been found to be more likely to be seropositive for rickettsiosis.[12–14] Surveillance for rickettsial disease in the U.S. military began in 1998, but it only included cases of RMSF.[15,16] In July 2017, the Armed Forces broadened the reportable medical event guidelines and case definitions to include all SFR, consistent with CDC surveillance.[16] However, the clinical criteria of these 2 case definitions differ in that the Armed Forces definition did not require the presence of fever to meet the confirmed or probable case definition.

Given the potential for severe disease presentation, the changing epidemiology in the U.S., and the potential for service-related risk, surveillance for SFR is critical to informing Department of Defense (DoD) efforts in force health protection risk assessment, mitigation, and communication. However, the recent epidemiology of SFR among military populations has not been evaluated. Furthermore, public health personnel at Fort Leonard Wood had been reporting concerns about high rates of SFR at that installation since the 2017 change in surveillance. The primary goal of this study was to characterize the epidemiology of the SFR among active component (AC) Army service members and other beneficiaries assigned to Army installations in the Central and Atlantic regions of the U.S. from 2012 to 2018, with a special focus on Fort Leonard Wood, MO. The secondary goal of the study was to assess the completeness and accuracy of SFR reporting at these installations.

METHODS

Study population

The study population included all AC and other U.S. military beneficiaries assigned to all of the Army installations in the Atlantic and Central regions of the U.S. between 1 January 2012 and 31 December 2018. Installations in the Pacific and European regions were excluded from the study because of differences in climate, geography, and disease epidemiology.

Case definition

Cases were classified according to the 2017 Armed Forces Reportable Medical Event Guidelines and Case Definitions.[16] The clinical criteria for SFR included a patient with any of the following: rash, headache, myalgia, nausea/vomiting, anemia, thrombocytopenia, an ulcer at the site of the bite, or any hepatic transaminase elevation. A confirmed case was defined as a case that met the clinical criteria along with any of the following: 1) 4-fold increase in immunoglobulin G (IgG) antibody titer, 2) DNA detected by polymerase chain reaction (PCR) from a clinical specimen, 3) histopathologic identification from a biopsy, or 4) identification by culture from a clinical specimen. A probable case was defined as a case that met the clinical criteria along with a single serum specimen positive for SFR immunoglobulin M (IgM) or IgG. A suspected case was defined as a case that met any of the laboratory criteria above but none of the clinical criteria.

Data sources

The primary data sources used in this study were the Disease Reporting System internet (DRSi), the Defense Medical Surveillance System (DMSS), the Armed Forces Health Longitudinal Technology Application (AHLTA), and laboratory data.[17,18] The DMSS database was queried for records of care at or near Army installations in the Atlantic and Central regions (as indicated by the patient zip code) if the records contained International Classification of Diseases, 9th Revision code of 082.0 or International Classification of Diseases, 10th Revision code of A77.0 in any diagnostic position. All SFR cases reported to the DRSi are validated by epidemiologists the next day. Laboratory tests with an IgG or IgM value of ≥1:64 by indirect immunofluorescence antibody (IFA) for SFR were considered positive; an IgG or IgM value of 1:64 is the lowest value that can be interpreted as a positive result.

Additional data on cases reported from Fort Leonard Wood, including clinical and laboratory details of each case, were collected from 2017–2018 by the Fort Leonard Wood Preventive Medicine Department. This department reviews records from the laboratory, hospital, and clinics for every case of tick-borne disease and performs additional investigation for each case to determine its case classification and exposure history. Information was collected on the laboratory type, result, symptoms, tick exposure history, and treatment.

Extensive record reviews were also performed at the Armed Forces Health Surveillance Branch (AFHSB) using ALHTA for 62 randomly selected cases that had either been reported to the DRSi or clinically diagnosed and found in the DMSS between 2012 and 2018 at these installations. The reviews covered clinicians' documentation of medical encounters, medication records, and laboratory records. Case classifications based on the Armed Forces case definition were compared to the classification entered by the original DRSi reporter to identify inconsistencies.[16]

Statistical analysis

An individual was counted once per calendar year during the study period, and the earliest of the test order date (laboratory data), diagnosis date (DMSS), or report date (DRSi) in each year was used to determine when the case occurred. Cases could appear in more than 1 data source. If cases were found in multiple data sources, their records were matched by social security number and approximate date of test, DRSi report, or diagnosis. Duplicate or follow-up cases were removed based on social security number and date. An incidence rule of 365 days was implemented for laboratory data after matching cases by social security number to remove follow-up laboratory tests. Incidence rates were calculated using person-years (p-yrs) in the AC population from the DMSS. Because information on time at risk was not available for non-AC beneficiaries (e.g., the start and end dates of active duty service periods of reserve component members), rates were not calculated for these populations. Agreement between case classification recorded in the DRSi and that obtained from record review was measured by percent agreement and weighted kappa, which allows for partial agreement between the ordinal classification groups. All analyses were conducted using SAS/STAT software, version 9.4 (2014, SAS Institute, Cary, NC).

RESULTS

Installations located in 3 (Missouri, North Carolina, and Oklahoma) of the 5 states that reported the greatest numbers of possible cases to CDC during 2008–2012 included Fort Leonard Wood, MO; Fort Bragg, NC; and Fort Sill, OK. Two installations in Kentucky (Fort Campbell, KY and Fort Knox, KY) were used as proxies for Tennessee. Taken together, these 5 installations accounted for 702 (66.4%) of the total possible cases identified in the study **(Table 1)**. No cases were reported from the DoD in Arkansas. At Fort Leonard Wood, the rates of possible cases in the AC population increased approximately 40-fold from before (12.4 per 100,000 p-yrs) to after (502.5 per 100,000 p-yrs) the change in case definition **(data not shown)**. The increase in rates associated with the definition change was 3,952.4%. At Fort Bragg, rates approximately doubled from before (39.1 per 100,000 p-yrs) to after (78.9 per 100,000 p-yrs) the case definition change **(data not shown)**.

From 1 January 2012–31 December 2018, a total of 1,057 possible cases were captured from either DRSi case reports, DMSS diagnosed cases, the laboratory database, or a combination of the 3 **(Table 2)**. Of the 1,057 possible cases, there were 1,046 unique individuals with just 1 SFR event; 8 people had repeat infections, 2 had DRSi case reports but did not have an identifying social security number, and 1 had more than 1 repeat infection of SFR per year **(data not shown)**. Similar to civilian trends, possible cases most frequently occurred during June–September, with the highest number of possible cases occurring in July (n=176; 16.7%). Of the 1,057 possible cases, 25.5% were between 19–29 years of age and 20.9% were between 30–39 years of age. The greatest number of possible cases occurred in 2017 (n=338), a 255.8% increase from 2016 (n=95). Throughout the study period, the majority of possible cases were among AC service members (n=636; 60.2%) compared to other beneficiary types (n=421; 39.8%). The rate of cases reported to the DRSi among the AC population increased by 381.8% from 2016 through 2017, then increased by 3.0% between 2017 and 2018, for a net increase of 396.4% between 2016 and 2018 **(Figure)**.

Fort Leonard Wood record review

The Preventive Medicine Department at Fort Leonard Wood tracked all cases that tested positive for SFR in 2017 and 2018 **(Table 3)**. Of the 174 cases tracked in these years, 7 were classified as confirmed (1 RMSF and 6 SFR), 108 were probable (11 RMSF and 97 SFR), and 59 were suspected (1 RMSF and 58 SFR). Of the 7 confirmed cases reported to the DRSi after the change in case definition, only 1 experienced a fever ≥100.5°F. A total of 11 cases (6.3%) were hospitalized; those hospitalized were mostly reported as probable (n=9; 81.8%). All antibody titers were performed using IFA assays; other serum antibody tests do not provide quantitative titers. A total of 83 (47.7%) cases had an antibody titer below the threshold of 1:64 for their first test (indicating a negative antibody result), and 58 (33.3%) reported cases had a negative acute antibody test and no convalescent test performed. These cases instead had a positive *R. typhi* or unidentifiable rickettsia antibody IgM or IgG that the healthcare provider determined was clinically compatible. A total of 60 (34.5%) cases had a convalescent sera test performed, of which 7 (11.7%) showed at least a 4-fold increase in antibody titer. The average number of days between acute and convalescent sera was 28 days (median 19 days) **(data not shown)**. Of the 174 reported cases, 136 (78.2%) received antibiotic treatment for SFR. It could not be determined if any antibiotic treatment was prescribed for 38 cases (21.8%). Nearly half (n=84; 48.3%) of cases tracked from 2017–2018 reported recently seeing or removing ticks from their bodies.

AFHSB record review

Record reviews were completed at AFHSB using AHLTA for 62 randomly selected cases from either DRSi or DMSS data with diagnosis dates from 2014–2018. Only 2 of the 51 cases (3.9%) diagnosed at military treatment facilities (MTFs) met the case definition for a confirmed case of SFR, both of which were diagnosed at Fort Leonard Wood **(Table 4)**. Of the 36 possible cases that met the case definition for probable SFR (clinical symptoms plus an initial positive test for IgM or IgG antibody), only 15 had a follow-up test (convalescent) for antibody. Of those 15 with acute and convalescent tests, 13 had subsequent titer results that indicated an old infection rather than a new infection caused by recent exposure to the bacteria **(data not shown)**. Thus, only 2 of the 15 (13.3%) who had paired testing appeared to be recent cases. Most cases (n=49; 79.0%)

TABLE 1. Possible cases of SFR by installation, U.S. Central and Atlantic regions, 2012–2018

Installation	2012	2013	2014	2015	2016	2017	2018	Total	2017's % of 2012–2018 total[a]
Fort Leonard Wood, MO	6	6	10	26	15	155	93	311	49.8
Fort Bragg, NC	30	21	50	22	25	64	57	269	23.8
Fort Hood, TX	0	0	0	2	4	44	11	61	72.1
Fort Campbell, KY	11	11	7	5	11	10	2	57	17.5
Fort Belvoir, VA	12	2	3	5	3	12	16	53	22.6
Fort Knox, KY	11	4	10	12	8	7	1	53	13.2
Fort Rucker, AL	6	3	3	0	8	9	0	29	31.0
Fort Lee, VA	6	2	8	2	1	4	1	24	16.7
Fort Riley, KS	2	4	10	4	2	0	1	23	0.0
JB Myer–Henderson Hall, VA	1	1	3	1	2	7	7	22	31.8
Fort Benning, GA	8	2	1	1	2	3	4	21	14.3
Fort Jackson, SC	4	3	3	4	3	0	2	19	0.0
Fort Carson, CO	7	0	1	1	2	3	4	18	16.7
Fort Leavenworth, KS	5	0	6	2	1	3	1	18	16.7
Fort Bliss, TX	6	0	3	4	2	1	1	17	5.9
Fort Gordon, GA	3	0	1	1	1	2	5	13	15.4
Fort Sill, OK	3	0	4	2	1	2	0	12	16.7
Fort Stewart, GA	1	0	0	1	1	4	0	7	57.1
JB Langley-Eustis, VA	0	0	0	0	2	2	1	5	40.0
JB San Antonio, TX	1	0	1	0	0	0	3	5	0.0
Redstone Arsenal, AL	0	0	1	0	0	3	1	5	60.0
Fort Drum, NY	1	1	0	0	1	0	1	4	0.0
Fort Meade, MD	1	2	0	1	0	0	0	4	0.0
Carlisle Barracks, PA	1	0	0	0	0	1	0	2	50.0
West Point, NY	0	0	0	1	0	1	0	2	50.0
Aberdeen Proving Grounds, MD	0	0	0	0	0	1	0	1	100.0
Fort Irwin, CA	1	0	0	0	0	0	0	1	0.0
Fort Polk, LA	0	0	0	0	0	0	1	1	0.0
Total	127	62	125	97	95	338	213	1,057	32.0

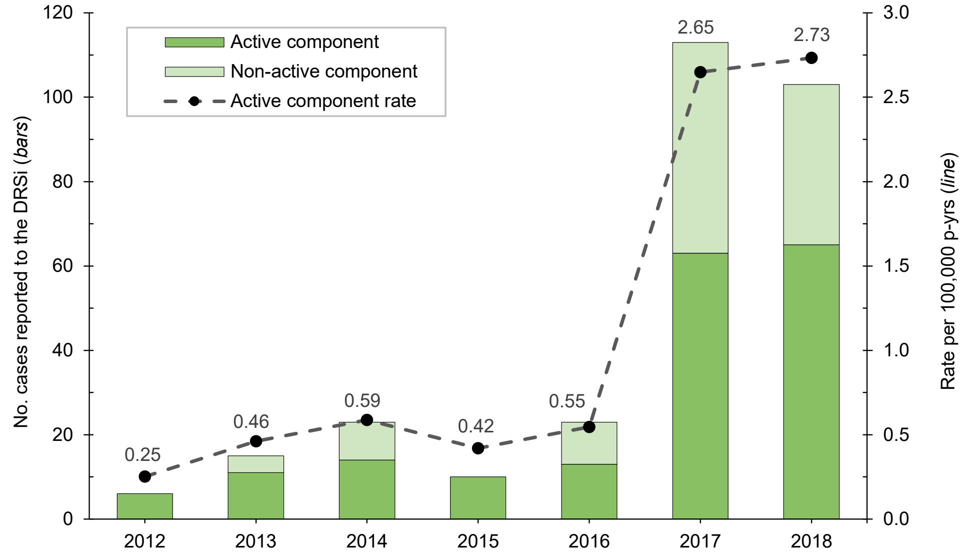
[a]Values in this column represent the percentage of the total number of possible cases during 2012–2018 that were contributed by the cases recorded in 2017, the first year after the change in the surveillance case definition.
SFR, spotted fever rickettsioses; JB, Joint Base.

TABLE 2. Demographic characteristics of possible SFR cases reported, diagnosed, and tested positive at Army medical treatment facilities in the U.S. Central and Atlantic regions and the temporal distribution of those cases during 2012–2018

	No.	% of total
Total	1,057	100.0
Age group (years)		
<19	114	10.8
19–29	270	25.5
30–39	221	20.9
40–49	167	15.8
50–59	159	15.0
60–69	86	8.1
70+	40	3.8
Beneficiary type		
Service member	636	60.2
Spouse	243	23.0
Child	92	8.7
Unknown	86	8.1
Month of case report, diagnosis, or specimen collection		
January	20	1.9
February	31	2.9
March	34	3.2
April	55	5.2
May	117	11.1
June	164	15.5
July	176	16.7
August	152	14.4
September	128	12.1
October	76	7.2
November	55	5.2
December	49	4.6
Year of case report, diagnosis, or specimen collection		
2012	127	12.0
2013	62	5.9
2014	125	11.8
2015	97	9.2
2016	95	9.0
2017	338	32.0
2018	213	20.2

SFR, spotted fever rickettsioses; No., number.

FIGURE. Numbers of incident cases of SFR reported to the DRSi, by beneficiary type, and incidence rates among active component Army members, U.S. Central and Atlantic regions, 2012–2018



SFR, spotted fever rickettsioses; DRSi, Disease Reporting System internet; No., number; p-yrs, person-years.

TABLE 3. Findings from Fort Leonard Wood case review of all possible cases of SFR tracked at the Preventive Medicine Department, 1 January 2017–31 December 2018

	Confirmed	Probable	Suspected	Total
Total[a]	7	108	59	174
RMSF	1	11	1	13
SFR	6	97	58	161
Reported with fever ≥100.5°F	1	6	n/a	7
Hospitalized	1	9	1	11
Laboratory testing				
1st test ≤1:64	5	47	31	83
1st test ≤1:64 and no convalescent test	0	31	27	58
1st test ≥1:64	2	66	30	98
Convalescent test performed	7	38	15	60
Convalescent test with 4-fold increase	6	0	1	7
Treatment				
Doxycycline	6	89	38	133
Other (azithromycin/clindamycin/amoxicillin)	1	2	0	3
Unknown	0	17	21	38
Exposure				
Reported seeing or removing ticks	4	62	18	84

[a]Totals in some sections of this table may not equal 174 because they may have met multiple or no criteria within each category.
SFR, spotted fever rickettsioses; RMSF, Rocky Mountain spotted fever.

were treated presumptively despite lack of evidence of recent infection; empirical treatment of cases that did not show evidence of recent infection did not vary significantly by location. Among the cases treated presumptively, a tick bite alone as the reason for treatment was documented in only 6.1% (n=3) of chart reviewed cases. In cases with any documented symptoms, a tick bite was discussed in 37.3% of cases (n=19).

In general, the recognized reason for testing in the 62 reviewed cases was based on clinical indication of symptoms (n=51; 82.3%), but the clinical symptoms were often inconsistent with those expected from SFR **(Table 5)**. For example, indications included chronic low back pain, chest pain, multiple sclerosis, lupus, paresthesia, and fatigue. Two-thirds of diagnosed cases from Fort Bragg were from non-MTFs for which medical records were not available for review. In contrast, at Fort Leonard Wood almost all cases (n=30; 96.8%) were diagnosed at the MTF. At the other locations considered in this analysis, most SFR cases were diagnosed at MTFs (n=18; 81.8%) **(Table 5)**.

After reviewing the cases' medical records, an assessment of the appropriate case classification status based on the Armed Forces reportable medical event (RME) case definition was determined. Of the 62 records reviewed, 37 had case reports in the DRSi to allow assessment of reliability; the other 25 had either no DRSi record (n=24) or did not report the case classification in the DRSi (n=1) **(Table 6)**. Agreement between the information recorded and classified in the DRSi and the record review of cases was poor, at 59.5% agreement (22 of 37) (weighted kappa=0.23; 95% confidence interval: -0.03–0.49) **(Table 6)**.

EDITORIAL COMMENT

After expanding surveillance requirements in 2017 from only RMSF to the broader SFR group, there was a substantial increase in the numbers of diagnoses and reports of rickettsial diseases at U.S. Army installations in the Central and Atlantic regions **(Figure)**. The largest proportions of these cases were seen at Fort Leonard Wood and Fort Bragg. A smaller increase in incidence was also seen in the civilian population but was part of an increasing national trend that has continued since the mid-1990s.[7] In contrast, this report shows Army incidence increased only in the period from 2017 through 2018, suggesting a substantial surveillance bias effect. While only 4% of cases met the case definition for a confirmed case in the medical record review, this is consistent with the 1–7% of cases that were confirmed nationally in CDC estimates.[2,6] Many patients lacked documented symptoms consistent with the diagnosis of SFR, and only 13.3% of the patients who had paired testing had evidence of acute disease. Additionally, agreement between the DRSi and record reviews was poor (agreement=59.5%; weighted kappa=0.23). These factors suggest a considerable amount of overdiagnosis and related overreporting of cases, and potentially unnecessary treatment.

Recent passive surveillance for SFR cases in the U.S. suggests that the severity of illness in humans has decreased for unknown reasons.[1] Dahlgren and colleagues hypothesized that less pathogenic rickettsiae are causing human infections, while the incidence of disease caused by more pathogenic rickettsiae, such as *R. rickettsii,* has remained relatively stable over the years.[1] Because of limitations in laboratory testing techniques across the U.S. and cross-reactivity of rickettsial species, this hypothesis has not yet been proven.[1–3,11,14,19] In U.S. surveillance, the number of cases reported annually increased from 1,617 in 2010 to 2,275 in 2015, yet the percentage of confirmed cases with supportive laboratory evidence decreased from 1.9% in 2010 to 0.7% in 2015.[2] Delisle and colleagues suggest that species other than *R. rickettsii* may be the most common rickettsial infections in Tennessee.[19] Without more advanced laboratory testing in human cases to evaluate the spread of emerging pathogens in ticks, these hypotheses cannot be validated.

In this review, all laboratory tests performed at MTFs for SFR were IFA and other antibody tests; no records of testing with PCR of blood or eschar specimens were found. The diagnosis of SFR can be confirmed by paired IFA IgG serum specimens separated by 2–4 weeks, but this often does not result in a species-specific diagnosis. Diagnosis through molecular methods (i.e., real-time PCR) can both confirm the diagnosis in 1 sample and also offer species-specific diagnosis, which assists in understanding and controlling rickettsial diseases in military populations and supports force health protection efforts.[2] The Naval Infectious Disease Diagnostic Laboratory (NIDDL) is certified to perform molecular diagnostic testing for rickettsial diseases on blood and eschars. Additionally, since 2018, real-time molecular assays have been made available to qualified

TABLE 4. Characteristics of the possible cases of SFR for which records were reviewed (n=62)

Characteristic	No.	%
Location (n=62)		
Fort Leonard Wood, MO	31	50.0
Fort Bragg, NC	9	14.5
Other	22	35.5
Timing relative to the 2017 change in case definition (n=62)		
Before (1 January 2012–15 July 2017)	24	38.7
After (16 July 2017–31 December 2018)	38	61.3
Report type (n=62)		
DRSi only	35	56.5
DMSS only	24	38.7
Both DRSi and DMSS	3	4.8
Symptoms (n=51)		
Tick bite	19	37.3
Fever	15	29.4
Rash	21	41.2
Headache	15	29.4
Myalgia	24	47.1
Other	32	62.7
Documented reason for testing (n=51)		
Clinical	48	94.1
Tick bite	3	5.9
Treatment (n=62)		
Doxycycline	48	77.4
Other	1	1.6
None recorded	13	21.0
Lab results (n=51)		
No testing documented	2	3.9
Single IgG and/or IgM negative	4	7.8
Single IgG and/or IgM positive	30	58.8
2 IgG positives (without 4-fold rise in titer)	12	23.5
2 IgM positives (without 4-fold rise in titer)	1	2.0
2 IgG positives (with 4-fold rise in titer)	2	3.9
Case classification based on record review (n=51)		
None	6	11.8
Suspected	7	13.7
Probable	36	70.6
Confirmed	2	3.9

SFR, spotted fever rickettsioses; No., number; DRSi, Disease Reporting System internet; DMSS, Defense Medical Surveillance System; IgG, immunoglobulin G; IgM, immunoglobulin M.

TABLE 5. Characteristics of the possible SFR cases for which records were reviewed, by location (n=62)

Characteristic	Fort Bragg (n=9)		Fort Leonard Wood (n=31)		Other (n=22)		p-value
	No.	%	No.	%	No.	%	
Indication for testing							
Clinical	3	33.3	29	93.5	16	72.7	.0004
Tick bite	0	0.0	1	3.2	2	9.1	
No documentation	6	66.7	1	3.2	4	18.2	
Report type[a]							
DRSi	0	0.0	27	87.1	11	50.0	<.0001
DMSS	9	100.0	5	16.1	13	59.1	
Type of facility where diagnosed							
Military	3	33.3	30	96.8	18	81.8	.0002
Non-military	6	66.7	1	3.2	4	18.2	
Case classification based on record review							
None	8	88.9	2	6.5	7	31.8	.0001
Suspect	0	0.0	4	12.9	3	13.6	
Probable	1	11.1	23	74.2	12	54.5	
Confirmed	0	0.0	2	6.5	0	0.0	
Treated							
Yes	7	77.8	23	74.2	19	86.4	.530
No	2	22.2	8	25.8	3	13.6	
Time period (in relation to the 2017 change in case definition)							
Before ("RMSF")	7	77.8	4	12.9	13	59.1	<.0001
After ("SFR")	2	22.2	27	87.1	9	40.9	

[a]Numbers add to >100% because 1 case at Fort Leonard Wood and 2 cases at other installations were reported in both the DRSi and DMSS.
SFR, spotted fever rickettsioses; No., number; DRSi, Disease Reporting System internet; DMSS, Defense Medical Surveillance System; RMSF, Rocky Mountain spotted fever.

TABLE 6. Agreement between case classification for cases of possible SFR between DRSi and medical record review (n=37)

	Medical record review			
DRSi	Confirmed	Probable	Suspected	Total
Confirmed	2	5	1	8
Probable	0	18	2	20
Suspected	0	7	2	9
Total	2	30	5	37

Agreement=59.5%
Weighted kappa=0.23 (95% CI:-0.03–0.49)
SFR, spotted fever rickettsioses; DRSi, Disease Reporting System internet; CI, confidence interval.

state and local laboratories through CDC's Laboratory Response Network.[2] In cases of suspected rickettsiosis, military healthcare providers should consider sending out laboratory specimens to both the NIDDL and their state health department for molecular testing. Use of these improved testing methods would not only improve adherence to CDC recommendations for clinical testing, but it would also enhance force health protection and readiness by improving public health surveillance. Such specific testing results would allow better targeting of prevention and control efforts and a better understanding of the expanding geographic distribution of the diseases carried by ticks.

The main limitation of this study is the difficulty in distinguishing true increases in SFR disease incidence from increases due to misclassification (surveillance) bias. The sudden increase in 2017 coincident with the change in case definition, however, strongly suggests a surveillance bias. IgG antibodies can remain elevated for months or years following exposure and subsequent clinical recovery from illness.[2,11] National studies have estimated antibody seroprevalence in the U.S. population to be between 6%–22%, the latter for persons living in endemic regions.[2] Many of those with positive acute titers may represent antibody persistence rather than recent infection.[3] Since it is not possible to differentiate acute illness from previous infection using a single elevated IgG titer, the inclusion of cases based on single elevated IgG titers overestimates disease incidence. Further, IFA assays are insensitive during the early stages of infection when most patients seek medical attention; therefore, the low proportion of possible cases who are tested with paired samples may lead to underestimates of the risk of infection. Other limitations of this study include the relatively small sample size of charts that were reviewed and the inability to generalize findings to the civilian population or other locations where U.S. military forces are stationed.

The discrepancies seen between diagnostic trends among civilian and military providers at specific installations also suggest the need for better communication of risk between these providers at the installation level. For example, the lack of documentation of SFR diagnoses in AHLTA and the DRSi at Fort Bragg suggests different diagnostic practices between MTFs and non-MTFs, which may indicate a significant gap in disease surveillance. As more installations reduce their medical treatment capabilities, the gaps between military and civilian providers may become more significant across the DoD.[20]

Preventive medicine departments at military installations should position themselves to establish regular communications with civilian health departments and healthcare facilities frequented by military beneficiaries in order to have better awareness of disease burden in their population.

This study suggests the need for additional education of healthcare providers about CDC guidelines for diagnosis and treatment to reduce unnecessary treatment and increase confirmatory testing. CDC guidelines state that treatment is not indicated for an asymptomatic tick bite or an isolated IgG positive lab test, both of which were seen in this study. While CDC guidelines support the use of empiric therapy with doxycycline because of the nonspecific symptoms of rickettsial disease, providers appeared to be giving treatment to many patients whose symptoms are inconsistent with the diagnosis. For example, SFR testing was commonly included in a broad battery of testing in patients with longstanding, chronic illnesses, such as lupus, multiple sclerosis, or low back pain. In these cases, empiric therapy was not provided at time of testing, likely because of the low probability of infection. With that in mind, providers should avoid unnecessary treatment of chronic illnesses inconsistent with SFR infection while also continuing to follow CDC guidelines to initiate immediate treatment in patients with acute signs and symptoms that are consistent with SFR infection without waiting for laboratory confirmation.[5] Despite the findings of potential case misclassification and overdiagnosis and treatment, this report endorses the continued need for robust prevention, detection, and response capabilities at all installations in risk areas. These measures include ensuring leaders are aware of the need to adhere to the DoD repellent system, to practice tick avoidance, and to promote awareness of the high-risk season and high-risk areas for tick exposure. Medical and public health assets should communicate the risk of SFR, its mitigation, and prevention to commanders, service members, and other beneficiaries. Practices that reduce tick bites can also reduce the risk of other arthropod-borne diseases as well as nuisance bites and other conditions that detract from daily readiness.

Future studies could evaluate the knowledge and implementation of tick-borne disease prevention practices in service members as well as the knowledge, skills, and behaviors of military providers regarding vector-borne disease indications, best testing practices, and proper treatment protocols. Simultaneously, public health assets must ensure that surveillance data are valid, complete, and communicated in a timely manner in order to allow for public health action and force health protection in their population. All SFR cases must be reported to both military and state/local health departments to ensure that requirements are met and that proper control measures are in place. Finally, agreement between the DRSi and record review classification of cases was poor and suggests an area for improvement by more thorough review and analysis of case reports.

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