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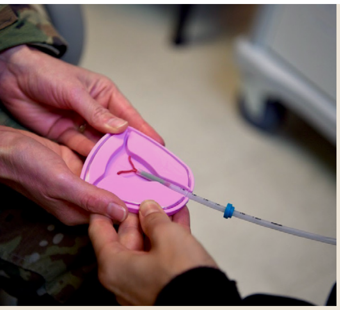

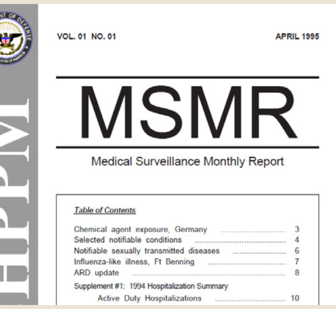
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Long-Acting Reversible Contraceptive Use, Active Component Service Women, U.S. Armed Forces, 2016–2020

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Long-acting reversible contraceptives (LARCs) are highly effective means of birth control that can improve service women's overall health and readiness. This report expands upon prior data and summarizes the annual prevalence (overall and by demographics) of LARC use from 2016 through 2020 among active component U.S. service women, compares LARC prevalence to the prevalence of short-acting reversible contraceptives (SARCs), and evaluates the probability of continued use of LARCs by type. LARC use increased from 21.9% to 23.9% from 2016 through 2019 while SARC use decreased from 28.3% to 24.9%. Both SARC and LARC use decreased in 2020 which may have been related to the coronavirus disease 2019 (COVID-19) pandemic. The prevalence of intrauterine devices (IUDs) was greater than implants, and IUDs also had a higher probability of continuation than implants. At 12 months, the continuation for IUDs was 81% compared to 73% for implants. At 24 months, the probabilities of continuation were 70% for IUDs and 54% for implants. Probabilities of continuation were similar across outsourced care and direct care settings. The increased use of LARCs along with their high frequency of continuation in U.S. service women may have a positive impact on overall health and readiness.

WHAT ARE THE NEW FINDINGS?

LARC use continued to increase among service women through 2019. Use decreased in 2020 possibly due to the COVID-19 pandemic. Differences in prevalence and continuation by demographics highlight important areas for further research and provider awareness.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

LARCs are highly effective and long-acting birth control that can improve service women's overall health and readiness. LARCs are available in a variety of clinics both on and off base.

Women need access to safe and effective forms of contraception for family planning, treatment of menstrual disorders, and if desired, for menstrual suppression. These needs hold true for women in the military as well, whether it be for career planning, deployments, or due to unique job demands. A recent study found that female officers reported the desire for menstrual suppression during training.[1] In response to concerns from the Assistant Secretary of Defense for Health Affairs regarding the health care and readiness of female service members, the Defense Health Board (DHB) released a report in November 2020 recommending improved contraceptive education and services, particularly access to long-acting reversible contraceptives (LARCs).[2] This recommendation stemmed from studies reporting that service women have an unintended pregnancy rate 50% higher than civilians and studies demonstrating lower unintended pregnancy rates among women with access to LARCs.[2]

LARCs are well established as the most effective form of reversible contraception with a typical use failure rate of <1% compared to 4–7% for short-acting reversible contraceptives (SARCs).[3] The rate of unintended pregnancies in the U.S. has decreased by 18% since LARC use became more common in the early 2000s.[4] LARCs have become more commonly used largely because no ongoing effort is required of the patient, and once the device is removed, fertility rapidly returns. LARCs are considered safe and have few contraindications. Aside from providing effective contraception, some LARCs effectively manage menstrual irregularities and can be used for menstrual suppression. The 2 types of LARCs available in the U.S. are the intrauterine device (IUD) and the implant. These devices can stay in place for 3–10 years depending on the product. However, some women experience side effects such as irregular bleeding that lead them to have the devices removed.

U.S. service women have universal access to health care, including contraceptive counseling and services, at no personal cost. In 2017, Stahlman et al. evaluated the use of contraceptives in service women from 2012 through 2016.[5] This study found that more than three-quarters (76.2%) of active component U.S. service women of childbearing potential used either a LARC or SARC.[5] During the study period, LARC use increased from 17.2% to 21.7% while SARC and sterilization use decreased.[5] LARC use was most common among service women 25–29 years old, American Indian/Alaska Native women, Hispanic women, senior enlisted personnel, those in health care occupations, and those with "other/unknown" marital status.[5] A study on LARC use in all military beneficiaries found that 74.6% of women who initiated LARCs selected IUDs.[6] Women were more likely to continue IUDs than implants, although overall continuation of LARCs was high. LARC discontinuation was more common in women aged 20–24, those using an implant, and those initiating LARCs in military clinics (versus outsourced care).[6]

Despite the advantages of LARCs, their use remains relatively low. The goal of this study was to assess the current status of LARC use in U.S. service women and expand upon the findings of previous studies of this population. The first objective was to determine the annual prevalence of LARC compared to SARC use in active component women from 2016–2020 and evaluate differences in LARC use by demographic groups. The second objective was to evaluate whether discontinuation of LARCs inserted from 2016 through 2019 differed by LARC type and other covariates present at the time of insertion.

TABLE 1. ICD-9/ICD-10 diagnosis, procedure, and CPT codes for LARC insertion, continued use, and removal

	ICD-9		ICD-10		CPT
	Diagnosis	Procedure	Diagnosis	Procedure	
IUD insertion	V25.11, V25.13	69.7	Z30.014, Z30.430, Z30.433	0UH97HZ, 0UH98HZ, 0UHC7HZ, 0UHC8HZ	58300
IUD removal	V25.12	---	Z30.432	---	58301
Implant insertion	V25.5	---	Z30.017	---	11975, 11981, 11983, 11977
Implant removal	---	---	---	---	11976, 11982

ICD, International Classification of Diseases; CPT, current procedural terminology; LARC, long-acting reversible contraceptive; IUD, intrauterine device.

METHODS

This study used a retrospective cohort design. The surveillance period was 1 January 2016 through 31 December 2020. The study population consisted of all active component service women aged 17 or older who served in the Army, Navy, Air Force, or Marine Corps at least 1 day during the surveillance period.

All data used for analyses were derived from the Defense Medical Surveillance System (DMSS) which includes data for all active duty service members.[7] The prevalence of LARC and SARC coverage by calendar year was estimated using methods similar to those of a prior *MSMR* report.[5] Service members were identified as using LARCs or SARCs using the following criteria: 1) receipt of a prescription for contraception (per American Hospital Formulary Service Pharmacologic-Therapeutic Class: 681200 or 683200); 2) or International Classification of Diseases, 9th and 10th Revision, Clinical Modification (ICD-9/10-CM) procedure **(Table 1)**, diagnosis, or Current Procedural Terminology (CPT) code for insertion documented in a record of an inpatient or outpatient medical encounter. LARCs included IUDs and implants, whereas SARCs included oral contraceptives, patches, vaginal rings, and injectables.

Women were considered to be covered by a LARC in a given calendar year if they had a filled prescription for 1 of the contraceptives listed in **Table 2** and/or an ICD code for insertion without removal code for a LARC. A removal with reinsertion code or a same day removal and insertion was considered to be the insertion of a new LARC. Periods of contraceptive coverage were created based on the FDA-approved coverage period for a given contraceptive type during the surveillance period. IUDs were assigned a default 5-year coverage period; however, Skyla IUDs were assigned a 3-year coverage period and ParaGard IUDs were assigned a 10-year coverage period. Implants were assigned a default 3-year coverage period except for both Norplant® and Jadelle implants, which were assigned a 5-year coverage period. Coverage ended on the date that the implant or IUD was removed, based on documentation of a removal in ICD diagnostic, procedural, or CPT codes, or at the end of the coverage period. For SARCs, service members who had a filled prescription at any point during the calendar year were considered covered for that year.

Women were counted in the denominator as long as they were in the active component at least 1 day during the calendar year. Women were only counted as being covered by a LARC or SARC during a calendar year if they were also in the denominator for that calendar year. If a woman had both IUD and implant coverage for a given year, the IUD was prioritized over the implant. In addition, if they had both a LARC and a SARC, the LARC was prioritized.[5] Time-dependent variables, such as age and military rank, were determined at the end of each calendar year. A service member was considered deployed if she had at least 1 deployment of 30 days or greater length during that calendar year.

TABLE 2. Brand names of study LARCs

IUDs	Implants
Mirena	Nexplanon
Kyleena	Norplant
Liletta	Jadelle
Skyla	
Paragard	

LARC, long-acting reversible contraceptive; IUD, intrauterine device.

Descriptive statistics were used to characterize the overall proportion of women utilizing LARCs and SARCs, and the proportion by age group, race/ethnicity group, military rank, service branch, military occupation, educational level, and whether or not they had a deployment during the surveillance period. Data were stratified by calendar year. Poisson regression with robust error variance was used to calculate adjusted prevalence ratios for LARC use compared to no LARC use for calendar year 2020. The model included age group, race/ethnicity group, military rank, service branch, marital status, education level, military occupation, and whether or not women were deployed in 2020. The reference groups were those aged 17–19, non-Hispanic White women, single women, those with a high school education or less, Army members, junior enlisted women, those in communications career fields, and those with no deployment.

For the second objective, a time-to-event analysis was performed to assess probability of continuation for LARCs among women who had a LARC inserted between 2016 and 2019. Women who had a LARC inserted in 2020 were excluded to ensure that all women in the analysis had at least 1 year of follow-up time. This analysis only included women with a first-ever insertion encounter during that time period. Service women were followed for up to 3 years after LARC insertion until either removal of the LARC or loss to follow-up. Loss to follow-up was defined as leaving military service or the end of the surveillance period, 31 December 2020, whichever came first. Time to event analyses were stratified by age group, race/ethnicity group, rank, service, military occupation, marital status, education level, and insertion site.

RESULTS

There were on average 243,025 women who served in the active component of either the Army, Navy, Air Force, or Marine Corps in a given calendar year between 2016 and 2020 **(Table 3)**. In 2016, 50,365 (21.9%) of these women used LARCs with use increasing to 59,942 (23.9%) in 2019 before dropping to 59,193 (23.2%) in 2020 with an average annual prevalence of 23.0%. LARC use trended up through 2019 in almost all demographic categories. During this same time period, SARC use trended down from 65,121 (28.3%) in 2016 to 58,379 (22.9%) in 2020 **(Figure 1)**. Overall combined LARC or SARC use trended down from 50.2% in 2016 to 46.1% in 2020.

Overall, LARC users were most likely to be aged 20–34, senior enlisted, and "other" marital status **(Table 3)**. There was a notable increase (4.3%) in LARC use over time by women 40 years or older. Prevalence was highest among non-Hispanic White, Hispanic, and American Indian/Alaska Native service women. Use increased in Asian/Pacific Islander service women over the course of the study period, but remained relatively constant in non-Hispanic Black service women. Unlike other race/ethnicity groups, and all other demographic groups, non-Hispanic Black service women's LARC use was relatively stable over the surveillance period **(Figure 2)**. Use of LARCs was more prevalent among members of the Navy and Marine Corps followed by the Air Force and Army. By 2020, LARC use was most prevalent among service women in pilot/air crew occupations followed by those in repair/engineering occupations. Women with a high school education had slightly higher prevalence of LARC use compared to women with a college education. In addition, women with a deployment during the calendar year had a slightly higher prevalence of LARC use.

Use of IUDs was more prevalent than implants with an average overall prevalence of 13.8% for IUDs compared to 9.2% for implants **(Table 4)**. Both IUD and implant use increased slightly until 2019 before dropping in 2020 **(Figure 1)**. IUD use was more prevalent in women in their 30s, officers, those with a college education, and women in the Air Force and Navy **(Table 4)**. Implant use was more prevalent in younger, single marital status, junior enlisted, and Hispanic service women. Implants were also most prevalent in the Marine Corps followed by the Navy as well as the armor/motor transport and repair/engineering career fields. The adjusted findings from the multivariable model demonstrated similar patterns as the unadjusted prevalence analysis with some findings reaching statistical significance **(Table 5)**.

Survival analyses showed that service women had a higher probability of continuing IUD use compared to implants **(Figure 3)**. At 12 months, the continuation for IUDs was 81% compared to 73% for implants. At 24 months, the probability of continuation was 68% for IUDs and 54% for implants. Continuation dropped to 59% for IUDs and 42% for implants at 36 months, at which point most implants need to be removed or replaced. Women over 35 and women who were single had the highest continuation for both types of LARCs, compared to their respective counterparts at the 36-month point **(Table 6)**. Asian/Pacific Islander, Native American/Alaska Native women, and other women had higher implant continuation while Native American/Alaska Native, Asian/Pacific Islander, non-Hispanic White, and other women had higher IUD continuation. Notably, non-Hispanic Black women had the lowest LARC prevalence as well as the lowest continuation rates. In contrast, Hispanic women had high LARC utilization but low continuation compared to other race/ethnicity groups. Service women in the Navy had much higher continuation of implants and IUDs compared to those in the other services. Pilot/air crew had the highest continuation of both IUDs and implants, compared to those in other occupations. Combat-specific occupations also had high rates of continuation for IUDs. For implants, women working in health care and communications/intelligence had the lowest continuation. Finally, LARC continuation was higher in those with a college education and also for officers and warrant officers versus enlisted members.

Similar probabilities of continuation were observed for LARCs inserted in outsourced care and direct care settings **(Table 6)**. For both IUDs and implants inserted in a military treatment facility (MTF) (direct care), continuation was longer for LARCs inserted in primary care clinics versus obstetrics/gynecology (OB/GYN) clinics. For IUDs, continuation was similar among MTF type; however, implant continuation was longer if inserted at a clinic or medical center compared to a hospital. Continuation was similar for both types of LARCs whether or not they were inserted at teaching facilities.

EDITORIAL COMMENT

This report summarizes the prevalence of LARC use and continuation for active component service women between 2016 and 2020 and expands upon the findings of previous studies. LARC use overall and among almost all demographic groups

TABLE 3. Annual prevalence of LARC use, by demographic and military characteristics, female service members, active component, U.S. Armed Forces, 2016–2020

	2016			2017			2018		
	No.	Total	%	No.	Total	%	No.	Total	%
Total	50,365	230,293	21.9	53,551	236,523	22.6	56,157	242,923	23.1
Age group (years)									
17–19	3,138	24,206	13.0	3,765	26,839	14.0	4,261	28,871	14.8
20–24	18,707	77,115	24.3	19,748	78,997	25.0	20,927	81,867	25.6
25–29	13,573	54,591	24.9	14,220	55,677	25.5	14,655	56,871	25.8
30–34	8,168	34,050	24.0	8,373	34,025	24.6	8,500	34,006	25.0
35–39	4,455	21,928	20.3	4,951	22,816	21.7	5,161	23,530	21.9
40–44	1,686	11,029	15.3	1,787	10,850	16.5	1,907	10,716	17.8
45+	638	7,374	8.7	707	7,319	9.7	746	7,062	10.6
Race/ethnicity group									
Non-Hispanic White	22,646	100,405	22.6	24,237	102,378	23.7	25,396	104,130	24.4
Non-Hispanic Black	11,578	59,397	19.5	11,848	59,933	19.8	11,869	60,490	19.6
Hispanic	9,323	38,594	24.2	10,228	41,458	24.7	11,249	44,704	25.2
Asian/Pacific Islander	1,819	9,955	18.3	2,046	10,524	19.4	2,253	10,899	20.7
American Indian/Alaska Native	642	2,577	24.9	630	2,516	25.0	623	2,477	25.2
Other/unknown	4,357	19,365	22.5	4,562	19,714	23.1	4,767	20,223	23.6
Marital status									
Married	24,747	105,160	23.5	25,968	107,299	24.2	26,644	108,866	24.5
Single, never married	20,559	105,969	19.4	21,014	105,333	20.0	22,683	109,813	20.7
Other/unknown	5,059	19,164	26.4	6,569	23,891	27.5	6,830	24,244	28.2
Education level									
High school or less	29,855	130,562	22.9	31,399	134,971	23.3	32,870	139,111	23.6
College/other	20,510	99,731	20.6	22,152	101,552	21.8	23,287	103,812	22.4
Service									
Army	14,570	79,163	18.4	14,975	79,705	18.8	15,256	80,711	18.9
Navy	17,711	67,273	26.3	19,205	69,704	27.6	20,131	72,062	27.9
Air Force	13,583	66,585	20.4	14,655	69,028	21.2	15,620	71,443	21.9
Marine Corps	4,501	17,272	26.1	4,716	18,086	26.1	5,150	18,707	27.5
Rank/grade									
Junior enlisted (E1–E4)	22,280	108,250	20.6	23,130	110,784	20.9	23,758	112,529	21.1
Senior enlisted (E5–E9)	19,941	79,629	25.0	21,299	82,604	25.8	22,470	86,123	26.1
Junior officer (O1–O3)	5,490	27,204	20.2	6,146	27,593	22.3	6,583	28,238	23.3
Senior officer (O4–O10)	2,284	13,434	17.0	2,591	13,772	18.8	2,931	14,250	20.6
Warrant officer (W1–W5)	370	1,776	20.8	385	1,770	21.8	415	1,783	23.3
Military occupation									
Combat-specific[a]	1,023	5,123	20.0	1,240	5,831	21.3	1,386	6,327	21.9
Armor/motor transport	1,617	7,263	22.3	1,740	7,699	22.6	1,788	7,895	22.6
Pilot/air crew	776	3,194	24.3	884	3,244	27.3	1,004	3,384	29.7
Repair/engineering	11,647	48,044	24.2	12,069	48,150	25.1	12,509	48,545	25.8
Communications/intelligence	16,180	73,926	21.9	16,505	73,609	22.4	17,235	76,280	22.6
Health care	10,749	43,089	24.9	11,476	43,675	26.3	12,131	44,622	27.2
Other/unknown	8,373	49,654	16.9	9,637	54,315	17.7	10,104	55,870	18.1
Deployed during calendar year									
Yes	1,967	8,563	23.0	2,809	11,292	24.9	3,176	12,479	25.5
No	48,398	221,730	21.8	50,742	225,231	22.5	52,981	230,444	23.0

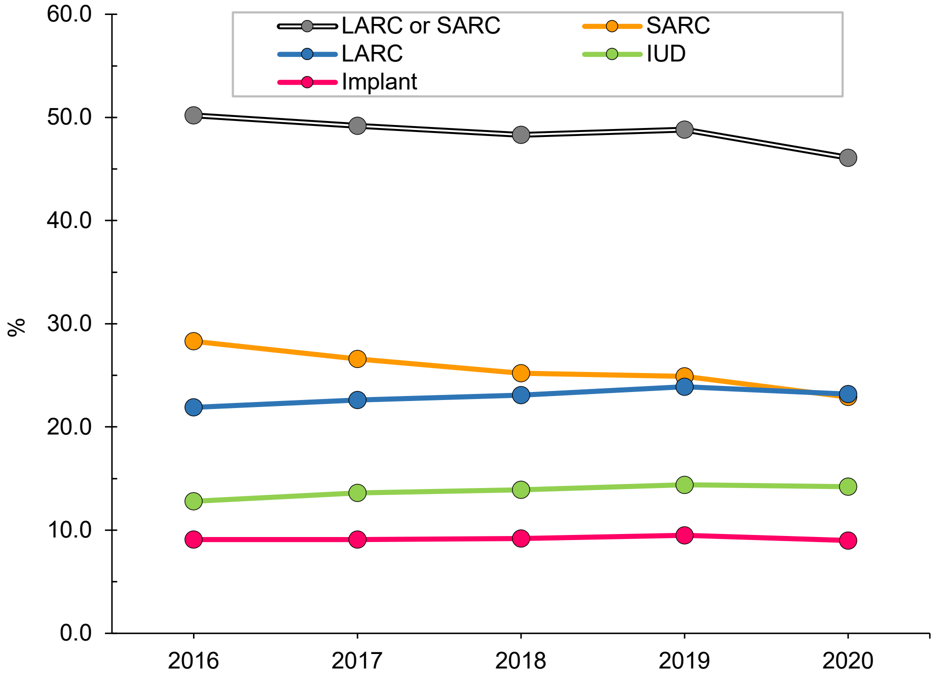
[a]Infantry/artillery/combat engineering.
LARC, long-acting reversible contraceptive.

TABLE 3. (continued) Annual prevalence of LARC use, by demographic and military characteristics, female service members, active component, U.S. Armed Forces, 2016–2020

	2019			2020			Overall average (2016-2020)		
	No.	Total	%	No.	Total	%	No.	Total	%
Total	59,942	250,560	23.9	59,193	254,824	23.2	55,842	243,025	23.0
Age group (years)									
17–19	5,084	29,852	17.0	4,173	27,959	14.9	4,084	27,545	14.8
20–24	22,386	84,644	26.4	22,273	86,886	25.6	20,808	81,902	25.4
25–29	15,486	58,984	26.3	15,404	60,043	25.7	14,668	57,233	25.6
30–34	8,650	34,819	24.8	8,788	36,413	24.1	8,496	34,663	24.5
35–39	5,503	24,414	22.5	5,536	25,162	22.0	5,121	23,570	21.7
40–44	2,085	10,923	19.1	2,237	11,418	19.6	1,940	10,987	17.7
45+	748	6,924	10.8	782	6,943	11.3	724	7,124	10.2
Race/ethnicity group									
Non-Hispanic White	27,073	106,120	25.5	26,993	107,151	25.2	25,269	104,037	24.3
Non-Hispanic Black	12,119	61,729	19.6	11,547	62,401	18.5	11,792	60,790	19.4
Hispanic	12,641	48,096	26.3	12,655	50,533	25.0	11,219	44,677	25.1
Asian/Pacific Islander	2,448	11,646	21.0	2,443	12,086	20.2	2,202	11,022	20.0
American Indian/Alaska Native	619	2,458	25.2	625	2,454	25.5	628	2,496	25.2
Other/unknown	5,042	20,511	24.6	4,930	20,199	24.4	4,732	20,002	23.7
Marital status									
Married	27,674	111,434	24.8	27,230	112,950	24.1	26,453	109,142	24.2
Single, never married	25,213	114,321	22.1	24,956	116,730	21.4	22,885	110,433	20.7
Other/unknown	7,055	24,805	28.4	7,007	25,144	27.9	6,504	23,450	27.7
Education level									
High school or less	35,475	144,488	24.6	34,443	146,408	23.5	32,808	139,108	23.6
College/other	24,467	106,072	23.1	24,750	108,416	22.8	23,033	103,917	22.2
Service									
Army	15,824	82,655	19.1	15,911	83,843	19.0	15,307	81,215	18.8
Navy	21,586	74,089	29.1	20,657	76,586	27.0	19,858	71,943	27.6
Air Force	16,563	74,440	22.3	16,742	75,326	22.2	15,433	71,364	21.6
Marine Corps	5,969	19,376	30.8	5,883	19,069	30.9	5,244	18,502	28.3
Rank/grade									
Junior enlisted (E1–E4)	25,755	116,210	22.2	24,598	116,763	21.1	23,904	112,907	21.2
Senior enlisted (E5–E9)	23,445	88,529	26.5	23,451	91,004	25.8	22,121	85,578	25.8
Junior officer (O1–O3)	7,095	29,172	24.3	7,294	29,801	24.5	6,522	28,402	23.0
Senior officer (O4–O10)	3,204	14,824	21.6	3,402	15,363	22.1	2,882	14,329	20.1
Warrant officer (W1–W5)	443	1,825	24.3	448	1,893	23.7	412	1,809	22.8
Military occupation									
Combat-specific[a]	1,689	7,543	22.4	1,808	7,957	22.7	1,429	6,556	21.8
Armor/motor transport	1,888	8,079	23.4	1,773	8,324	21.3	1,761	7,852	22.4
Pilot/air crew	1,109	3,586	30.9	1,214	3,818	31.8	997	3,445	29.0
Repair/engineering	13,165	49,391	26.7	13,039	51,106	25.5	12,486	49,047	25.5
Communications/intelligence	18,416	78,959	23.3	18,261	80,484	22.7	17,319	76,652	22.6
Health care	12,761	45,739	27.9	12,765	46,113	27.7	11,976	44,648	26.8
Other/unknown	10,914	57,263	19.1	10,333	57,022	18.1	9,872	54,825	18.0
Deployed during calendar year									
Yes	2,961	11,412	25.9	1,740	6,648	26.2	2,531	10,079	25.1
No	56,981	239,148	23.8	57,453	248,176	23.2	53,311	232,946	22.9

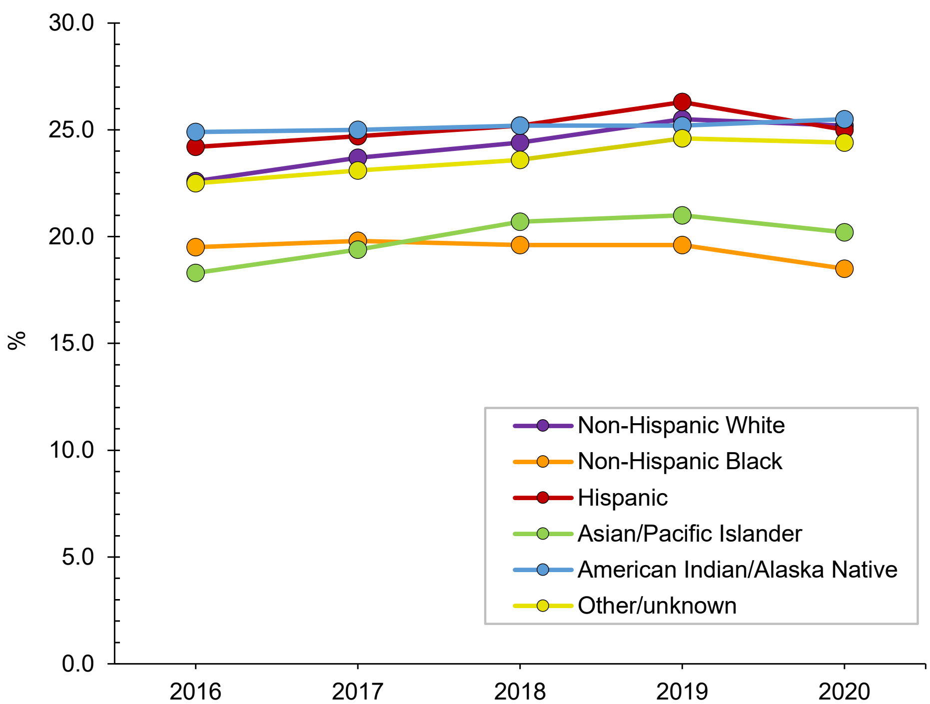
[a]Infantry/artillery/combat engineering.
LARC, long-acting reversible contraceptive.

FIGURE 1. Annual prevalence of LARC, SARC, IUD, and implant use, female service members, active component, U.S. Armed Forces, 2016–2020



SARC, short-acting reversible contraceptive; LARC, long-acting reversible contraceptive; IUD, intrauterine device.

FIGURE 2. Annual prevalence of LARC use, by race/ethnicity group, female service members, active component, U.S. Armed Forces, 2016–2020



LARC, long-acting reversible contraceptive.

increased through 2019 but decreased in 2020. This decline may have been due to the coronavirus disease 2019 (COVID-19) pandemic, as women may have avoided coming in for appointments during this time. Additionally, there were limitations on appointments and types of procedures being performed during the pandemic. SARC use decreased as LARC use increased during the study period; however, it is unclear whether the increase in LARC use fully accounted for the decrease in SARC use as combined contraceptive use declined over this time period.

This study also found that LARC use during the surveillance period was more prevalent in service women than U.S. civilian women, with an average annual prevalence of 23.0% compared to 10.4%, respectively.[8] One explanation for this difference could be the universal and free access to health care in the military, which could make service women more likely to take advantage of these services. Age patterns of women using LARCs were similar for service women and civilian women, although use differed by education level, with LARC use being more prevalent among civilian women with a higher education level compared to those with a high school education.[8] However, service women with higher education levels did have a higher prevalence of LARC use compared to civilian women of a similar education level. This difference could be because the majority of service women are enlisted which does not require a college degree. Civilian studies showed no difference by race/ethnicity group in LARC use; however, both this study and a similar study in military populations did show differences.[5,8,9] The cause for this divergence is unclear. Institutional or personal biases could limit the contraceptive options offered to these women.[10,11] These patient populations may also not be choosing LARCs for some reason, such as distrust of the health care system.[10,11]

Among active component service women, LARC use was more prevalent in the Navy and Marine Corps with those in the Navy also having high continuation. This finding may be a result of the Navy actively working to increase awareness and access to contraception.[12] Certain career fields seem to prefer the use of LARCs, and

TABLE 4. Average annual prevalence of IUD and implant use, by demographic and military characteristics, female service members, active component, U.S. Armed Forces, 2016–2020

	%	
	IUD	Implant
Total	13.8	9.2
Age group (years)		
17–19	4.3	10.4
20–24	11.4	13.9
25–29	16.4	9.2
30–34	19.1	5.5
35–39	18.8	2.9
40–44	16.1	1.5
45+	9.6	0.6
Race/ethnicity group		
Non-Hispanic White	15.8	8.5
Non-Hispanic Black	11.0	8.4
Hispanic	13.2	11.8
Asian/Pacific Islander	10.6	9.3
American Indian/Alaska Native	15.4	9.7
Other/unknown	14.5	9.2
Marital status		
Married	16.3	7.9
Single, never married	10.0	10.7
Other/unknown	19.6	8.0
Education level		
High school or less	11.5	12.1
College/other	16.8	5.3
Service		
Army	11.4	7.5
Navy	15.6	12.0
Air Force	14.7	6.9
Marine Corps	13.3	15.0
Rank/grade		
Junior enlisted (E1–E4)	9.0	12.2
Senior enlisted (E5–E9)	17.8	8.0
Junior officer (O1–O3)	17.8	5.1
Senior officer (O4–O10)	18.7	1.4
Warrant officer (W1–W5)	18.6	4.2
Military occupation		
Combat-specific[a]	12.5	9.2
Armor/motor transport	10.3	12.2
Pilot/air crew	22.6	6.2
Repair/engineering	13.5	11.9
Communications/ intelligence	13.6	8.9
Health care	19.0	7.8
Other/unknown	10.0	8.0
Deployed for all or part of calendar year		
Yes	15.3	9.7
No	13.7	9.2

[a]Infantry/artillery/combat engineering.
IUD, intrauterine device.

TABLE 5. Adjusted prevalence ratios for LARC use, by demographic and military characteristics, female service members, active component, U.S. Armed Forces, 2020

	APR	95% CI
Age group (years)		
17–19	ref	--
20–24	1.51	(1.46–1.56)
25–29	1.35	(1.31–1.40)
30–34	1.19	(1.14–1.24)
35–39	1.04	(0.99–1.09)
40–44	0.90	(0.85–0.95)
45+	0.49	(0.45–0.53)
Race/ethnicity group		
Non-Hispanic White	ref	--
Non-Hispanic Black	0.79	(0.77–0.80)
Hispanic	0.99	(0.98–1.01)
Asian/Pacific Islander	0.80	(0.77–0.83)
American Indian/ Alaska Native	0.92	(0.86–0.98)
Other/unknown	0.92	(0.90–0.95)
Marital status		
Married	1.09	(1.07–1.11)
Single, never married	ref	--
Other/unknown	1.32	(1.29–1.35)
Education level		
High school or less	ref	--
College/other	0.95	(0.93–0.97)
Service		
Army	ref	--
Navy	1.38	(1.35–1.40)
Air Force	1.12	(1.10–1.15)
Marine Corps	1.63	(1.59–1.67)
Rank/grade		
Junior enlisted (E1–E4)	ref	--
Senior enlisted (E5–E9)	1.27	(1.25–1.30)
Junior officer (O1–O3)	1.19	(1.16–1.23)
Senior officer (O4–O10)	1.48	(1.42–1.54)
Warrant officer (W1–W5)	1.76	(1.61–1.91)
Military occupation		
Combat-specific[a]	1.01	(0.97–1.06)
Armor/motor transport	0.91	(0.87–0.95)
Pilot/air crew	1.22	(1.16–1.29)
Repair/engineering	1.03	(1.01–1.05)
Communications/ intelligence	ref	--
Health care	1.30	(1.27–1.32)
Other/unknown	0.82	(0.80–0.84)
Deployed during calendar year		
Yes	1.12	(1.07–1.17)
No	ref	--

[a]Infantry/artillery/combat engineering.
LARC, long-acting reversible contraceptive; APR, adjusted prevalence ratio.

in particular, LARC use was high in pilots and air crew, as well as in health care personnel. Pilot/air crews deploy frequently and spend long hours in aircraft that may not afford them access to convenient restrooms. Additionally, women in these fields may be grounded for part or all of their pregnancies. Therefore, they have an incentive to use highly effective contraception and for menstrual suppression. Health care workers may be more knowledgeable regarding their options for medical care because of the nature of their jobs.

Continuation among active component service women in this study was overall lower than what has been seen in the U.S. population,[13] and slightly lower than that seen in prior studies of military health system (MHS) populations.[5,6] However, it should be noted that all of these studies were conducted differently so direct comparisons are challenging. This study did not exclude women who removed their LARC due to desire for pregnancy. This study also included only active component service members and not all MHS beneficiaries. Continuation was higher for IUDs versus implants and this may be due to the side effect profiles, although this study did not assess reason for discontinuation. Other studies also showed higher continuation for IUDs compared to implants.[5,6,13] Continuation was lower in younger women and those with lower education level, which has also been noted in other studies in both the U.S. and the MHS.[6,13] Lower continuation could be due to providers not explaining efficacy and side effects at a level appropriate to the patient's health literacy.

Both the current study and a U.S. study showed racial differences in continuation.[13] A prior study of all female MHS beneficiaries showed higher continuation in outsourced care, but that was not the case for this study.[6] This study also found minimal differences in continuation among LARCs inserted at military treatment facilities (MTF) of different sizes, teaching facilities, and clinics. These findings suggest that women have access to LARCs at facilities of all sizes with both primary care and OB/GYN providers, and in both outsourced and direct care.

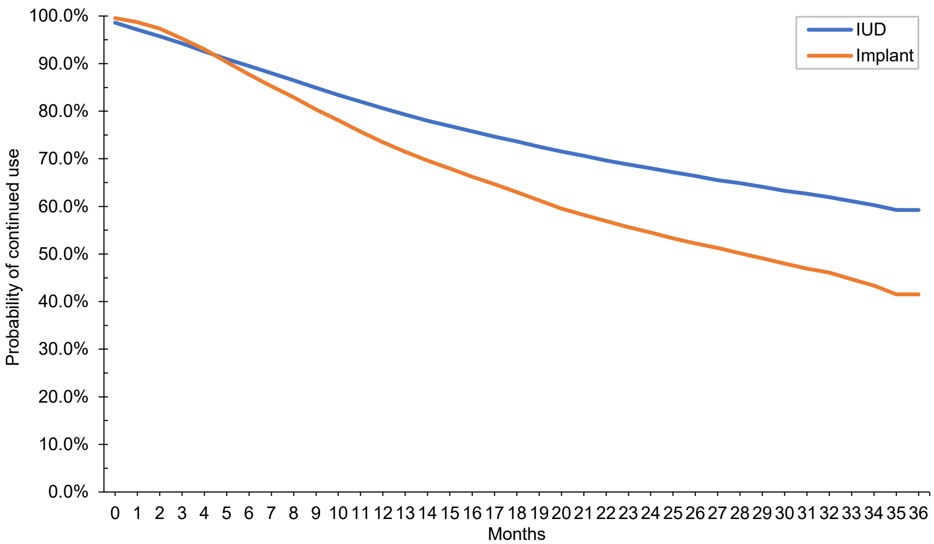
This study had several limitations. Retrospective data were used to estimate

TABLE 6. Kaplan-Meier estimates of LARC continuation over 36 months among female service members who initiated LARC use during 2016–2019, active component, U.S. Armed Forces

	12 months				24 Months				36 Months			
	IUD		Implant		IUD		Implant		IUD		Implant	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Age group (years)												
17–19	80.2	(78.7–81.5)	75.5	(74.5–76.4)	67.6	(65.8–69.3)	56.2	(55.0–57.4)	57.2	(55.0–59.3)	43.2	(41.8–44.6)
20–24	78.6	(77.7–79.3)	72.3	(71.5–73.1)	65.2	(64.1–66.2)	53.6	(52.6–54.6)	55.9	(54.7–57.1)	40.1	(38.9–41.3)
25–29	82.2	(81.1–83.1)	72.4	(70.8–73.9)	69.1	(67.8–70.4)	53.7	(51.8–55.5)	60.2	(58.6–61.7)	41.8	(39.7–43.9)
30–34	82.7	(81.2–84.1)	73.0	(70.1–75.7)	70.5	(68.6–72.3)	51.1	(47.7–54.5)	62.4	(60.2–64.5)	40.8	(37.1–44.5)
35–39	84.2	(82.2–86.0)	79.0	(73.9–83.2)	74.5	(72.0–76.9)	60.3	(54.0–66.0)	69.5	(66.6–72.2)	45.6	(38.2–52.7)
40–44	83.3	(79.8–86.2)	81.1	(69.1–88.8)	76.8	(72.7–80.4)	66.7	(51.4–78.1)	72.8	(68.1–77.0)	54.1	(3.06–69.1)
45+	86.6	(81.0–91.0)	67.5	(29.1–88.2)	84.5	(78.1–89.2)	50.6	(14.0–79.0)	82.5	(74.7–88.1)	50.6	(14.0–79.0)
Race/ethnicity group												
Non-Hispanic White	83.4	(80.7–85.8)	79.3	(76.8–81.6)	71.0	(67.6–74.2)	64.5	(61.3–67.4)	63.7	(59.7–67.4)	51.6	(47.9–55.2)
Non-Hispanic Black	78.7	(77.4–79.9)	73.7	(72.5–74.8)	66.2	(64.7–67.7)	53.9	(52.5–55.3)	55.8	(53.9–57.7)	39.8	(38.1–41.4)
Hispanic	87.8	(82.9–91.4)	74.0	(67.2–79.5)	73.8	(66.9–79.4)	61.8	(54.0–68.6)	63.9	(55.2–71.4)	51.3	(42.2–59.7)
Asian/Pacific Islander	76.3	(75.0–77.6)	70.2	(68.9–71.4)	62.7	(61.1–64.3)	51.1	(49.5–52.5)	54.6	(52.8–56.4)	40.2	(38.5–41.8)
American Indian/Alaska Native	82.2	(81.5–82.9)	73.9	(73.0–74.8)	70.0	(69.0–70.8)	54.6	(53.4–55.7)	61.4	(60.3–62.4)	41.0	(39.8–42.3)
Other/unknown	82.0	(80.3–83.7)	76.3	(74.2–78.2)	69.1	(66.9–71.3)	58.5	(56.1–60.9)	60.8	(58.1–63.4)	45.8	(43.0–48.6)
Marital status												
Married	78.8	(77.9–79.6)	69.1	(67.9–70.4)	65.2	(64.1–66.2)	49.2	(47.7–50.1)	56.6	(55.4–57.8)	36.4	(34.7–38.0)
Single, never married	79.5	(77.4–81.4)	68.7	(65.3–71.9)	67.4	(64.8–69.9)	46.6	(42.4–50.3)	58.4	(55.3–61.4)	35.4	(31.2–39.7)
Other/unknown	82.1	(81.4–82.7)	75.1	(74.4–75.7)	70.1	(69.3–71.0)	56.5	(55.7–57.3)	61.3	(60.2–62.3)	43.4	(42.4–44.3)
Education level												
High school or less	84.5	(83.8–85.3)	76.0	(74.5–77.3)	73.6	(72.6–74.6)	58.5	(56.8–60.1)	65.6	(64.4–66.8)	45.7	(43.7–47.6)
College/other	78.1	(77.4–78.8)	73.0	(72.4–73.6)	64.4	(63.5–65.2)	53.7	(52.9–54.5)	55.0	(54.0–56.0)	40.1	(39.8–41.5)
Service												
Army	80.8	(79.8–81.7)	70.6	(69.2–71.8)	67.4	(66.2–68.5)	50.6	(49.1–52.0)	58.3	(56.9–59.7)	36.3	(34.6–37.9)
Navy	79.0	(78.0–78.4)	67.8	(66.7–69.0)	66.5	(65.2–67.8)	48.3	(47.0–49.6)	57.6	(56.1–59.1)	35.5	(33.9–37.0)
Air Force	77.6	(75.7–79.4)	72.7	(71.1–74.2)	63.8	(61.4–66.1)	50.4	(48.4–52.3)	55.0	(52.1–57.8)	37.1	(34.7–39.5)
Marine Corps	82.5	(81.6–83.3)	79.8	(79.0–80.1)	70.7	(69.7–71.8)	62.8	(61.7–63.9)	62.3	(61.0–63.6)	50.2	(48.9–51.5)
Rank/grade												
Junior enlisted (E1–E4)	77.6	(76.9–78.3)	73.1	(72.4–73.7)	63.9	(63.0–64.7)	53.7	(53.0–54.5)	54.3	(53.3–55.4)	40.7	(39.8–41.6)
Senior enlisted (E5–E9)	87.5	(86.5–88.5)	79.9	(77.8–81.9)	77.3	(75.9–78.6)	64.3	(61.6–66.9)	69.3	(67.6–70.9)	49.9	(46.7–53.1)
Junior officer (O1–O3)	81.6	(80.5–82.7)	73.0	(71.1–74.8)	69.3	(67.8–70.7)	54.2	(51.9–56.3)	60.8	(59.1–62.4)	42.9	(40.4–45.3)
Senior officer (O4–O10)	86.2	(83.6–88.3)	73.0	(62.2–81.1)	77.5	(74.3–80.3)	54.9	(43.1–65.2)	73.0	(69.3- 76.3)	34.0	(21.4–47)
Warrant officer (W1–W5)	86.9	(77.1–92.7)	70.4	(53.7–81.9)	76.4	(64.0–85.0)	65.3	(48.6–77.8)	60.9	(46.3–72.6)	47.6	(28.7–64.4)
Military occupation												
Combat-specific[a]	83.7	(80.5–86.5)	71.6	(67.8–75.1)	71.2	(67.0–75.0)	54.7	(50.0–59.2)	65.3	(60.4–69.7)	42.1	(36.6–47.6)
Armor/motor transport	78.9	(77.9–80.0)	70.4	(69.1–71.6)	66.4	(65.0–67.6)	51.0	(49.6–52.5)	57.3	(55.8–58.8)	37.2	(35.6–38.9)
Pilot/air crew	80.8	(79.7–81.9)	68.1	(66.4–69.8)	68.5	(67.1–69.9)	48.3	(46.3–50.2)	60.3	(58.6–61.9)	35.6	(33.4–37.8)
Repair/engineering	79.4	(76.6–81.8)	77.6	(75.3–79.7)	65.9	(62.5–69.1)	58.6	(55.7–61.3)	57.7	(53.7–61.4)	46.9	(43.7–50.0)
Communications/ intelligence	81.7	(80.7–82.7)	76.0	(75.1–76.9)	69.0	(67.7–70.2)	56.6	(55.5–57.8)	59.3	(57.8–60.8)	43.6	(42.2–44.9)
Health care	88.5	(85.2–91.1)	79.5	(70.7–85.9)	79.9	(75.7–83.5)	63.3	(53.1–72.0)	68.0	(62.3–73.0)	41.0	(29.2–52.4)
Other/unknown	80.2	(79.0–81.4)	74.7	(73.4–76.0)	67.1	(65.6–68.6)	57.2	(55.5–58.7)	59.2	(57.4–61.0)	44.8	(42.9–46.6)
Teaching Facility												
No	80.9	(80.2–81.5)	74.0	(73.4–74.7)	67.8	(67.0–68.6)	54.9	(54.2–55.7)	58.9	(57.9–59.8)	42.0	(41.1–42.9)
Yes	80.2	(79.3–81.0)	71.5	(70.2–72.7)	68.4	(67.3–69.5)	52.8	(51.2–54.3)	59.9	(58.6–61.1)	39.8	(38.0–41.6)
MTF type												
Clinic	81.5	(80.7–82.2)	75.0	(74.3–75.7)	68.6	(67.7–69.6)	56.0	(55.2–56.9)	59.6	(58.5–60.7)	42.9	(41.9–43.8)
Hospital	79.8	(78.7–80.8)	68.7	(67.2–70.1)	66.6	(65.2–67.9)	49.2	(47.5–50.9)	58.2	(56.5–59.8)	37.0	(35.1–38.9)
Medical Center	79.7	(78.6–80.7)	72.2	(70.7–73.4)	68.0	(66.7–69.3)	53.5	(51.7–55.3)	59.4	(57.9–60.9)	40.6	(38.4–42.7)
Source												
Direct care	80.6	(80.1–81.1)	73.4	(72.9–74.0)	68.0	(67.3–68.7)	54.4	(53.8–55.2)	59.2	(58.4–60.0)	41.5	(40.7–42.3)
Outsourced	80.2	(77.8–82.3)	76.8	(72.0–81.0)	67.8	(64.9–70.6)	55.1	(48.8–60.9)	59.2	(55.6–62.5)	44.2	(36.9–51.2)
Clinic type												
OB/GYN	80.0	(79.4–80.7)	71.9	(71.0–72.8)	67.1	(66.3–68.0)	53.0	(51.9–54.1)	58.5	(57.7–59.5)	39.4	(38.1–40.7)
Primary care	81.7	(80.8–82.5)	74.7	(73.9–75.4)	69.5	(68.4–70.6)	55.7	(54.7–56.6)	60.4	(59.1–61.7)	43.0	(41.9–44.0)

[a]Infantry/artillery/combat engineering.
LARC, long-acting reversible contraceptive; IUD, intrauterine device; CI, confidence interval; MTF, military treatment facility; OB/GYN, obstetrics/gynecology.

FIGURE 3. Probability of continuation for IUD and implants inserted in female service members, active component, U.S. Armed Forces, 2016–2020



IUD, intrauterine device.

coverage periods and assumptions about how long a LARC remained inserted could have resulted in incorrect coverage periods. Because this study utilized administrative health care data, there was the potential for misclassification of LARC coverage or discontinuation due to inaccurate coding. The type of IUD or implant (e.g., Paragard, Nexplanon) could only be distinguished using pharmacy records, which were sometimes missing. In addition, the reason for LARC removal could not be determined (e.g., desiring pregnancy compared to discomfort or dissatisfaction with the LARC).

Overall, this study found that LARC use in active component U.S. service women is increasing with relatively high continuation especially for IUDs. U.S. service women have higher utilization of LARCs than their civilian counterparts. However, this study highlights the need to continue to promote LARC use in U.S. service women which includes ensuring proper education on efficacy and side effects as well as increased awareness about where LARCs can be obtained. The Air Force Medical Service (AFMS) needs to ensure there are adequate numbers of providers at all facilities to counsel patients about contraception and place LARCs. Future studies could evaluate patient comfort with male providers as well as LARC use and prevalence stratified by gender of provider as well as clinic model (e.g., a traditional clinic versus a walk-in model).

Further evaluation should be undertaken to investigate trends such as the high prevalence of use in the Navy, racial/ethnic differences seen in the military but not the U.S. population, reasons as to why certain career fields favor LARCs, and reasons for discontinuation. The findings of this study can be utilized to individualize care for certain patient populations such as by age or occupation. Minimal difference in continuation was noted by insertion site which means that women have access to LARCs in a variety of medical facilities and in both primary care and OB/GYN clinics. These findings highlight the role of primary care clinics in providing LARC services. Ensuring such clinics are fully staffed is vital for women's health care. Finally, even in a global pandemic, access to effective birth control remains important and should be considered when determining essential medical services.

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Oral Cavity and Pharynx Cancers, Active Component, U.S. Armed Forces, 2007–2019

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The purpose of this study was to determine the incidence of oral cavity and pharynx (OCP) cancer among service members in the active component military (i.e., Army, Air Force, Navy, and Marine Corps) from 2007 through 2019, and to provide an overview of the rates and trends throughout this period. There were 443 cases of oral cavity and pharynx cancer in the active component during those 13 years. The overall male incidence rate (2.7 per 100,000 service members) was greater than the female incidence rate (1.3 per 100,000 service members). Service members 40 years or older had the highest overall incidence rate (11.3 per 100,000 service members) which was 3.4 times the next highest rate (3.3 per 100,000 service members) observed among those aged 35–39. The Army had the greatest number of cases (n=201) followed by the Air Force (n=103), Navy (n=102), and Marine Corps (n=37). The Army had the highest overall 13-year incidence rate (3.0 per 100,000 service members) when compared to the Air Force (2.4 per 100,000 service members), Navy (2.4 per 100,000 service members), and Marine Corps (1.5 per 100,000 service members). By anatomical location, cancer of the parotid gland accounted for the highest percentage of cases (16.3%).

WHAT ARE THE NEW FINDINGS?

There were 443 cases of OCP cancer among active component service members from 2007 through 2019. Rates increased with advancing age. The Army had the greatest number of cases (n=201), as well as the highest 13-year incidence rate (3.0 per 100,000 service members); the Marine Corps had the lowest incidence rate (1.5 per 100,000 service members). The most common site of OCP cancer was the parotid gland (n=72).

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

OCP cancer often progresses with little to no pain or symptoms in the beginning, and is not discovered until it has metastasized to another location. These cancers may be accompanied by severe esthetic and debilitating functional complications, as well as a poor prognosis, thereby threatening service member readiness.

Oral cavity and pharynx (OCP) cancers are known collectively as head and neck cancers[1–4] and represent 2.9% of all new cancer cases in the U.S.[2] Among the estimated 53,260 new cases of OCP cancer in the U.S. in 2020, roughly half will survive 5 years.[1,2] Men are twice as likely as women to be diagnosed with OCP cancer,[1,2] and it is most common among those aged 55 to 64.[1,2,4] OCP cancer is not very common compared to other forms of cancer; however, the OCP-related death rate is particularly high because it is usually not discovered until late in its development.[1,2]

Almost all OCP cancers begin in the thin, flat squamous cells of the mouth.[1–3] The oral cavity includes the lip, floor of the mouth, salivary glands, and other sites such as the palate, buccal mucosa, alveolar ridges, anterior two-thirds of the tongue, and retromolar trigone (the area behind the last mandibular molars).[1–3] The pharynx includes the nasopharynx, oropharynx, and hypopharynx.[1–3] Surveillance reports tend to present data on cancers of the salivary gland, nasopharynx, and hypopharynx separately from those of the other sites listed previously because they are etiologically and biologically distinct and may present with different prognoses and treatment options.[1–4] In order to provide a broad overview of OCP cancer in the active component service member population, cancer of any site anatomically located in the oral cavity or pharynx was included in this report.

OCP cancer is an extremely troubling form of cancer because it can be overlooked easily in its early stages.[1,5] It often progresses with little to no pain or symptoms in the beginning and is not discovered until it has metastasized to another location, usually the lymph nodes of the neck.[1,5] In addition, head and neck cancers have a high risk of producing a second primary tumor, usually in the lungs, esophagus, neck, or head.[1]

The most common risk factors for OCP cancer include a history of combustible or smokeless tobacco product use, heavy alcohol consumption, and infection with human papillomavirus (HPV).[1,6,7] HPV is the most common sexually transmitted infection in the U.S. and can spread through direct sexual contact to genital areas as well as the mouth and throat;[7] virtually all sexually active men and women will be infected with at least 1 type of HPV during their lifetimes.[8] It is estimated that HPV causes 70% of oropharyngeal cancers in the U.S.[7]

Examples of signs and symptoms of OCP cancer in its earlier stages include sudden tooth mobility, pain, unusual oral bleeding, persistent red and/or white patches inside the mouth, non-healing oral ulcers, and unusual intraoral surface changes.[9,10] In the later stages of OCP cancer, a patient might experience airway obstruction, paresthesia (tingling, prickling, or burning sensation), altered vision, hardened areas, numbness, persistent pain, swollen lymph nodes in the neck, or referred pain.[9,10]

The stage of OCP cancer at diagnosis refers to the extent of the disease, which is associated with the 5-year survival rate.[2] OCP cancer is characterized by 3 stages, localized, regional, and distant.[2] If the stage is determined to be regional or distant, the cancer has spread to another location of the body.[2] Localized OCP cancer has the highest 5-year survival rate of 85.1%, regional 66.8%, and distant 40.1%.[2]

The approach to treatment of OCP cancer is usually a combination of surgery, radiation, and chemotherapy, which will vary from patient to patient.[11,12] When OCP cancer is not detected until a later stage, treatment may result in severe complications which can impact both function and esthetics. Some complications include infection, pain, bleeding, and muscle damage, as well as difficulty speaking, breathing, and swallowing.[1,2,9] Any disease capable of causing such impairment has the potential to threaten military readiness and should be monitored. The purpose of this report is to determine the incidence of OCP cancer among active component service members from 2007 through 2019 and to provide an overview of the rates and trends of these cancers throughout the study period.

METHODS

The U.S. Army Public Health Center (APHC) Public Health Review Board approved this study. It was assigned project #18-676 under the Disease Epidemiology Program Umbrella Plan. The data presented were obtained from the Armed Forces Health Surveillance Division, which manages the Defense Medical Surveillance System (DMSS). The DMSS is the central repository of medical surveillance data for the U.S. Armed Forces. It contains current and historical data on diseases and medical events, as well as longitudinal data on personnel and deployments.

This investigation obtained and analyzed data on active component service members of the Army, Navy, Air Force, and Marine Corps for the years 2007 through 2019. Diagnoses were classified using the International Classification of Diseases, 9th and 10th Revisions (ICD-9 and ICD-10) **(Table 1)**. For surveillance purposes, a case of OCP cancer was defined as: 1) one hospitalization with any of the defining diagnoses of OCP cancer in the primary diagnostic position; or 2) one hospitalization with a Z- or V-code indicating a radiotherapy, chemotherapy, or immunotherapy treatment procedure in the primary diagnostic position; and any of the defining diagnoses of OCP cancer in the secondary diagnostic position; or 3) three or more outpatient medical encounters, occurring within a 90-day period, with any of the defining diagnoses of OCP cancer in the primary or secondary diagnostic position. The incidence date was the date of the first qualifying hospitalization or outpatient medical encounter that included a diagnosis of OCP cancer. An individual was considered an incident case only once per lifetime. Additional variables employed in the analysis included year of diagnosis, age at diagnosis, rank, military service, and sex. Annual incidence rates were calculated for each service by dividing the number of OCP cancer cases by the number of active component service members reported in the Defense Medical Epidemiology Database (DMED) for that particular service and year.

RESULTS

There were 443 cases of OCP cancer among active component service members from 2007 through 2019, for a crude overall incidence rate of 2.5 per 100,000 service members **(Table 2)**. Overall, the number of OCP cancer cases (n=408) and the incidence rate (2.7 per 100,000 service members) among male service members exceeded that among female service members (n=35 and 1.3 per 100,000 service members, respectively). Male service members accounted for 92.1% of all cases during the study period and, as of 2019, 83.2% of the active component. The largest proportion of all cases (46.7%) occurred among active component service members 40 years or older; in 2019, this age group made up only 9.5% of the active component. Service members 40 years or older had the highest 13-year rate of incident OCP cancer (11.3 per 100,000 service members) which was 3.4 times the next highest rate (3.3 per 100,000 service members) observed among service members 35–39 years of age. The greatest number of cases was in the Army (n=201) followed by the Air Force (n=103), Navy (n=102), and the Marine Corps (n=37). The Army constitutes the greatest proportion of the active component (35.8% in 2019), and made up an even greater proportion of all cases (45.3%) during the 13-year study period. Similarly, the Marine Corps constitutes the smallest proportion of the active component (14.2% in 2019), and made up the smallest proportion of all cases (8.4%). The Army had the highest overall 13-year incidence rate of OCP cancer (3.0 per 100,000 service members), followed by the Air Force (2.4 per 100,000 service members), the Navy (2.4 per

TABLE 1. ICD-9 and ICD-10 diagnostic codes used to identify cases of OCP cancer

ICD-9	ICD-10	Site
140.*	C00.*	Malignant neoplasm of lip
141.*	C01, C02.*	Malignant neoplasm of tongue
142.*	C07, C08.*	Malignant neoplasm of major salivary glands
143.*	C03.*	Malignant neoplasm of gum
144.*	C04.*	Malignant neoplasm of floor of mouth
145.*	C05.*, C06.*	Malignant neoplasm of palate,other and unspecified parts of mouth
146.*	C09.*, C10.*	Malignant neoplasm of tonsil, oropharynx
147.*	C11.*	Malignant neoplasm of nasopharynx
148.*	C12, C13.*	Malignant neoplasm of hypopharynx
149.*	C14.*	Malignant neoplasm of other and ill-defined sites within the lip oral cavity and pharynx

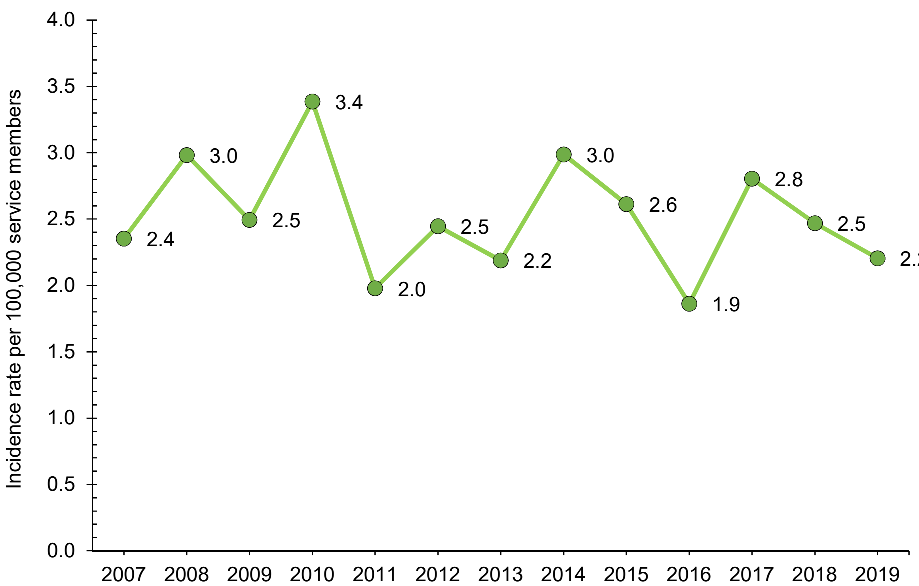
An asterisk (*) indicates that any subsequent digit/character is included.

TABLE 2. Counts, rates, percentage of all OCP cancer cases, and percentage of active component by category, active component, U.S. Armed Forces, 2007–2019

	No.	Rate[a]	% of total cases 2007–2019	% of active component 2019
Total	443	2.5	100.0	---
Sex				
Male	408	2.7	92.1	83.2
Female	35	1.3	7.9	16.8
Age group				
<20	4	0.3	0.9	7.9
20–24	56	1.0	12.6	32.2
25–29	56	1.3	12.6	23.1
30–34	53	2.0	12.0	15.7
35–39	67	3.3	15.1	11.7
40+	207	11.3	46.7	9.5
Service				
Army	201	3.0	45.3	35.8
Navy	102	2.4	23.0	25.2
Air Force	103	2.4	23.3	24.8
Marine Corps	37	1.5	8.4	14.2

[a]Incidence rate per 100,000 service members.
No., number; OCP, oral cavity and pharynx.

FIGURE 1. Annual OCP cancer incidence rates, active component, U.S. Armed Forces, 2007–2019



OCP, oral cavity and pharynx.

100,000 service members), and the Marine Corps (1.5 per 100,000 service members) **(Table 2)**.

During 2007 through 2019, crude annual rates of incident OCP cancer fluctuated between 1.9 per 100,000 service members and 3.4 per 100,000 service members **(Figure 1)**. Small case counts precluded the examination of trends over time by sex.

The majority of all cases (60.5%) occurred in the following 6 sites: parotid gland, oropharynx (unspecified), tongue (unspecified), tonsil, base of tongue, and nasopharynx (unspecified). The greatest number of cases (n=72; 16.3%) occurred in the parotid gland **(Figure 2)**.

EDITORIAL COMMENT

This study used surveillance data to estimate the incidence of OCP cancer in the active component military from 2007 through 2019. Previously, this group of cancers had not been investigated by the APHC.

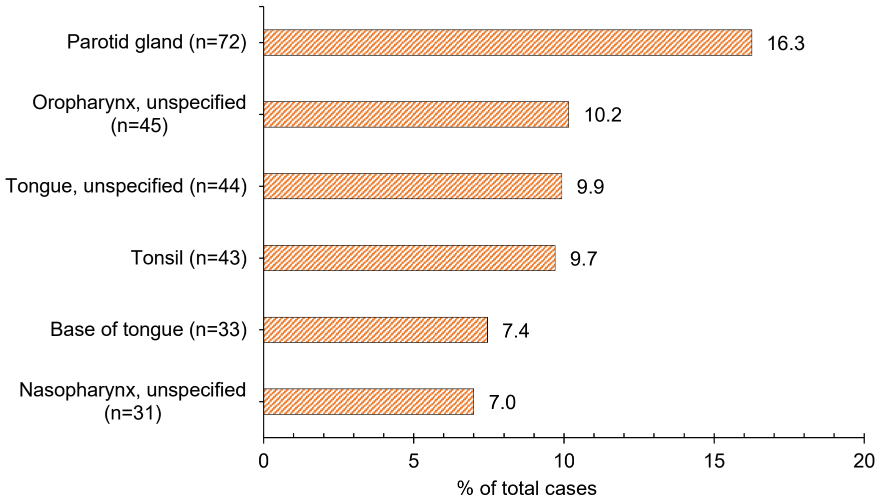
Men in the U.S. general population are known to be at a greater risk of developing OCP cancer than women; the same pattern was apparent for the active component. The vast majority of the OCP cancer cases (92.1%) were among male service members and the rate of incident OCP cancer among male service members was twice that of female service members.

In the U.S. general population, OCP cancer is most frequently diagnosed among those aged 55 to 64.[2] Service members 40 years or older made up the smallest proportion of the active component (9.5% in 2019), yet out of the 6 age groups observed in this study, this category contained the greatest proportion of cases (46.7%) and the highest incidence rates per 100,000 service members.

Given the size distribution of the services, the distribution of cases among them throughout the study period was as expected. The greatest proportion of cases was among Army members (45.3%); the smallest proportion of cases was among Marine Corps members (8.4%).

Incidence rates per 100,000 service members were calculated for each service by year to compare risk between the services. Although these populations differ by size, they share similarities in sex distribution, diet, physical fitness, access to health care, etc. Nevertheless, there still seems to be an OCP cancer disparity between the services. The Army had the highest overall 13-year incidence rate which was 2.1 times that of the Marine Corps, 1.3 times the Navy rate, and 1.2 times the Air Force incidence rate. This finding may be explained by the differing age distributions of the services. Active component service members 40 years or older constituted the greatest

FIGURE 2. Top 6 most frequent sites of OCP cancer, by percentage of total cases, active component, U.S. Armed Forces, 2007–2019



OCP, oral cavity and pharynx.

proportion of cases (46.7%) and their risk of diagnosis was more than 3.4 times that of any other age group. The percentage of Army service members in the 40 years or older age group (9.1%) exceeded that of the Navy (8.6%), Air Force (7.4%), and Marine Corps (3.9%) **(data not shown).**

The higher incidence of OCP cancer among Army members may also be due to dissimilar contributing risk factors across the services (e.g., tobacco use, alcohol use, HPV infection). However, according to the 2015 Department of Defense Health Related Behaviors Survey (HRBS), use of all types of tobacco products was more common among Marine Corps service members than among members of any other service; such use was least common among members of the Air Force.[13] Incidence rates of OCP in the Marine Corps may be higher if service members remained in service comparatively as long as the Army (and therefore, were older in age).

The primary limitation of this study was the use of de-identified data. Names, social security numbers, etc. did not accompany the case list provided by AFHSD. Therefore, linking individual risk factors available in alternate databases was not possible. Another limitation was the small number of cases of OCP cancers. Rates based on such small case counts are unstable, which precluded the examination of trends over time by service or sex. Additionally, when compared to other health conditions among active component service members, OCP cancer accounts for an extremely small percentage of the overall disease burden.

Although this study did examine demographic risk factors of OCP cancer, it did not examine those lifestyle factors that are well known (i.e., tobacco use, alcohol abuse, and HPV infection). Because these risk factors are modifiable, behavior changes may play a significant role in decreasing risk. Dental providers, as well as service members themselves, contribute considerably to the prevention and detection of OCP cancer. Yearly dental examinations provide dentists with an opportunity to assess service members' risk of OCP cancer. However, given the importance of early detection, it is highly recommended that service members conduct their own monthly self-screenings—a process of examining one's own mouth for any signs of oral cancer.

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Disclaimer: The views expressed in this publication are those of the authors and do not necessarily reflect the official policy or position of the Department of Defense, Department of the Army, or the U.S. Government.

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The Evolution of Military Health Surveillance Reporting: A Historical Review

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Introduction

The Centers for Disease Control and Prevention (CDC) defines Public Health Surveillance as "the ongoing, systematic collection, analysis, and interpretation of health data, essential to the planning, implementation, and evaluation of public health practice, closely integrated with the dissemination of these data to those who need to know and linked to prevention and control."[1] Department of Defense (DoD) Directive 6490.02 defines comprehensive military health surveillance as "Health surveillance conducted throughout Service members' military careers and DoD civilian employees' employment, across all duty locations, and encompassing risk, intervention, and outcome data."[2] While military health surveillance largely mirrors civilian practices, there are 2 main differentiating characteristics of military health surveillance. First, the military applies surveillance towards force health protection (FHP) and medical readiness to ensure a healthy and effective fighting force. The focus on the ability to work imparts military health surveillance with an occupational medicine component not seen in general civilian public health surveillance efforts. Second, surveillance occupies a central role in communicating health threats to military commanders to ensure both the health of the command and mission capability. Also, under military law the commander has intervention authorities not available in the civilian world. Other challenges differentiate military health surveillance from its civilian counterpart: its dynamic population, with continuous changes in membership; the mobility and geographic dispersion of the force; unique exposures possible during military service; and the public and political dimensions which can complicate the assessment of the effects of interventions.[3]

When the Defense Health Agency (DHA) was established, it had a mandate to consolidate the public health surveillance activities among the military services,[4] which prompted a review of these capabilities. That review generated a report stressing the importance of surveillance to "enhance DoD's operational capabilities" and ensure a "ready, healthy, and fit" force to support Combatant Command objectives.[5] This report also identified key weaknesses in surveillance at that time, including inaccessibility of data, fragmentation of processes and systems, poorly standardized and inconsistent practices, and lack of accuracy and relevance for current military operations.

To identify successes and failures that may inform how to best meet future needs, this historical review critically examines how Military Health Surveillance reporting systems have evolved over time. While the understanding of diseases, diseases of military importance, surveillance methods, and persons responsible for surveillance have changed over time, it is surveillance reporting as a tool to maintain operational readiness that has determined its impact and thus its importance in military activities.

Historical Origins of Military Public Health Surveillance (1662–1861)

Modern public health surveillance is often traced to the works of John Graunt in the 17th century, when he wrote the *Observations on the Bills of Mortality* of the city of London.[6] Scholars remain divided on whether the *Bills of Mortality* were designed to keep track of the ability to field the militia in the face of public unrest, or to help monitor the need for public support of hospitals after the Reformation-based changes in church support of hospital charity. The data collected served both functions at different times, so the 2 areas of surveillance may have a common origin.

In the 1760s, the discipline of Military Medicine, in the sense of medical advice to ensure a healthy and mission-capable fighting force, began to establish itself in England. John Pringle's *Observations on the Diseases of the Army* and James Lind's *An Essay on the Most Effectual Means of Preserving the Health of Seamen in the Royal Navy* described the importance of monitoring the health of soldiers and sailors.[7,8] Pringle counseled that "Tracing the more evident causes of military distempers, in order that whatever depended upon officers in command, and was consistent with the service, might be clearly stated, so as to suggest measures, either for preventing, or for lessening such causes in any future war."[7]

In the U.S., the military also began to collect health surveillance data for the purpose of preventive intervention before the civilian community. Prominent military physicians including Surgeon General (SG) James Tilton and Dr. James Mann recognized the importance of surveillance during the War of 1812 in order to control "camp diseases."[9,10] These diseases fell into several categories including 1) childhood diseases such as smallpox and measles; 2) diseases of poor sanitation such as dysentery, diarrhea, and typhus; 3) geographic diseases such as malaria and yellow fever; 4) "inflammatory fevers" such as influenza and pneumonia; and 5) diseases associated with "Army life" such as trauma, sexually transmitted infections, and alcoholism.[11] Dr. Mann recognized that these preventable sources of disease were "frequent causes of the failure of important expeditions, and ruin of armies; by which, the highest expectations of a nation are disappointed."[10]

Under SG Tilton, medical officers were first directed in 1814 to "make quarterly reports…of the sick and wounded… and report to the commanding officer every circumstance tending to restore or preserve the health of the soldiers."[12] The problem he encountered was that these sick reports were only transmitted at the local level from the medical officer to the commander, and frequently, neither made any attempt to investigate the causes of illness or prevent their further occurrence. Furthermore, reporting was not standardized. Many surgeons provided little or no information, while others offered detailed data and narrative accounts of the impact of diseases on their forces. Finally, the imprecisely defined nature of the conditions, and the use of counts rather than rates, frequently impaired meaningful interpretation or public health use. There were several reasons for this imprecision, the most important of which was likely that the traditional purpose of reporting was to determine the number of trained soldiers ready to fight. Another important issue was that the understanding of the relationships between the multiple proximal and distal causes of most diseases were often not clear or not amenable to modification in military life. These problems persisted, even when the War Department issued regulations in December 1814, which directed medical officers to keep records of this comprehensive system of monthly and quarterly reports, including "the appearance of epidemicks."[13] Because of these problems, the corresponding impact of surveillance on military readiness was relegated to the local level at which surveillance was conducted.[14]

As detailed in a recent book by Colonel (Ret.) Steve Craig, the power of health surveillance as a guide for disease prevention was not realized until 1818, when the Army appointed Joseph Lovell as the first permanent SG and established the Army Medical Department.[15] Before his appointment, SG Lovell's 1817 report to the Commanding Officer of the Northern Division on the causes of disease in the Army stressed that "every surgeon… should consolidate the quarterly reports; and make such remarks and suggest such improvements both in practice and police, as may appear to be required for the benefit and comfort of the sick…And finally from his own observations, and from the reports and accompanying remarks of the surgeons, to form a manual of medical police and practice suited to the circumstances of the soldier; and to make such reports to the commanding general..."[16]

Upon his appointment as Surgeon General in 1818, SG Lovell instituted immediate changes through the Regulations of the Medical Department. These regulations required a standardized format that the surgeons (i.e., any physician) "make quarterly reports of sick to the Surgeon General, and morning reports to the commanding officer, in the form and manner directed for the surgeons of the army," in order to "discover as far as practicable the probable causes of disease, and recommend the best means of preventing them."[17] The SG would further "receive such reports and returns from [the surgeons]," which, in turn, would enable him to communicate to the Secretary of War "such remarks relative to improvements in practice and police… as may seem to be required for the preservation of health." These regulations sought to ensure that health data were communicated to the SG rather than just to the command, and to create a "medical police" to enforce the prevention of disease. "Police" during this period meant policy and procedure rather than personnel, but it was still an effort to improve health conditions in a systematic way.

In the first of the SG's reports, SG Lovell concluded that the Commanders who followed his rules for medical police had regiments that are "worth at least three of those whose soldiers [did not follow these rules]…"[18] The most important diseases in these early reports again emphasized the "camp diseases" of military importance, as seen in the first tabular display of these data from 1 September 1818 **(Figure 1)**. Although the exact pathologies of these diseases were not known at the time, they were heavily influenced by environmental and sanitary conditions that could be modified by Lovell's "medical police." By submitting these quarterly reports to the Secretary of War, SG Lovell used health data to advocate for conditions that would prevent common diseases and promote the health of the Army—such as improvements in environmental conditions, better food and clothing, and "abolition of the whiskey ration."[16] SG Lovell also began submitting a published, annual report to the Secretary of War in 1822. Although the annual report at first was solely a financial accounting of the medical department, it gradually introduced surveillance and sanitary data, including the first statistical table of morbidity in the 1835 report.[17]

In 1840, SG Lawson began compiling its quarterly reports into statistical surveillance reports using new techniques of rates and stratification developed by the British epidemiologist William Farr.[19] In addition to the data on illnesses and climatic/environmental data from the surgeons' reports, these reports included the use of population-based denominators obtained from non-medical sources, i.e., the Adjutant General. These reports again emphasized the need to use this information for public health practice, now called "military hygiene," that was defined as "the knowledge of maintaining the health of soldiers, and of promoting their efficiency." It was not until 1850 that similar work incorporating statistical analysis of health data to inform public health practice was begun outside of military populations in Massachusetts by Lemuel Shattuck.[20] The success of SG Lawson's efforts at improving sanitation and the health of the Army through these reports is evident in the documented improvements in health demonstrated in subsequent surveillance reports, such as the use of vaccination to reduce smallpox transmission or quinine to control malaria.[21] A notable exception was during the Mexican-American War between 1846 and 1848, during which no comprehensive reports other than mortality were available due to the difficulties of transmitting these reports across the frontier.[22, 23] In 1842, the Bureau of Medicine (BUMED) also began reporting to the Secretary of Navy, but these reports initially consisted of only financial accounts rather than reports of important diseases.[24] By 1860, however, BUMED was compiling sick reports and performing analyses similar to Army reports.[25]

Expansion and Institutionalization of Military Public Health Surveillance (1861–1945)

Up to the beginning of the Civil War, the quarterly reports by surgeons continued as before, while additional, more rigorous statistical analyses of these reports were compiled in 1856[23] and 1860.[21] There was a broad, emerging appreciation of the medical hazards of mobilization based on the reported Crimean War experience of the British as revealed by the work of Florence Nightingale.[26] After the first year of the Civil War, however, the "Sick and Wounded" reports were found to be "insufficient and defective," leading SG William Hammond to order "more detailed and exact reports"

FIGURE 1. First presentation of sick and wounded in tabular form for the quarter ending 30 September 1818

Report of the Sick and Wounded of the U.S. Army for the Quarter ending September 30th, 1818.

Remaining at last report			Taken sick during the quarter.																							Remaining		
			Fevers																									
Sick	Convalescent	Total	Typhus	Inflammatory	Intermittent	Remittent	Pleurisy	Rheumatism	Diarrhoea	Dysentery	Gonorrhoea	Syphilis	Wounds	Ulcers	Catarrh	Jaundice	Phthisis	Burns	Contusions	Colic	Contingencies	Total	Grand Totel	Cured	Died	Sick	Convalescent	Total
"	"	345	64	424	195	163	12	40	231	395	36	141	137	39	15	2	4	4	13	39	749	2703	3048	2490	24	"	"	534

JOSEPH LOVELL,
Surgeon General

from his medical officers.[27] In 1863, General Order Number 355 was promulgated in Circular Number 25, stating that "all obtainable statistics and data" should be compiled and forwarded to the SG, with particular attention paid to sanitation, medical supplies, environmental factors, the nature of the injuries, and other epidemiologic information. An example of a part of 1 of these reports "miasmatic diseases" is shown in **Figure 2**. The understanding of disease pathology was limited at the time, but the classification of disease in these reports was consistent with those published by Dr. Farr, including these major groups: zymotic (contagious), constitutional (e.g., tuberculosis), parasitic, local (e.g., eyes, ears), and wounds/injuries.[27,28] SG Hammond also directed his Medical Officers to "diligently collect and preserve…pathological surgical specimens."[28] Although this was originally intended to better understand the treatment of battle injuries, this collection and study of pathological specimens also enabled a better understanding of "camp diseases" such as typhoid and malaria.

These experiences also had a profound impact on the large number of American physicians in the Union Army and shaped an appreciation of medical sciences and public health after the war.[29] The information from these reports was published after the war in a multi-volume set, *The Medical and Surgical History of the War of Rebellion,* which greatly expanded the scope of the previous (peacetime) *Reports of the Surgeon Genera*l in size, scope, complexity, and detail.[27] Professor Rudolph Virchow, the father of modern pathology and founder of social medicine, was "astounded by the richness" of these reports, praising them for "the utmost accuracy of detail, the painstaking statistics embracing the minutest details…comprehending every aspect of the practice of medicine…in order to preserve and transmit to contemporaries and posterity, in the most thorough way possible, the wisdom purchased at so great a price."[30] These developments demonstrate the increased importance of surveillance data to support wartime operations compared to peacetime, as well as the influence military health surveillance on civilian public health practice. However, none of these reports were published during the Civil War itself, as the SG's office did not have the resources to publish the massive quantities of data in a timely fashion.[30] In 1872, military medical officers, members of the new Marine Hospital Commissioned Corps (later the Public Health Service), and urban practitioners responsible for public health gathered in Atlantic City to form the American Public Health Association, beginning a process of professionalization and standardization in public health examinations and reporting. Their work would be synergistic with Army efforts for several generations.

Within a few years after the end of the Civil War, the *Reports of the Sick and Wounded* returned to their prewar size, averaging less than 10 pages in the late 1860s and 14 pages in the 1870s, and the reports contained no detailed information on specific diseases of military importance. This reduction in the length and level of detail of the report suggests the trend of military leaders recognizing the relevance of surveillance during times of conflict but less so after the cessation of conflict.

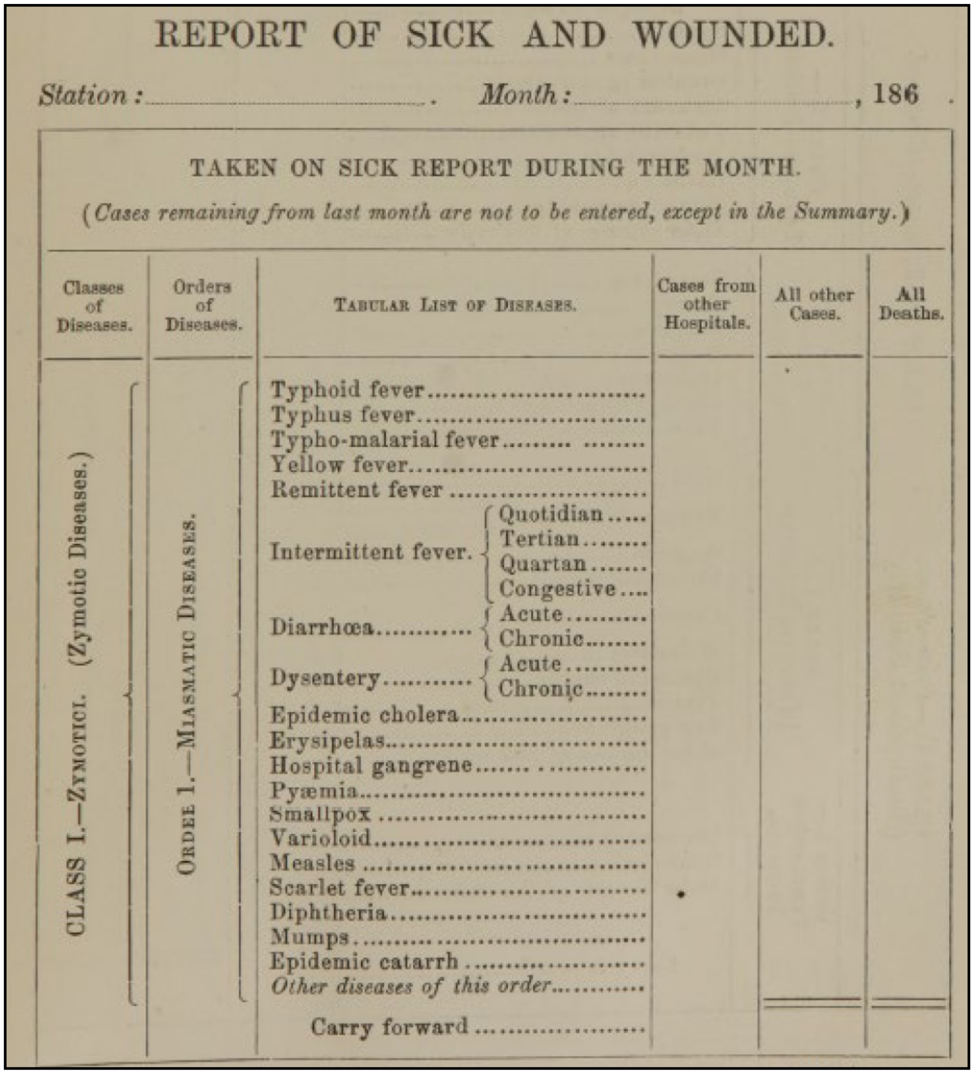
Nevertheless, the example of the *Medical and Surgical History* inspired young Americans to study the new sciences in Europe, and the methods of military and civilian public health surveillance evolved dramatically with advances in science and medicine over the next several decades. These advances included the understanding of the etiology of diseases (e.g., germ theory and laboratory diagnosis), statistical techniques such as rates and stratification, and specialization of surveillance activities.

Dr. George Sternberg brought many of these advances to military use through his pioneering personal use of microscopy to study bacteria and disinfection.[31,32] Upon being named SG in 1893, he immediately established the Army Medical School to increase the military's preparedness through military medical education, with an emphasis on sanitation and laboratory diagnosis.[33] William Osler, who is considered by many the father of modern medicine, would later describe the Army Medical School as America's first school of public health.[34] The military also developed innovative epidemiologic approaches relevant to military readiness. For example, the Army and Navy SG's surveillance reports were the first to track disability outcomes such as lost duty time and medical discharges, which was not standard practice in civilian occupational health surveillance until the early 20th century.[35] By 1883, the Army report had increased in size to 43 pages, and by the 1890s each volume averaged 150 pages.

The scope, complexity, and detail of the SG's surveillance reports further expanded during the Spanish-American War due to the impact of health threats encountered in tropical locations, such as malaria, typhoid, and yellow fever. SG Sternberg credited the reductions in mortality and improvements in the health of the Army, that were demonstrated in surveillance reports during the War, to "energetic measures" in sanitation and hygiene.[36,37] An example of this is illustrated in **Figure 3**, which demonstrates the impact of prevention efforts on mortality from typhoid and compares the Army's experience with typhoid fever during the Spanish-American War with that of the Civil War. The impact of military public health surveillance was further realized in detailed, in-depth outbreak and epidemiologic investigations such as the Typhoid Fever Board. SG Sternberg originally appointed Major Walter Reed to investigate and control an epidemic of undiagnosed febrile disease that was causing morbidity and mortality in U.S. military camps. The resulting application of surveillance and epidemiologic investigation of this typhoid outbreak led to the initiation of water sterilization and other improvements in sanitation and hygiene and dramatic declines in morbidity and mortality.[38]

The recognition of the power of timely data, captured by Sternberg in his publication of the lessons of the war with Spain, also impacted the British in their deployments to South Africa and the Japanese in their 1905 war with Russia.[36,37] Well-trained military medical officers with both adequate laboratory support, as well as access to Commanders who could order the change in field conditions, had the ability to save lives and significantly preserve the unit's fighting strength. Following the Spanish-American War, the basic reporting of monthly health surveillance data was performed in the Army through Form 51, which continued to be called the "Report of Sick and Wounded."[39] In 1914, the Chief Surgeon during the U.S. occupation of Veracruz recognized the need for weekly and even daily

FIGURE 2. Part of the "Report of the Sick and Wounded" used during the Civil War



REPORT OF SICK AND WOUNDED.

Station: .... *Month:* ...., 186 .

TAKEN ON SICK REPORT DURING THE MONTH.

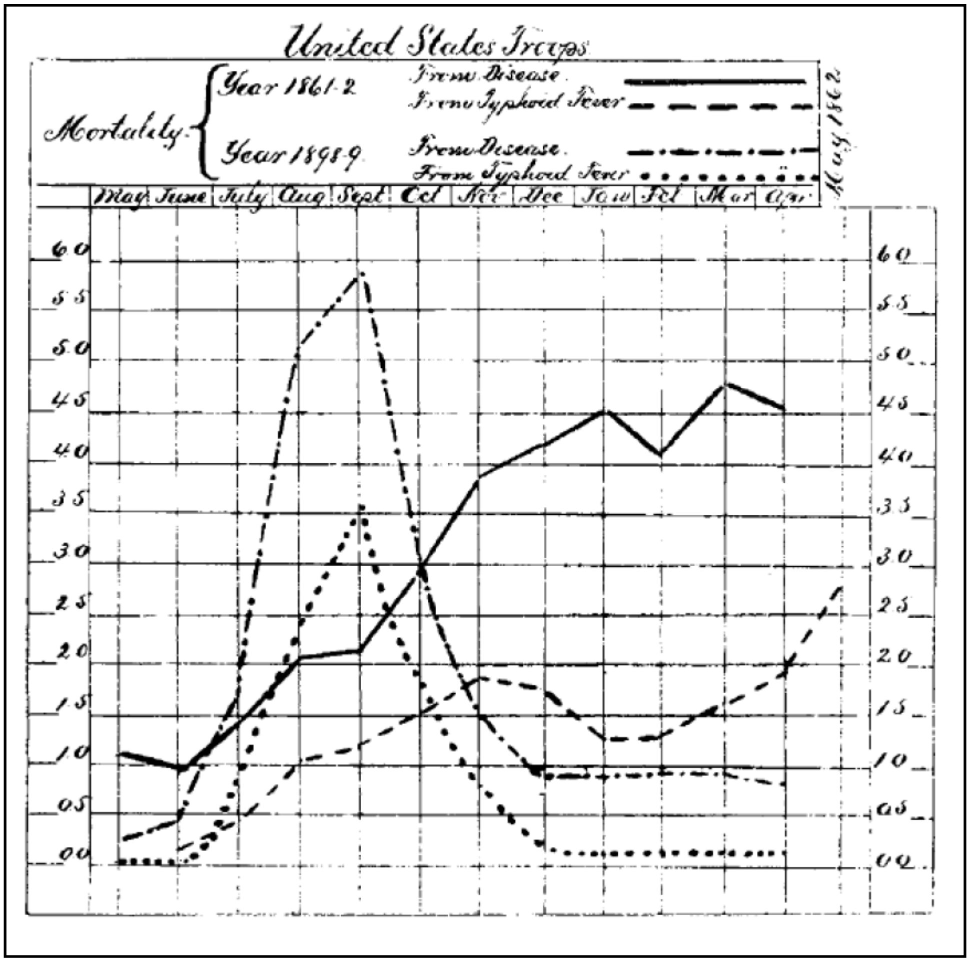
(*Cases remaining from last month are not to be entered, except in the Summary.*)

Classes of Diseases.	Orders of Diseases.	Tabular List of Diseases.	Cases from other Hospitals.	All other Cases.	All Deaths.
CLASS I.—Zymotici. (Zymotic Diseases.)	Order 1.—Miasmatic Diseases.	Typhoid fever			
		Typhus fever			
		Typho-malarial fever			
		Yellow fever			
		Remittent fever			
		Intermittent fever. Quotidian			
		Intermittent fever. Tertian			
		Intermittent fever. Quartan			
		Intermittent fever. Congestive			
		Diarrhœa .... Acute			
		Diarrhœa .... Chronic			
		Dysentery .... Acute			
		Dysentery .... Chronic			
		Epidemic cholera			
		Erysipelas			
		Hospital gangrene			
		Pyæmia			
		Smallpox			
		Varioloid			
		Measles			
		Scarlet fever			
		Diphtheria			
		Mumps			
		Epidemic catarrh			
		Other diseases of this order			
		Carry forward			

reporting of casualties and communicable diseases and directed more prompt reporting of the health status of the Army.[22] This report was adopted for use in other settings, including by the American Expeditionary Forces (AEF) during World War I. Of note, the SG's office encountered difficulties in estimating strength (denominator) data due to inconsistencies between the numbers in the medical reports and the reports to the Adjutant General's office, as well as delays in getting accurate data due to the "necessity for secrecy."[39] After World War I, surveillance reports were published with a scope, complexity, and detail never before seen in the U.S. Military, again suggesting their importance and impact in assessing FHP and readiness.[39] These reports showed increasingly sophisticated graphical displays of data and incorporated medical advances such as new laboratory and radiography diagnostics used to mitigate tuberculosis (TB) and typhoid.[40–42] The impact of these surveillance reports on FHP and readiness was demonstrated by the low rates of TB and typhoid transmission among U.S. forces compared to the other major combatants.[40,42] Surveillance for chronic health, behavioral health, and other non-communicable diseases was also increasingly conducted due to its potential impact on military readiness and operations.[41]

After World War I, surveillance in the *Report of the Surgeon General* again began to decline in size, scope, complexity, and detail. With the advent of World War II, once again a flurry of surveillance activity occurred. Reports became more detailed and encompassed an increasingly broad scope of the military's worldwide

FIGURE 3. U.S. Army Surgeon General Sternberg's use of surveillance data during the Spanish-American War to demonstrate the impact of public health interventions



operations, although again much of the surveillance data would not be accessible in published reports until after the end of the war. A board was established to study the feared impact of respiratory diseases in barracks, and it became the first of a series of commissions on various classes of infections that impacted mobilization.[43] As in World War I, civilian experts from academic medical centers were brought into these commissions to supplement undermanned military staffs. These commissions were collectively called the Army Epidemiological Board, later renamed the Armed Forces Epidemiological Board (AFEB) after the war (it is now called the Defense Health Board). The AFEB addressed FHP threats such as acute respiratory diseases, influenza, enteric infections, vaccinations, and others.[44] The goal of these commissions was similar: to reduce the impact of these diseases on military readiness. Surveillance activities were therefore a critical component of ensuring readiness by monitoring the burden of disease, trends, and effectiveness of interventions aimed at their control.

The impact of the military's varied and enhanced prevention efforts, including surveillance, on FHP and readiness was demonstrated by World War II being the first conflict during which the number of fatalities caused by disease was less than those caused by battle.[45] Specific examples showing the impact of surveillance data include demonstrating that the vast majority of TB cases existed prior to military service,[46,47] documenting the effectiveness of malaria control efforts in endemic areas,[48] and in communicating to commanders the importance of sanitation efforts in preventing diarrhea and dysentery.[49]

Modern Military Health Surveillance (1945–present)

The modern concept of public health surveillance was formalized after World War II by Alexander Langmuir at the Communicable Disease Center, the precursor of the modern CDC.[50] While surveillance activities had been taking place previously in military and civilian settings, this was the first real use of the term "surveillance"—previously these activities were called "reports" or "statistics." Nevertheless, the name Langmuir chose was significant in making explicit the importance of the systematic nature of the collection and evaluation of health data, as well as the need for communication to stakeholders and policy development. Langmuir further built the Epidemic Intelligence Service (EIS), with its central training of local experts, to assure systematic and consistent standards in public health surveillance and disease outbreak investigations, particularly for biothreat agents.[51]

After World War II, the services pulled their public health surveillance portions out of the *Report of the Surgeon General* and made them into monthly publications called *The Health of the Army* and *Statistics of Navy Medicine* **(Figures 4a, 4b)**. In contrast to the periods after previous conflicts, these reports were not reduced in scope, complexity, and detail. Instead, these reports provided detailed, up-to-date articles on topics of military and public health significance which impacted military operations and readiness. The Navy determined that the *Annual Report of the Surgeon General* could not meet the "planning needs of an active medical department either during war or peace." Therefore, the *Statistics of Navy Medicine* was developed and designed "to provide data on morbidity, mortality, and related subjects as early and quickly as possible…for use by the Medical Department in planning disease control, hospitalization, and adequate personnel requirements."[52] Similarly, the *Health of the Army* was launched "to serve as a medium for providing the Medical Department and other interested War Department agencies with data on the health and hospitalization of troops…as a basis for evaluating established policies and for determining any changes that need to be made in such policies."[53] The continued importance of surveillance seen even after the conclusion of the war is probably due to the continued operations in both the European and Pacific Theaters despite the end of hostilities, as well as the close proximity in time to the onset of the Korean War. For the first time after the end of a military conflict, the U.S. did not drastically reduce its armed forces, but rather kept a frequently drafted, worldwide-based, standing military force that was forward-deployed in support of the Cold War. Although communicable diseases continued to occupy a prominent place in these Cold War-era reports, increasing attention was paid to issues of non-effectiveness, hospitalization, medical evacuation, mortality, and civil public health. Despite their quality and utility, few of these reports are accessible today because they were published as "gray" literature, meaning that they are not commonly available in medical libraries, nor are they found in PubMed or other similar databases.

With improvements in medical care, access, and overall health status in the U.S. population, outpatient care assumed a growing importance in assessing the burden of disease in surveillance data.[20] Both outpatient and inpatient reports continued to occupy a prominent place during the Vietnam War, during which surveillance continued to impact military operations and readiness. For example, malaria rates were shown to be associated with geography, climate, enemy contact, preventive measures, and command discipline.[54]

During this time, military authors increasingly communicated their public health surveillance data in the peer-reviewed medical literature rather than in internal military documents and publications. The greater accessibility and recognition of these journals by the non-military medical community made them more attractive vehicles for authors to publish military surveillance data. However, this led to fragmentation of the literature and sometimes mixed messages. An example of this is the differing reports regarding the risk of TB disease and skin test conversion resulting from deployment to Vietnam, which led to conflicting assessments about the effectiveness of control measures and need for additional control measures.[55–61] It also led to the demise of the *Health of the Army* and *Statistics of Navy Medicine*, which began to decrease in complexity, detail, and scope, with a corresponding decrease in their relevance and impact. By the mid-1980s these reports contained only large quantities of computer-generated tables of health care utilization data without any analysis or relevance to improving FHP or readiness. Ultimately, the publication of both reports ended by 1988.

In 1995, the Army Medical Surveillance Activity (AMSA) began publishing the *Medical Surveillance Monthly Report (MSMR)* **(Figure 5)**. The purpose of the *MSMR* was "to provide readily available information necessary to inform, motivate, and empower commanders, their surgeons, and medical staffs to design, implement, and resource programs that enhance health, fitness, and readiness."[62] This publication, patterned on the CDC's *Morbidity and Mortality Weekly Report*, marked the first real use of the terms "surveillance" and "readiness" in military public health reports. Major strengths of the *MSMR* included 1) its access to all administrative health data through the Defense Medical Surveillance System (DMSS);[3] 2) its accessibility to military and civilian health professionals, as it had free full text from its inception and was first indexed in Medline in 2011; and 3) its scientific credibility through its peer review process and editorial independence.[63] Initial reports were similar to the *Health of the Army* reports, with tabular data, analysis, and recommendations for public health action. While current reports still have this format, they often use modern statistical methods such as regression and advanced laboratory methods such as genotyping or other molecular testing. The focus of the surveillance has also changed. In 1995, 66% (59/90) of articles were on communicable disease topics such as HIV infection and other sexually transmitted infections, adenovirus and other respiratory infections, and malaria and other vector-borne infections. By 2020, this proportion had dropped to 40% (20/50), with the other topics including public health issues such as heat and cold weather injuries, medical evacuations, cardiovascular diseases, opioid use, and mental health disorders.

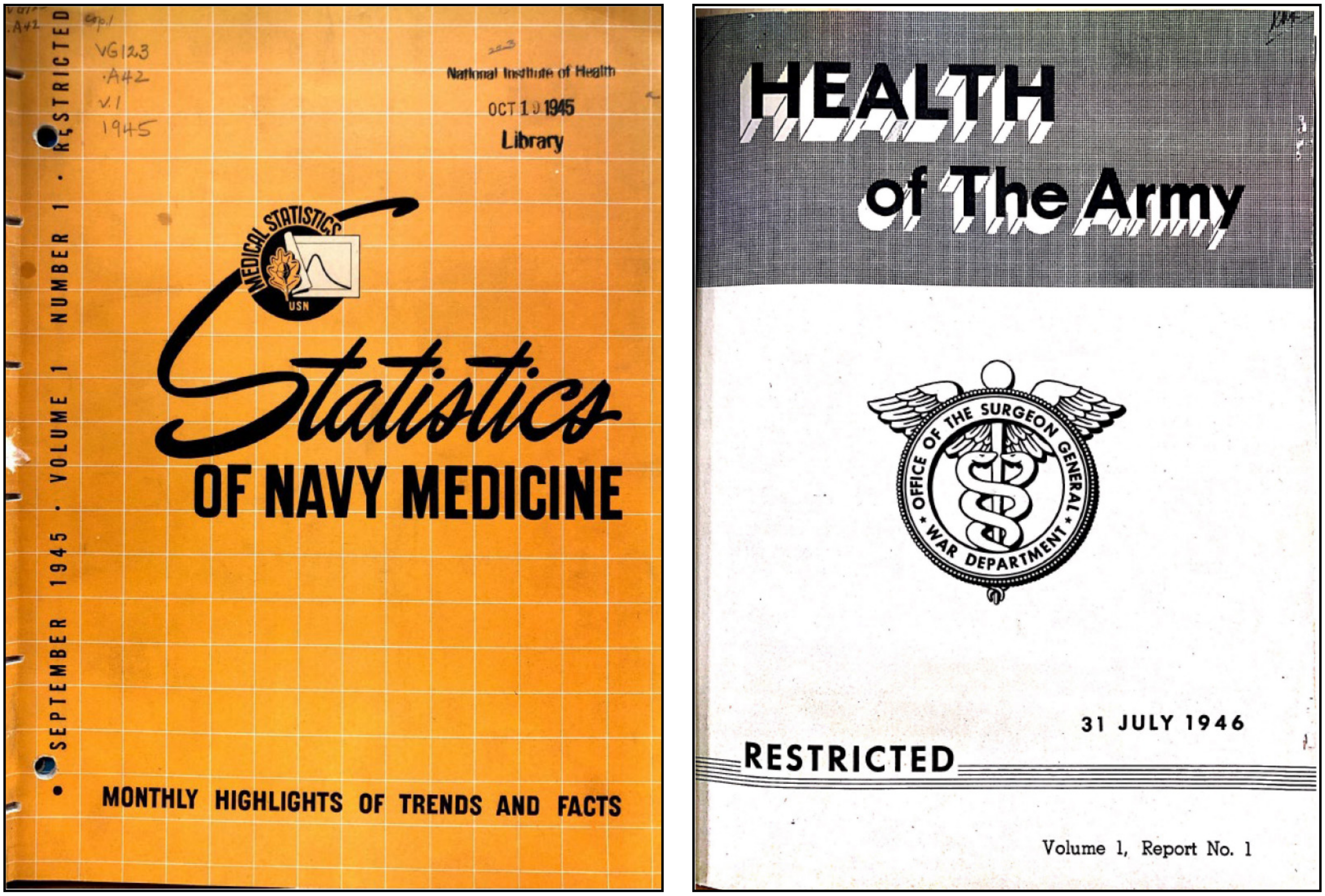
In 2015, the Army began publication of a surveillance report called *The Health of the Force*, the goal of which was to "track the health of the Army…to improve the health readiness of the Total Force."[64] This report focused almost entirely on non-communicable health factors, including lifestyle factors such as physical activity, obesity, and tobacco use, behavioral health conditions, occupational and environmental exposures, injuries, and other factors affecting military medical readiness. This report not only provided surveillance data at a force-wide and local installation level, but also examined interventions aimed at promoting health, how they were implemented, and their impact on health and readiness at different installations. However, because the report was published as gray literature it had limited accessibility, credibility, and overall impact. The Army, Navy, and Air Force public health hubs all routinely publish other surveillance data in both the gray literature and in the scientific literature.

How can history inform current and future military health surveillance?

While the understanding of diseases of military importance, laboratory and statistical surveillance methods, and persons responsible for this surveillance have evolved over time, it is the linkage towards maintaining readiness that has determined the impact and thus the success of military public health surveillance. Surveillance has gone from an activity practiced primarily by general medical officers to an activity primarily led by specialists in preventive medicine and public health. Furthermore, although the miasmatic understanding of disease has evolved to germ theory and the molecular basis of disease, the underlying principles and purpose of public health surveillance in the military have remained consistent: ensuring the readiness of the fighting force in times of both peace and in conflict.

Although military health surveillance has developed remarkably over the past 200 years, several limitations remain. The DHA's recent capabilities-based assessment found shortfalls in the areas of accessibility of data, integration of processes and systems, standardization of practices, communication

FIGURES 4a and 4b. Inaugural issues of *Statistics of Navy Medicine* (1945) and the *Health of the Army* (1946)



of key findings efficiently and effectively to commanders, and evaluation.[5] Surveillance data are not useful if the information is considered invalid or do not address public health issues in a timely fashion. An important challenge for public health surveillance is the potential for misclassification of exposure, as demonstrated by the challenges in quantifying exposures to Agent Orange in the Vietnam War or burn pits in the Iraq and Afghanistan conflicts.[65,66] Military health surveillance must ensure that it encompasses rigorous, up-to-date laboratory and statistical methods in order to maintain credibility within both military and civilian medical and public health communities. For these reasons, peer-reviewed, scientifically-credible reports such as those found in the *MSMR* are powerful tools that promote impact through accessibility and strategic communication, and these should be promoted and expanded. This review does not consider formal or informal surveillance activities which may be extremely important but for which no accessible documentation or reports exist. These include public health surveillance information provided to inform Commanders of health threats in real time, or actionable surveillance provided by the Armed Forces Health Surveillance Division's Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE) or Health Surveillance Explorer (HSE) available at https://health.mil/Military-Health-Topics/Combat-Support/Armed-Forces-Health-Surveillance-Branch.

Public health has achieved its greatest impact during times of conflict, when prevention and medical readiness are directly tied to the success of the operational mission. When the impact of medical readiness and prevention activities are not considered as important, surveillance activities are correspondingly undervalued. The case for maintaining a robust military public health surveillance capability is therefore closely aligned with the case for maintaining prevention activities in support of FHP and readiness. As stated by Brigadier General Love more than 50 years ago, the effectiveness of surveillance activities "depends in large part upon its responsiveness to current problems and developing trends in military and medical affairs."[22] Public health personnel must maintain a linkage to medical and public health policy makers, in particular non-medical military leaders, to ensure that the most important public health issues are identified, communicated, and acted upon. Finally, as the CDC was integral in federalization of state and local public health departments, so too can a central body such as the DHA standardize joint service data collection and reporting so that it can be better aggregated centrally and more easily accessed to inform policy and improve health. These are the historical lessons of military public health surveillance that must be considered as DHA develops the military's public health surveillance system of the future.

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FIGURE 5. The inaugural issue of the *Medical Surveillance Monthly Report*


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MSMR

Medical Surveillance Monthly Report

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