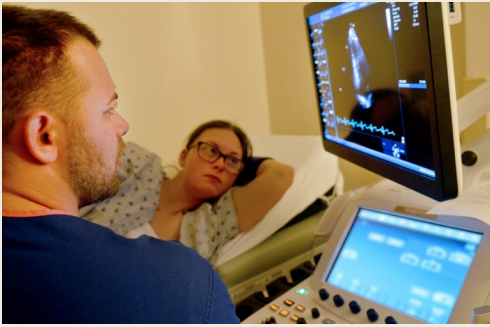


# MSMR



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# Cold Weather Injuries Among the Active and Reserve Components of the U.S. Armed Forces, July 2019–June 2024

Alexis L. Maule, PhD; Katherine S. Kotas, MPH; Kiara D. Scatliffe-Carrion, MPH; John F. Ambrose, PhD

Over the 5-year surveillance period, from July 2019 through June 2024, the crude incidence rate of any cold weather injury was 31.1 per 100,000 person-years (p-yrs) for the active component and 6.4 per 100,000 persons for the reserve component. From July 2023 through June 2024, a total of 456 members of the active (n=403) and reserve (n=53) components of the U.S. Armed Forces had at least 1 cold weather injury. During the 2023-2024 cold season, the rates of any cold weather injury increased slightly for the active (31.1 per 100,000 p-yrs) and reserve (6.4 per 100,000 persons) components compared to the previous cold season. The rate of any cold weather injury varied among the services for the 2023-2024 cold season, with higher rates observed in the Army and the Marine Corps. Over the entire surveillance period, active component service member cold weather injury rates were higher among males, non-Hispanic Black or African Americans, and those under 20 years old.

Cold weather injuries are of significant military concern due to potential effects on service members (e.g., morbidity and potential disability) and the total force (e.g., adverse impacts on operations and costs of treatment).<sup>1,2</sup> In response, the U.S. Armed Forces have developed, and are continually improving, their training, doctrine, procedures, and protective equipment and clothing to counter the threat of cold environments.<sup>3-6</sup> Although these measures are effective when properly implemented, cold weather injuries continue to affect hundreds of service members each cold season due to exposures to both cold and wet environments.<sup>7,8</sup>

Cold weather injuries can be broadly categorized in 2 major groups: those with a central effect, and those primarily affecting the body's periphery. Hypothermia occurs if the body cannot maintain a core temperature at or above 95°F. If skin temperatures reach 95°F, the body's physiological response is initiated to minimize loss

of heat and maintain the core temperature for vital organ protection.<sup>9-10</sup> This response is achieved by decreasing blood flow to the extremities and redistributing warm blood to the core.<sup>9-11</sup> Lack of blood flow to the extremities, even before a drop in core temperature, is the leading cause of peripheral cold injuries.

Initially, hypothermia may impair cognition (e.g., confusion, slurred speech, memory loss), heart rate, and breathing. Severe hypothermia can lead to loss of consciousness, pulmonary edema, coma, ventricular arrhythmias (including ventricular fibrillation), and asystole.<sup>10,12,13</sup> Freezing atmospheric temperatures are not required to produce hypothermia, particularly when water immersion is involved. Because heat loss occurs 2 to 5 times faster in water compared to air, core body temperature can start to drop in water temperatures as warm as 80°F.<sup>10</sup>

Peripheral cold injuries mainly affect the hands, feet, and face, and can be further

## What are the new findings?

The crude incidence rate for cold weather injuries among all active component service members (31.1 per 100,000 p-yrs, 2023-2024), increased by 8.4% from the injury rate observed last season (28.7 per 100,000 p-yrs, 2022-2023) but remains unchanged from the rate observed during the 5-year surveillance period (31.1 per 100,000 p-yrs, 2019-2024). During the 2023-2024 cold season, active component Air Force personnel experienced their highest rate of any cold weather injury of the 5-year surveillance period.

## What is the impact on readiness and force health protection?

Despite the terminology, cold weather injuries can occur in a variety of conditions, and in much warmer temperatures than expected, particularly when operating or training in wet or aquatic environments. It is essential that both service members and their leadership understand the hazards in their environments, the health risks those hazards pose, and prevention strategies to combat them (e.g., weather-appropriate clothing, clean and dry socks and footwear, and proper protective gear for extremities).

classified as either freezing injuries, such as frostbite, or non-freezing injuries, such as immersion foot. Freezing peripheral injury is defined as the damage sustained by tissues when skin temperatures fall below freezing, most frequently affecting tissues of the ears, nose, cheeks, chin, fingers, and toes.<sup>10,11,14-16</sup> A substantial proportion of patients with peripheral frostbite experience permanent changes in their microcirculation and disruption of localized nerve functions (e.g., reduced sensation in the affected area).<sup>15</sup> Although most frostbite damage is minor, severe injury may lead to impaired functioning and inability to perform occupational tasks due to cold hypersensitivity, chronic ulceration, vasospasm, localized osteoarthritis, or chronic pain.<sup>11,15,17</sup>

Non-freezing peripheral injury includes a spectrum of localized injuries to the soft tissues, nerves, and vasculature of distal extremities that result from prolonged exposure to wet, cold (generally 32-59°F) conditions; the injury process is generally slower in warmer water.<sup>10,11,14,18</sup> Although most non-freezing peripheral injuries involve feet, any body part can be affected by the condition, including hands.<sup>19</sup> When immersion foot occurs, the foot becomes hyperemic (i.e., increased blood flow), painful, and swollen with continuous exposure; progression to blistering, decreased blood flow, ulceration, and gangrene is gradual.<sup>11,18,20</sup>

Environmental factors that increase risk of cold weather injury include prolonged outdoor exposure to temperatures 40°F and lower, wind speeds exceeding 5 miles per hour, high altitudes, geographic location, wet conditions due to rain or snow, and submersion in water.<sup>19</sup> Situational factors that increase risk of cold weather injury include type of physical activity, inadequate shelter, and inappropriate clothing, including—specifically for non-freezing peripheral injuries of the foot—immobility, wet socks, and constrictive boots.<sup>20-22</sup> Individual risk factors vary and include prior cold weather injury, dehydration, fatigue, improper acclimatization, inadequate nutrition, alcohol use, smoking, chronic disease (e.g., peripheral vascular disease, diabetes), and medications that impair compensatory responses (e.g., oral antihyperglycemics, beta-blockers, general anesthetic agents).<sup>10,11,16,20-22</sup>

Continuous surveillance of cold weather injuries is essential to understand the magnitude of the risk they pose, inform prevention efforts, and remind leaders of the hazards of training and operating in wet and cold environments. Department of Defense guidelines for reportable medical events (RMEs) require reporting of cases of hypothermia, freezing peripheral injuries (e.g., frostbite), and non-freezing peripheral injuries (e.g., immersion injuries, chilblains).<sup>23</sup>

Since 2004, *MSMR* has published annual updates on the incidence of cold weather injuries affecting U.S. Armed Force members for the 5 most recent cold seasons.<sup>24</sup> The timing of these annual updates

is intended to call attention to the recurring risks of such injuries as winter approaches in the Northern Hemisphere, where most members of the U.S. Armed Forces are assigned. This 2024 report addresses the occurrence of frostbite, immersion hand and foot injuries, and hypothermia during the cold seasons from July 2019 through June 2024.

## Methods

This surveillance population included all individuals who served in the active or reserve components of the U.S. Armed Forces at any time during the surveillance period of July 1, 2019 through June 30, 2024. For analysis purposes, a cold season was defined as July 1 through June 30 intervals so complete cold weather seasons could be represented in annual summaries and comparisons. Service members in the Space Force were classified separately from the Air Force for the 2022-2023 and 2023-2024 cold seasons as a result of complete data availability for the newly formed service; for previous cold seasons they were classified as Air Force.

Records of cold weather injuries for freezing peripheral injuries (i.e., frostbite), non-freezing peripheral injuries (i.e., immersion hand and foot injuries), and hypothermia were identified from 2 sources: 1) RMEs submitted to the Disease Reporting System internet (DRSi) and 2) diagnostic codes from inpatient and outpatient medical encounters in the Defense Medical Surveillance System and in-theater records from the Theater Medical Data Store. A cold weather injury case was defined by the presence of an RME or 1 of any qualifying International Classification of Diseases, 9th or 10th revision (ICD-9/

ICD-10) codes in the first diagnostic position of a record of a health care encounter (Table 1).

To estimate the number of unique individuals who experienced a cold weather injury each cold season, and to avoid counting follow-up health care encounters, only 1 cold weather injury per individual per season was included in the counts of ‘any cold weather injury’. To count specific types of cold weather injury, namely frostbite, immersion hand and foot, and hypothermia cases, 1 of each type of cold weather injury per individual per season could be included in the counts of ‘all cold weather injuries’. For example, if an individual was diagnosed or reported with an immersion injury at 1 point during a cold season and then with frostbite later in the same cold season, each of those different injury types would be included in the injury-specific calculations. If a service member had multiple medical encounters for the same cold weather injury, only 1 encounter was used for analysis. The hospitalization encounter was prioritized over the ambulatory visit.

Annual seasonal incidence rates of cold weather injuries among active component service members (ACSMs) were calculated as incident cold weather injury diagnoses per 100,000 person-years (p-yrs) of service. Annual seasonal incidence rates of cold weather injuries among reservists were calculated as cases per 100,000 persons using the total number of reserve component service members for each cold season of the surveillance period. Counts of persons in the reserves were used as the denominator in these calculations because information on the start and end dates of active duty service periods of reserve component members is unavailable, so person-time cannot be accurately calculated.

**TABLE 1.** ICD-9 and ICD-10 Diagnostic Codes for Cold Weather Injuries

Case Classification	ICD-9	ICD-10 <sup>a</sup>
Frostbite	991.0, 991.1, 991.2, 991.3	T33.*, T34.*
Immersion hand and foot	991.4	T69.0*
Hypothermia	991.6	T68.*

Abbreviation: ICD, International Classification of Diseases, 9th and 10th revisions.  
<sup>a</sup> An asterisk (\*) indicates that any subsequent digit/character is included.

Cold weather injuries are summarized by the locations where service members were treated for those injuries, identified by a Defense Medical Information System Identifier (DMIS ID) of a health care encounter. Because such injuries can occur during field training, temporary duty, or outside usual duty stations, DMIS ID was used as a proxy for the location where the cold weather injury occurred.

## Results

### 2023-2024 cold season

From July 2023 through June 2024, a total of 456 members of the active (n=403) and reserve (n=53) components had at least 1 cold weather injury (Table 2, 1 per person per cold season). In the active component, soldiers had the highest rate of any cold

weather injury (n=233, 52.6 per 100,000 p-yrs) during the 2023-2024 cold season, followed by members of the Marine Corps (n=68, 40.5 per 100,000 p-yrs), Air Force (n=67, 21.4 per 100,000 p-yrs), and Navy (n=30, 9.2 per 100,000 p-yrs). One active component Space Force member (11.1 per 100,000 p-yrs) and 4 active component Coast Guard members (10.2 per 100,000 p-yrs) were affected by cold weather injuries during the 2023-2024 cold season (Table 2, Figure 1). Within the reserve component, Army personnel accounted for over half of the cases (n=29, 5.3 per 100,000 persons) in 2023-2024 (Table 2, Figure 2), although Reservists in the Marine Corps (n=10, 26.7 per 100,000 persons) had higher rates of cold weather injuries.

Within the different services in 2023-2024, frostbite was the most common type of cold weather injury among active component Army (n=125, 45.5%), Navy (n=20,

66.7%), and Air Force (n=47, 67.1%) members (Tables 3a-3c), whereas immersion injury was the most common type of cold weather injury among the Marine Corps active component (n=30, 44.1%) (Table 3d).

### Five cold seasons: July 2019–June 2024

For all 5 cold seasons, the crude incidence rate of any cold weather injury for all ACSMs was 31.1 per 100,000 p-yrs (Table 2). For the most recent cold season, the crude incidence rate of any cold weather injury for all ACSMs increased by 8.4% (from 28.7 per 100,000 p-yrs in 2022-2023 to 31.1 per 100,000 p-yrs in 2023-2024) compared to the prior cold season (Table 2). Throughout the surveillance period, cold weather injury rates remained consistently higher among ACSMs in the Army and Marine Corps (Figure 1). During the 5-year surveillance period, the crude incidence rate of any

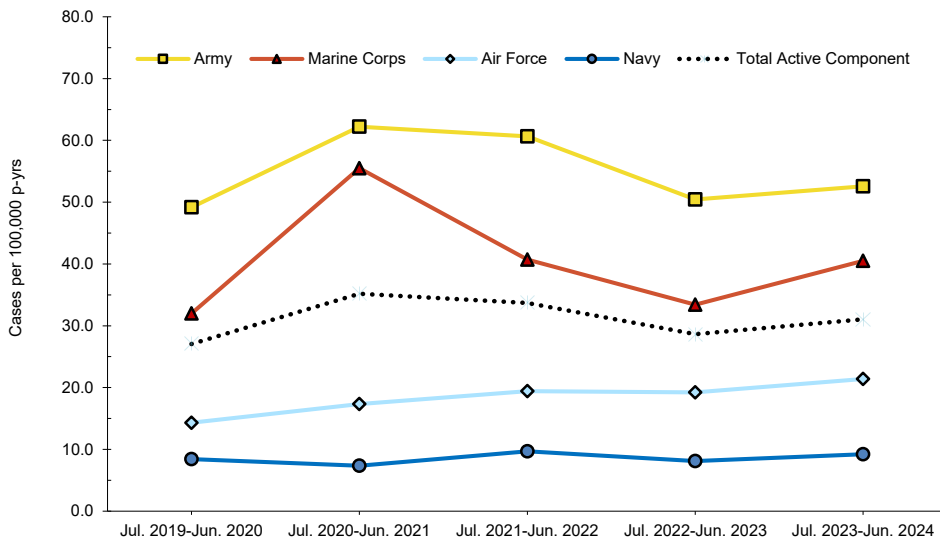
**TABLE 2.** Annual Incidence of Service Members Affected by Any Cold Injury (1 per person per season), by Service and Component, July 2019–June 2024

	Army		Navy		Air Force		Marine Corps		Coast Guard		Space Force		All Services	
	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>
<b>Active component</b>														
All years (2019-2024)	1,278	55.1	143	8.6	295	18.3	356	40.5	12	6.0	2	14.4	2,086	31.1
Jul. 2019–Jun. 2020	233	49.2	28	8.4	47	14.3	59	32.0	1	2.5	0	0.0	368	27.1
Jul. 2020–Jun. 2021	297	62.2	25	7.4	57	17.3	100	55.5	2	5.0	0	0.0	481	35.2
Jul. 2021–Jun. 2022	286	60.6	33	9.7	63	19.4	72	40.7	2	5.0	0	0.0	456	33.7
Jul. 2022–Jun. 2023	229	50.4	27	8.1	61	19.2	57	33.4	3	7.7	1	20.6	378	28.7
Jul. 2023–Jun. 2024	233	52.6	30	9.2	67	21.4	68	40.5	4	10.2	1	11.1	403	31.1
<b>Reserve component</b>														
All years (2019-2024)	175	6.2	13	4.2	48	5.2	34	16.5	4	12.2	0	0.0	274	6.4
Jul. 2019–Jun. 2020	35	6.0	2	3.1	9	4.8	4	9.0	0	0.0	0	0.0	50	5.7
Jul. 2020–Jun. 2021	42	7.3	6	9.5	12	6.4	11	25.6	1	15.1	0	0.0	72	8.2
Jul. 2021–Jun. 2022	34	6.0	2	3.2	7	3.7	5	11.9	2	30.3	0	0.0	50	5.8
Jul. 2022–Jun. 2023	35	6.4	1	1.7	9	4.9	4	10.2	0	0.0	0	0.0	49	5.9
Jul. 2023–Jun. 2024	29	5.3	2	3.4	11	6.1	10	26.7	1	15.4	0	0.0	53	6.4
<b>Overall, active and reserve</b>														
All years (2019-2024)	1,453		156		343		390		16		2		2,360	
Jul. 2019–Jun. 2020	268		30		56		63		1		0		418	
Jul. 2020–Jun. 2021	339		31		69		111		3		0		553	
Jul. 2021–Jun. 2022	320		35		70		77		4		0		506	
Jul. 2022–Jun. 2023	264		28		70		61		3		1		427	
Jul. 2023–Jun. 2024	262		32		78		78		5		1		456	

Abbreviations: No., number; Jul., July; Jun., June.

<sup>a</sup>For active component, rate is per 100,000 person-years. For reserve component, rate is per 100,000 persons.

**FIGURE 1.** Annual Incidence Rates of Service Members Affected by Any Cold Injury (1 per person per year) by Service, Active Component, U.S. Armed Forces, July 2019–June 2024



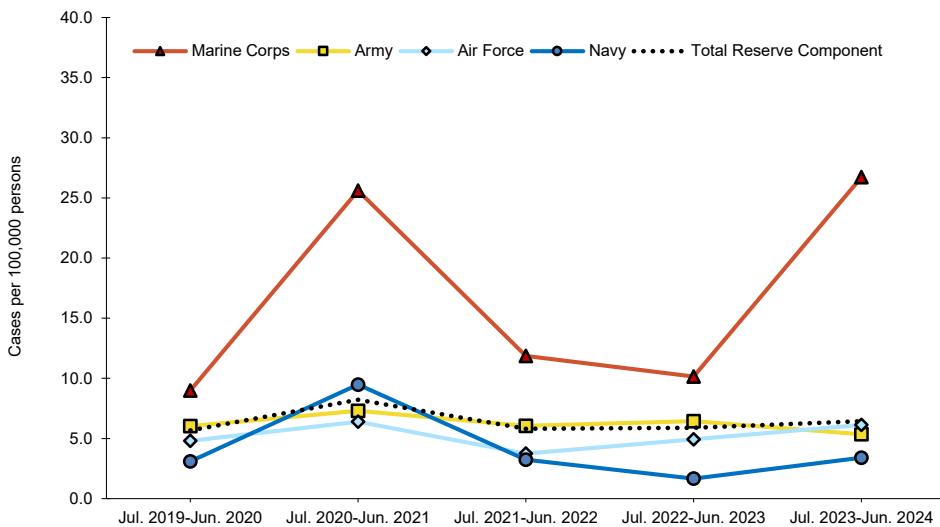
Abbreviations: P-yrs, person-years; Jul., July; Jun., June.

cold weather injury for the reserve component was 6.4 per 100,000 persons (Table 2). During the most recent current cold season, the crude incidence rates of any cold weather injury increased by 9.1% (from 5.9 per 100,000 persons in 2022-2023 to 6.4 per 100,000 persons in 2023-2024) compared to the prior cold season (Table 2).

Frostbite was the most common cold weather injury type among ACSMs during

the first 3 cold seasons of the surveillance period, except among active component sailors, for whom hypothermia resulted in the highest cold weather injury rate during the 2020-2021 and 2021-2022 seasons (Tables 3a–3e). The rate of immersion injury increased above the rate of frostbite injury for active component members of the Marine Corps during the 2022-2023 and 2023-2024 cold seasons (Table 3d).

**FIGURE 2.** Annual Incidence Rates of Service Members Affected by Any Cold Injury (1 per person per year) by Service, Reserve Component, U.S. Armed Forces, July 2019–June 2024



Abbreviations: P-yrs, person-years; Jul., July; Jun., June.

The rate of immersion injury also increased for Army active component members during the last 2 cold seasons, although the immersion injury rate in 2023-2024 (26.4 per 100,000 p-yrs) remained just below the rate of frostbite (28.2 per 100,000 p-yrs) (Table 3a).

During the 5-year surveillance period, overall rates of all cold weather injuries in the active component were generally higher among service members who were male, non-Hispanic Black or African American, and in the 2 youngest age groups (<20 and 20-24 years old) (Tables 3a–3d). When specific types of cold weather injury were considered, male and non-Hispanic Black or African American personnel had higher rates of frostbite in comparison to other types of cold weather injury (Tables 3a–3d). Among all cold weather injury cases reported within the active component during the 5-year period, the Marine Corps demonstrated the highest recruit cold weather injury rate (182.7 per 100,000 p-yrs). In all services, enlisted personnel had higher rates of cold weather injury compared to officers (Tables 3a–3e).

Throughout the 5-year surveillance period, a total of 37 ACSMs (1.8% of the total) were hospitalized. Of the 37 active component hospitalizations, hypothermia (n=18) and frostbite (n=18) were equally represented, while only 1 hospitalization was due to immersion injury. The Army (n=25) and Marine Corps (n=7) accounted for a majority (86.5%) of hospitalized cases (data not shown).

### Cold weather injuries during deployments

During the 5-year surveillance period a total of 65 cold weather injuries were diagnosed among service members deployed outside the U.S. (data not shown), of which 25 (38.5%) were frostbite, 30 (46.2%) were immersion injuries, and 10 (15.4%) were hypothermia. Approximately one-third (n=22) of all 65 deployment-associated cold weather injuries were diagnosed during the 2023-2024 cold season. Immersion injuries accounted for over three-quarters (n=18, 81.8%) of the cold weather injuries identified in service members deployed outside the U.S. during the 2023-2024 cold season.

**TABLE 3a.** Annual Incidence of Frostbite, Immersion Injury, and Hypothermia Among All Cold Injuries (1 type per person per year), Active Component, U.S. Army, July 2019–June 2024

	Frostbite		Immersion Injury		Hypothermia		All Cold Injuries	
	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>
Total	734	31.6	434	18.7	186	8.0	1,354	58.4
<b>Sex</b>								
Male	641	32.7	390	19.9	162	8.3	1,193	60.9
Female	93	25.8	44	12.2	24	6.7	161	44.7
<b>Race and ethnicity</b>								
White, non-Hispanic	247	20.2	199	16.3	87	7.1	533	43.6
Black, non-Hispanic	343	73.2	161	34.4	57	12.2	561	119.8
Hispanic	89	21.8	58	14.2	24	5.9	171	41.9
Other	55	24.9	16	7.3	18	8.2	89	40.3
<b>Age, y</b>								
<20	68	46.7	52	35.7	18	12.4	138	94.8
20–24	322	45.6	227	32.1	97	13.7	646	91.4
25–29	154	27.7	82	14.7	44	7.9	280	50.4
30–34	95	25.3	44	11.7	13	3.5	152	40.5
35–39	54	19.3	13	4.6	9	3.2	76	27.1
40–44	23	14.9	9	5.8	3	1.9	35	22.6
45+	18	17.7	7	6.9	2	2.0	27	26.5
<b>Rank</b>								
Recruit trainee	8	17.5	7	15.3	5	11.0	20	43.8
Enlisted	647	35.8	388	21.5	165	9.1	1,200	66.4
Officer	79	17.0	39	8.4	16	3.4	134	28.8
<b>Occupation</b>								
Infantry/artillery/armor/combat engineering	302	52.1	216	37.3	96	16.6	614	106.0
Motor transport	26	36.6	12	16.9	4	5.6	42	59.2
Repair/engineering	110	23.9	63	13.7	26	5.7	199	43.3
Communications/intelligence	151	26.2	83	14.4	28	4.9	262	45.5
Health care	47	20.7	17	7.5	13	5.7	77	33.9
Other	98	24.1	43	10.6	19	4.7	160	39.3
<b>Cold season (July–June)</b>								
2019–2020	115	24.3	94	19.8	46	9.7	255	53.8
2020–2021	180	37.7	81	17.0	38	8.0	299	62.6
2021–2022	190	40.3	67	14.2	38	8.1	295	62.5
2022–2023	124	27.3	75	16.5	31	6.8	230	50.7
2023–2024	125	28.2	117	26.4	33	7.4	275	62.1

Abbreviations: No., number; y, years.

<sup>a</sup>Rate per 100,000 person-years.

**TABLE 3b.** Annual Incidence of Frostbite, Immersion Injury, and Hypothermia Among All Cold Injuries (1 type per person per year), Active Component, U.S. Navy, July 2019–June 2024

	Frostbite		Immersion Injury		Hypothermia		All Cold Injuries	
	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>
Total	63	3.8	30	1.8	50	3.0	143	8.6
<b>Sex</b>								
Male	56	4.2	27	2.0	44	3.3	127	9.6
Female	7	2.0	3	0.9	6	1.8	16	4.7
<b>Race and ethnicity</b>								
White, non-Hispanic	32	3.9	12	1.5	28	3.4	72	8.7
Black, non-Hispanic	13	4.9	9	3.4	8	3.0	30	11.3
Hispanic	10	3.5	4	1.4	7	2.4	21	7.3
Other	8	2.7	5	1.7	7	2.4	20	6.8
<b>Age, y</b>								
<20	6	6.2	6	6.2	7	7.2	19	19.7
20–24	19	3.8	11	2.2	23	4.7	53	10.7
25–29	17	4.2	3	0.7	15	3.7	35	8.7
30–34	5	1.7	3	1.0	3	1.0	11	3.8
35–39	7	3.3	2	0.9	2	0.9	11	5.2
40–44	4	3.6	4	3.6	0	0.0	8	7.2
45+	5	7.6	1	1.5	0	0.0	6	9.1
<b>Rank</b>								
Recruit trainee	1	4.1	1	4.1	1	4.1	3	12.4
Enlisted	47	3.4	26	1.9	45	3.3	118	8.6
Officer	15	5.4	3	1.1	4	1.4	22	7.9
<b>Occupation</b>								
Infantry/artillery/armor/combat engineering	3	2.9	0	0.0	3	2.9	6	5.8
Motor transport	1	1.5	0	0.0	17	25.6	18	27.1
Repair/engineering	17	2.3	9	1.2	12	1.6	38	5.2
Communications/intelligence	8	3.0	8	3.0	3	1.1	19	7.1
Health care	18	10.3	0	0.0	3	1.7	21	12.1
Other	16	4.9	13	4.0	12	3.7	41	12.5
<b>Cold season (July–June)</b>								
2019–2020	14	4.2	6	1.8	8	2.4	28	8.4
2020–2021	9	2.6	3	0.9	13	3.8	25	7.4
2021–2022	12	3.5	8	2.3	13	3.8	33	9.7
2022–2023	8	2.4	7	2.1	12	3.6	27	8.1
2023–2024	20	6.2	6	1.8	4	1.2	30	9.2

Abbreviations: No., number; y, years.

<sup>a</sup>Rate per 100,000 person-years.

**TABLE 3c.** Annual Incidence of Frostbite, Immersion Injury, and Hypothermia Among All Cold Injuries (1 type per person per year), Active Component, U.S. Air Force, July 2019–June 2024

	Frostbite		Immersion Injury		Hypothermia		All Cold Injuries	
	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>
Total	233	14.4	25	1.5	43	2.7	301	18.7
<b>Sex</b>								
Male	206	16.2	22	1.7	35	2.8	263	20.7
Female	27	7.9	3	0.9	8	2.3	38	11.1
<b>Race and ethnicity</b>								
White, non-Hispanic	117	12.5	12	1.3	22	2.3	151	16.1
Black, non-Hispanic	58	26.0	4	1.8	6	2.7	68	30.5
Hispanic	34	12.9	5	1.9	10	3.8	49	18.6
Other	24	12.6	4	2.1	5	2.6	33	17.4
<b>Age, y</b>								
<20	19	26.8	4	5.6	3	4.2	26	36.6
20–24	114	25.0	12	2.6	17	3.7	143	31.4
25–29	45	11.2	4	1.0	11	2.7	60	15.0
30–34	25	8.3	0	0.0	8	2.6	33	10.9
35–39	19	8.1	5	2.1	1	0.4	25	10.6
40–44	4	3.9	0	0.0	3	2.9	7	6.7
45+	7	15.7	0	0.0	0	0.0	7	15.7
<b>Rank</b>								
Recruit trainee	0	0.0	0	0.0	1	5.0	1	5.0
Enlisted	213	16.6	21	1.6	35	2.7	269	21.0
Officer	20	6.4	4	1.3	7	2.2	31	10.0
<b>Occupation</b>								
Infantry/artillery/armor/combat engineering	9	71.1	0	0.0	0	0.0	9	71.1
Motor transport	0	0.0	0	0.0	0	0.0	0	0.0
Repair/engineering	94	19.1	8	1.6	8	1.6	110	22.3
Communications/intelligence	36	10.5	1	0.3	6	1.7	43	12.5
Health care	9	6.1	1	0.7	2	1.4	12	8.1
Other	85	14.1	15	2.5	27	4.5	127	21.0
<b>Cold season (July–June)</b>								
2019–2020	38	11.6	2	0.6	8	2.4	48	14.6
2020–2021	47	14.3	1	0.3	9	2.7	57	17.3
2021–2022	53	16.3	5	1.5	6	1.8	64	19.7
2022–2023	48	15.1	7	2.2	7	2.2	62	19.5
2023–2024	47	15.0	10	3.2	13	4.2	70	22.3

Abbreviations: No., number; y, years.

<sup>a</sup>Rate per 100,000 person-years.



**TABLE 3d.** Annual Incidence of Frostbite, Immersion Injury, and Hypothermia Among All Cold Injuries (1 type per person per year), Active Component, U.S. Marine Corps, July 2019–June 2024

	Frostbite		Immersion Injury		Hypothermia		All Cold Injuries	
	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>
Total	156	17.7	119	13.5	84	9.5	359	40.8
<b>Sex</b>								
Male	149	18.7	109	13.6	71	8.9	329	41.2
Female	7	8.6	10	12.3	13	16.0	30	36.9
<b>Race and ethnicity</b>								
White, non-Hispanic	72	14.5	68	13.7	38	7.7	178	35.9
Black, non-Hispanic	45	51.2	9	10.2	23	26.2	77	87.7
Hispanic	29	13.1	31	14.0	14	6.3	74	33.3
Other	10	13.3	11	14.7	9	12.0	30	40.0
<b>Age, y</b>								
<20	24	20.4	61	51.8	22	18.7	107	90.8
20–24	90	21.5	46	11.0	46	11.0	182	43.4
25–29	26	16.5	9	5.7	9	5.7	44	27.9
30–34	13	16.1	2	2.5	4	4.9	19	23.5
35–39	3	4.8	1	1.6	1	1.6	5	8.0
40–44	0	0.0	0	0.0	2	7.2	2	7.2
45+	0	0.0	0	0.0	0	0.0	0	0.0
<b>Rank</b>								
Recruit trainee	2	6.3	42	132.3	14	44.1	58	182.7
Enlisted	134	18.1	68	9.2	64	8.6	266	35.9
Officer	20	18.5	9	8.3	6	5.5	35	32.3
<b>Occupation</b>								
Infantry/artillery/armor/combat engineering	92	49.1	15	8.0	21	11.2	128	68.3
Motor transport	2	4.6	2	4.6	1	2.3	5	11.6
Repair/engineering	12	5.7	8	3.8	8	3.8	28	13.2
Communications/intelligence	24	11.4	10	4.7	8	3.8	42	19.9
Health care	0	0.0	0	0.0	0	0.0	0	0.0
Other	26	11.5	84	37.1	46	20.3	156	68.8
<b>Cold season (July–June)</b>								
2019–2020	26	14.1	15	8.1	18	9.8	59	32.0
2020–2021	55	30.5	25	13.9	20	11.1	100	55.5
2021–2022	33	18.7	23	13.0	18	10.2	74	41.9
2022–2023	21	12.3	26	15.2	11	6.4	58	34.0
2023–2024	21	12.5	30	17.9	17	10.1	68	40.5

Abbreviations: No., number; y, years.

<sup>a</sup>Rate per 100,000 person-years.

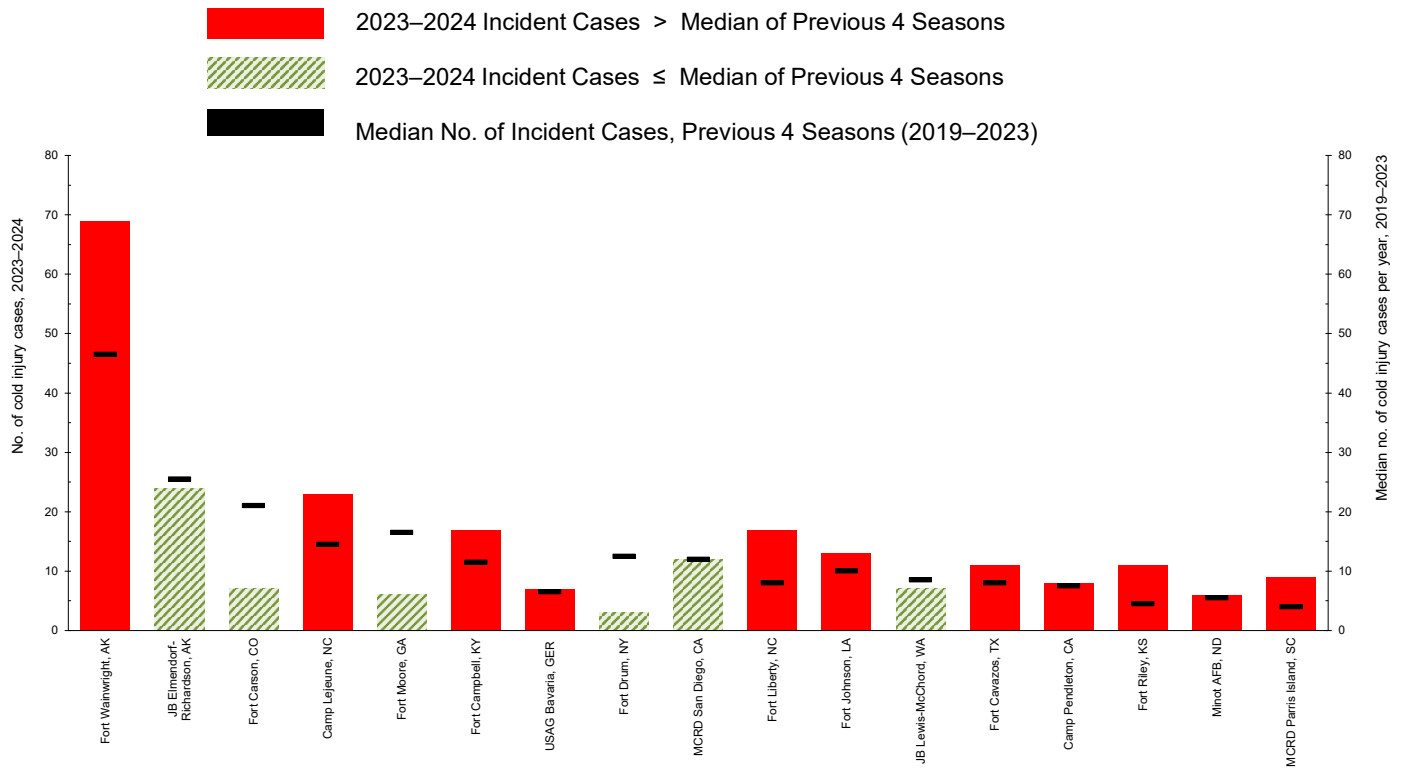
**TABLE 3e.** Annual Incidence of Frostbite, Immersion Injury, and Hypothermia Among All Cold Injuries (1 type per person per year), Active Component, U.S. Coast Guard, July 2019–June 2024

	Frostbite		Immersion Injury		Hypothermia		All Cold Injuries	
	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>
Total	7	3.5	0	0.0	5	2.5	12	6.0
<b>Sex</b>								
Male	7	4.2	0	0.0	4	2.4	11	6.5
Female	0	0.0	0	0.0	1	3.2	1	3.2
<b>Race and ethnicity</b>								
White, non-Hispanic	5	4.0	0	0.0	3	2.4	8	6.3
Black, non-Hispanic	0	0.0	0	0.0	2	19.6	2	19.6
Hispanic	1	3.3	0	0.0	0	0.0	1	3.3
Other	1	3.1	0	0.0	0	0.0	1	3.1
<b>Age, y</b>								
<20	0	0.0	0	0.0	0	0.0	0	0.0
20–24	0	0.0	0	0.0	2	4.8	2	4.8
25–29	2	5.0	0	0.0	2	5.0	4	9.9
30–34	1	2.6	0	0.0	0	0.0	1	2.6
35–39	1	2.6	0	0.0	1	2.6	2	5.3
40–44	3	13.2	0	0.0	0	0.0	3	13.2
45+	0	0.0	0	0.0	0	0.0	0	0.0
<b>Rank</b>								
Recruit trainees	0	0.0	0	0.0	0	0.0	0	0.0
Enlisted	6	3.9	0	0.0	5	3.3	11	7.2
Officer	1	2.3	0	0.0	0	0.0	1	2.3
<b>Occupation</b>								
Infantry/artillery/armor/combat engineering	0	0.0	0	0.0	0	0.0	0	0.0
Motor transport	1	3.5	0	0.0	2	7.0	3	10.5
Repair/engineering	2	3.2	0	0.0	1	1.6	3	4.8
Communications/intelligence	1	3.4	0	0.0	2	6.8	3	10.2
Health care	0	0.0	0	0.0	0	0.0	0	0.0
Other	3	4.0	0	0.0	0	0.0	3	4.0
<b>Cold season (July–June)</b>								
2019–2020	1	2.5	0	0.0	0	0.0	1	2.5
2020–2021	1	2.5	0	0.0	1	2.5	2	5.0
2021–2022	1	2.5	0	0.0	1	2.5	2	5.0
2022–2023	2	5.1	0	0.0	1	2.6	3	7.7
2023–2024	2	5.1	0	0.0	2	5.1	4	10.2

Abbreviations: No., number; y, years.

<sup>a</sup>Rate per 100,000 person-years.

**FIGURE 3.** Annual Frequency (cold season 2023–2024) and Median Numbers (cold seasons 2019–2023) of Cold Injuries at Locations with at Least 25 Cold Injuries During the Surveillance Period, Active Component, U.S. Armed Forces, July 2019–June 2024



Abbreviations: No., number; >, greater than; ≤, less than or equal to; JB, Joint Base; USAG, U.S. Army Garrison; GER, Germany; AFB, Air Force Base; MCB, Marine Corps Base; MCRD, Marine Corps Recruit Depot.

### Cold weather injuries by geographic location

During the 5-year surveillance period, 17 military locations reported at least 25 incidents of cold weather injury (1 per person per cold season) among ACSMs. **Figure 3** charts the 2023-2024 seasonal number of cold weather injuries (1 per person per year) in addition to the median case numbers for the previous 4 cold seasons for each of those 17 locations. The highest 5-year counts of incident cold weather injuries for seasons 2019-2024 were recorded at Fort Wainwright, AK (n=282), Joint Base Elmendorf-Richardson, AK (n=181), Fort Carson, CO (n=87), Marine Corps Base Camp Lejeune, NC (n=79), and Fort Moore, GA (n=75) (data not shown).

### Discussion

The overall rate of any cold weather injury in 2023-2024 for the active and reserve components increased by 8.4% and 9.1%, respectively, from the previous cold season. The rate increase for the current cold season was most pronounced in the Marine Corps active component (21.3%) and reserve component (163.3%). The Coast Guard and Space Force average less than 5 cases per year among their ACSMs, thus, small changes in the numbers of cases annually will result in abnormally large fluctuations in the injury rate. During the 2023-2024 cold season, the Air Force experienced its highest rate of any cold weather injury (21.4 per 100,000 p-yrs) over the 5-year surveillance period.

For the first 3 years of the 5-year surveillance period, the most common cold weather injury observed in ACSMs overall was frostbite, but in the last 2 years of the surveillance period immersion injury rates were higher for Marine Corps service members. This change in injury type prevalence could indicate a shift in environmental risk factors, but it does not signal a shift in injury severity. The long-term complications of non-freezing injury are similar to, and equally debilitating as, those produced by frostbite: hypersensitivity to cold, chronic pain, and severe pain induced by walking.<sup>17,18,20</sup>

Similar to previous *MSMR* reports, the highest cold weather injury rates were observed among male, younger age group, and non-Hispanic Black or African American service members.<sup>8,24</sup> Higher rates of

cold weather injury have also been noted among service members in the United Kingdom (U.K.) military with similar demographic characteristics.<sup>21,25,26</sup> Differences in physiological responses to cold stress have been observed between different racial and ethnic groups, with individuals of African descent demonstrating greater vasoconstriction responses compared to individuals of Asian or Caucasian descent.<sup>10,15,27</sup> Furthermore, signs and symptoms of cold weather injuries (e.g., skin redness, blotchy skin, waxy and white skin) may initially be more difficult to see on service members with skin of color.<sup>28-29</sup> Service members, leadership, and medical personnel should be educated on the early signs and symptoms of cold weather injuries for a wide range of skin types.

When examining the service-specific demographic groups with increased rates, it should be noted that there were differences in the most frequently observed cold weather injury type. Younger marines had higher rates of hypothermia and younger soldiers had higher rates of frostbite compared to other cold weather injury types. These differences could indicate different situational risk factors for cold weather injury within the services, for example, training activities, occupational tasks, and geographic region. A study of U.K. service personnel noted that the most common situational risk factors for non-freezing peripheral injury were standing guard, as well as wet socks and boots.<sup>21</sup> Unit leaders must be able to assess environmental, situational, and individual risk factors of their training and operational settings and understand how those factors increase risk of cold weather injuries for service members in their charge.

It should be noted that this analysis of cold weather injuries was unable to distinguish between injuries sustained during official military duties (e.g., training or operations) and those associated with unrelated or personal activities. In addition, the personnel files from the Defense Manpower Data Center used to calculate the population estimates for the active and reserve components as well as the demographic data presented in **Tables 3a–3e** for the active component were unavailable for May and June 2024; the duty statuses of

all service members, active and reserve, in April 2024 were assumed to be their May and June 2024 statuses. It is likely that some individuals in the U.S. Armed Forces both joined and left service during those months, and those movements are unaccounted for in the population estimates. Likewise, it is possible some time-varying demographics (e.g., age and rank) changed for individuals in May and June 2024, compared to April, and those shifts in categories are unaccounted. In all instances, however, the effect on the rates shown throughout the report should be minimal due to the large population size.

Cold weather injuries can be prevented by ensuring proper clothing, including layers that can be added or removed according to environmental conditions and physical activity, along with footwear that is non-constrictive, dry, and regularly changed if wet.<sup>9,10,22</sup> Maintenance of proper hydration and nutrition, avoidance of long periods of sedentary or immobile positions, and planning for appropriate shelter and opportunities for re-warming are also important. Military training or mission requirements in cold and wet weather conditions can preclude immediate warm or dry shelter, ability to change wet or damp clothing, or even healthy physical activity.<sup>2,3,11</sup> To prepare for all circumstances posing a threat for cold weather injury, service members should be cognizant of, and able to identify, signs of cold weather injury in addition to environmental, individual and situational risk factors. Service members should also be aware of protective measures for themselves and their fellow service members, whether during training, operations, combat, or recreational activities in wet or freezing conditions.

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#### *Disclaimer*

*The views expressed in this presentation are those of the authors and do not necessarily reflect the official policy of the Department of Defense, Defense Health Agency, nor the U.S. Government.*

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# Trends of Ischemic Heart Disease and Cerebrovascular Disease in Active Component Female Service Members, 2014–2023

Valentina Donici, MD; Shauna L. Stahlman, PhD, MPH; Michael T. Fan, PhD; Richard S. Langton, MD

This study summarizes trends from 2014 through 2023 in the incidence of ischemic heart disease and cerebrovascular heart disease among U.S. active component female service members and identifies potential military-specific risk factors for these conditions. Female-specific risk factors, such as mental health, for ischemic heart and cerebrovascular diseases have only recently been recognized. Crude incidence rates were assessed for each outcome and Poisson regression was used to calculate adjusted incidence rates, controlling for multiple covariates. After adjustment, non-Hispanic Black active component U.S. service women had higher rates for both ischemic heart disease and cerebrovascular disease compared to non-Hispanic White service women (IRR=1.68 and 1.24, respectively). A prior diagnosis of depressive or anxiety disorder resulted in a 90% increased rate of ischemic heart disease and 70% increased rate of cerebrovascular disease. Air Force members had a 55% increased rate of ischemic heart disease. This study identifies both military-specific and demographic risk factors for these 2 cardiovascular diseases and demonstrates potential opportunity for early age preventive care, even among a relatively young and healthy population.

A recent report on coronary heart disease in the U.S. noted that in 2018 the prevalence of ischemic heart disease in women was 4.7%.<sup>1</sup> While overall mortality from ischemic heart disease in the U.S. improved from 1979 to 2011 with medical advances, it has, unfortunately, stagnated for women under 55 years of age.<sup>2</sup> Studies have advocated for a closer analysis of the impact of new “emerging non-traditional” atherosclerotic cardiovascular disease risk factors, 1 of which is mental health disorder and psychological trauma.<sup>3</sup> Ebrahimi noted in 2017 that rates of cardiac disease mortality among female veterans were higher by 26.4% than among civilian women.<sup>4</sup> The authors of that study hypothesized that the causes are likely multifactorial and include treatment non-adherence, higher prevalence of cardiovascular risk

factors, and greater clinical complexity within the veteran female population.

Cerebrovascular disease is also an important source of morbidity and mortality among women, with many etiologic and pathologic pathways that are not optimally understood. It is reported that 54.2% of the 7 million stroke survivors in the U.S. are women.<sup>5</sup> Consequently, it is important to study the risk factors that may disproportionately affect women.

The U.S. Department of Defense has a growing female military population that functions in a variety of military settings, including deployments, combat trades, and other military-specific activities. These activities may increase individuals’ chronic stress and risk for post-traumatic stress disorder (PTSD), as noted by Bourassa and by Cohen, in their respective studies on 9/11

## What are the new findings?

Among active component U.S. service women, incidence of ischemic heart disease increased between 2014 (31.2 per 100,000 person-years) and 2019 (54.7 per 100,000 p-yrs), while incidence of cerebrovascular disease decreased during that period and increased between 2019 (28.5 per 100,000 p-yrs) and 2023 (46.4 per 100,000 p-yrs). Older age, non-Hispanic Black race and ethnicity, and prior depressive or anxiety disorder diagnosis were identified as potential risk factors for both outcomes.

## What is the impact on readiness and force health protection?

Cardiovascular diseases are often overlooked among women, but this study identified both military-specific (e.g., branch of service, prior depressive disorder diagnosis) as well as demographic (e.g., race, age) potential risk factors, and demonstrated there may be an opportunity for preventive intervention even among this relatively young and healthy population.

and military veterans.<sup>6,7</sup> Identifying potential correlations between these military experiences and rates of cerebrovascular disease could identify new areas of focus, to mitigate the effects of these risk factors on the long-term health of female service members. Given the paucity of existing data, this study aims to fill a gap in the current knowledge of active duty women’s health.

The primary objective of this study was to identify trends in incidence of ischemic heart disease and cerebrovascular disease among U.S. active component female service members between 2014 and 2023. The secondary objective was to identify potential military-specific risk factors for these conditions among U.S. active component female service members.

## Methods

This surveillance study examined a retrospective cohort of active component female service members in the U.S. Army, Air Force, Navy, Marine Corps, and Air Force (including Space Force) between January 1, 2014 and December 31, 2023. The data source was the Defense Medical Surveillance System (DMSS).

The outcomes assessed were ischemic heart disease and cerebrovascular disease (Table 1). To qualify as a case, an individual had to have an inpatient record with a diagnosis in the first or second diagnostic position, or at least 2 outpatient visits within a 60-day range with a diagnosis in the first or second diagnostic position, with a qualifying International Classification of Diseases, 9th Revision, Clinical Module (ICD-9-CM) or 10th Revision (ICD-10-CM) diagnosis. Incidence was calculated per 100,000 person-years (p-yrs) of active component service. Person-years were included from the time a woman enrolled in active component service until the time she separated from service, or the end of the surveillance period on December 31, 2023, whichever occurred first. In addition, prevalent

cases (i.e., incident cases prior to January 1, 2014) were excluded separately for each outcome, and person-time was censored at the incident diagnosis date.

The risk factors assessed included history of diagnosis of hyperlipidemia, hypertension, diabetes, obesity, tobacco use or nicotine dependence, depression, anxiety, PTSD, and sleep apnea (Table 1). An individual was defined as having a history of diagnosis for each of these conditions if the individual had at least 1 inpatient or 1 outpatient encounter with a specified diagnosis in any diagnostic position, including any diagnoses since the individual joined military service. Additional demographic covariates included age, race and ethnicity, service branch, rank, military occupation, and deployment history. The covariates were chosen based on known traditional cardiovascular factors, along with military-specific risk factors identified by the authors.

Crude (i.e., unadjusted) incidence rates were calculated per 100,000 p-yrs. A multivariable Poisson regression model was used to calculate adjusted incidence rate ratios, separately, for the outcomes of ischemic heart disease and cerebrovascular

disease. Age, race and ethnicity, service branch, military occupation, rank, deployment history, history of a prior risk factor (e.g., hyperlipidemia, hypertension, diabetes, obesity, tobacco use or nicotine dependence) diagnosis, history of anxiety or depression diagnosis, and history of PTSD diagnosis were included as independent variables in the model. Reference categories were selected based on the largest number of individuals for a given category. All analyses were performed using SAS Enterprise Guide version 8.4.

## Results

### Study Population

The population characteristics of U.S. active component female service members are described in prior MSMR reports.<sup>18</sup> This study included a total of 2,154,313.5 female active component p-yrs from 2014 to 2023, with 65.3% of the study population under 30 years of age and 26.5% from 30 to 39 years of age. Less than half (42.2%) were non-Hispanic White, 24.8% were non-Hispanic Black, and 18.8% were Hispanic.

**TABLE 1.** ICD-10-CM Codes Utilized to Identify Outcome and Exposure Variables

	ICD-10-CM	ICD-9-CM
<b>Outcome</b>		
Ischemic heart disease	I20.*–I25.*	410.*–414.*
Cerebrovascular disease	I60.*–I66.*, I67.2	430.*–436.*, 437.0, 437.1, 437.2
<b>Exposures</b>		
Essential hypertension	I10.0, I16.*	401.*
Hyperlipidemia	E78.0*–E78.5*	272.0–272.4
Obesity	E66.0*–E66.2*, E66.8, E66.9, Z68.3*, Z68.4*	278.00, 278.01, 278.03, V85.3*, V85.4*, V85.54
Diabetes mellitus or abnormal glucose level	E10.*, E11.*, R73.*	250.*, 790.2*
Depressive disorder	F32.*, F33.*, F34.0, F34.1, F34.8, F34.9, F39.0, F34.81, F34.89	296.2, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.20, 311.0, 296.3, 296.30, 296.31, 296.32, 296.33, 296.35, 296.36, 296.99, 300.4, 296.90, 296.9
Anxiety disorder	F40.*, F41.*, F42.*	300.22, 300.21, 300.23, 300.29, 300.20, 300.01, 300.02, 300.09, 300.00, 300.3
PTSD	F43.1, F43.10, F43.11, F43.12	309.81
Smoking or nicotine dependence	F17.2*, Z72.0, Z87.891	305.1, V15.82
Sleep apnea	G47.3*	780.51, 780.57, 327.2*, 780.53

Abbreviations: ICD-10-COM, International Classification of Diseases, 10th edition, Clinical Modification; ICD-9-COM, International Classification of Diseases, 9th edition, Clinical Modification; PTSD, post-traumatic stress disorder.

\*Includes all subsequent digits and characters.

## Ischemic Heart Disease

A total of 936 incident cases of ischemic heart disease were identified during the surveillance period (Table 2), resulting in a rate of 43.4 cases per 100,000 p-yrs. Over the observed 10 years, the total annual rate increased between 2014 and 2018, then stabilized between 2018 and 2023 (Figure 1).

The rate of ischemic heart disease of the 30-39-year age group was twice as high as the rate of the under-30 age group (48.3 and 23.5 cases per 100,000 p-yrs, respectively). Non-Hispanic Black service women had 1.7 times the rate of ischemic heart disease compared to non-Hispanic White service women. Air Force and Space Force members had the highest rates compared to other branches, and those in health care occupations had a higher rate compared to other military occupations. Senior enlisted members and senior officers had higher rates than junior enlisted members or junior officers. Those with a prior diagnosis of a depressive or anxiety disorder or PTSD had 3.1, 2.5, and 1.9 times, respectively, the rate of ischemic heart disease compared to those without such diagnoses.

After adjusting for potential confounders, non-Hispanic Black women had a 68% higher rate compared to non-Hispanic White women (Table 3). In addition, prior diagnosis of a depressive or anxiety disorder resulted in a 90% increased rate of ischemic heart disease. Deployment history, military occupation, and prior PTSD diagnosis were not, however, significantly associated with ischemic heart disease after adjustment for other factors. Compared to junior enlisted personnel, junior officers had a 27% smaller rate, while senior officers were not statistically significantly different from junior enlisted service members.

## Cerebrovascular Disease

There were 814 cases of cerebrovascular disease during the surveillance period (37.8 cases per 100,000 p-yrs.). The overall annual rate had a significant dip between 2016 and 2020, but then progressively returned to the 2014 rate thereafter (Figure 1). The rate for the 30-39-year age group was more than double of the under-30-year age group (48.8 and 23.8 cases per 100,000 p-yrs, respectively). Compared to their respective counterparts, unadjusted rates were highest among non-Hispanic Black female service members, senior officers, health care workers, and those with multiple prior deployments.

**TABLE 2.** Incident Counts and Rates of Cardiovascular Disease by Type and Demographic and Military Characteristics, Active Component, U.S. Armed Forces, 2014–2023

	Ischemic Heart Disease		Cerebrovascular Disease	
	No.	Rate <sup>a</sup>	No.	Rate <sup>a</sup>
<b>Total</b>	936	43.4	814	37.8
Inpatient	193	9.0	231	10.7
Outpatient	743	34.5	583	27.1
<b>Race and ethnicity</b>				
White, non-Hispanic	340	37.4	332	36.5
Black, non-Hispanic	342	64.0	272	50.9
Hispanic	139	34.3	112	27.6
Other/unknown	115	37.6	98	32.1
<b>Age group, y</b>				
<30	331	23.5	335	23.8
30–39	276	48.3	279	48.8
40–49	227	146.2	151	97.3
50+	102	471.5	49	224.3
<b>Service branch</b>				
Army	341	48.2	301	42.6
Navy	180	28.1	219	34.2
Air Force/Space Force	394	60.6	257	39.5
Marine Corps	21	13.5	37	23.8
<b>Rank</b>				
Junior enlisted (E1-E4)	248	25.8	257	26.8
Senior enlisted (E4-E9)	431	55.7	395	51.1
Junior officer (O1-O3)	73	26.9	57	21.0
Senior officer (O4-O10)	168	127.0	92	69.6
Warrant officer (W01-W05)	16	93.5	13	76.2
<b>Occupation</b>				
Combat-specific	14	24.9	12	21.4
Armor/motor transport	21	31.2	18	26.8
Pilot/air crew	13	39.0	9	27.0
Repair/engineering	141	32.9	145	33.8
Communications/intelligence	310	45.0	277	40.3
Health care	241	59.8	205	50.9
Other	196	41.0	148	31.0
<b>Number of prior deployments</b>				
0	449	31.4	434	30.3
1	211	53.7	166	42.3
2+	276	83.6	214	64.8
<b>PTSD history</b>				
Yes	250	73.1	194	56.7
No	686	37.9	620	34.2
<b>Depressive disorder history</b>				
Yes	382	98.4	305	78.6
No	554	31.4	509	28.8
<b>Anxiety disorder history</b>				
Yes	109	102.2	105	98.4
No	827	40.4	709	34.6
<b>Hyperlipidemia</b>				
Yes	272	254.5	192	124.1
No	664	32.4	622	33.4
<b>Hypertension</b>				
Yes	241	230.3	130	124.1
No	695	33.9	684	33.4
<b>Diabetes or abnormal glucose</b>				
Yes	275	103.8	194	73.2
No	661	35.0	620	32.8
<b>Obesity</b>				
Yes	145	182.9	98	123.6
No	791	38.1	716	34.5
<b>Tobacco use or nicotine dependence</b>				
Yes	319	91.1	279	79.8
No	617	34.2	535	29.7
<b>Obstructive sleep apnea</b>				
Yes	174	183.0	119	125.1
No	762	37.0	695	33.8

Abbreviations: No., number; y, year; PTSD, post-traumatic stress disorder; p-yrs, person-years.  
<sup>a</sup>Rate per 100,000 p-yrs.



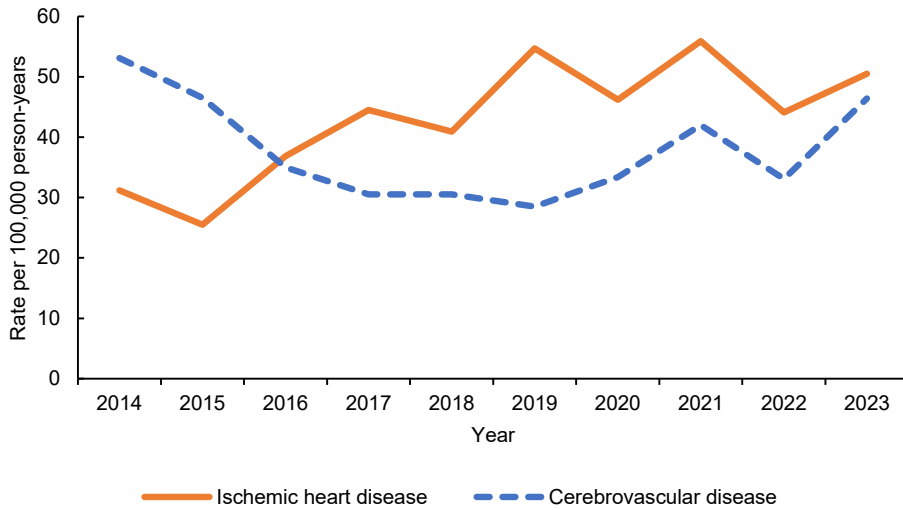
**TABLE 3.** Adjusted Incidence Rate Ratios for Cardiovascular Disease, Active Component Service Women, U.S. Armed Forces, 2014–2023

	Ischemic Heart Disease			Cerebrovascular Disease		
	aIRR	95% LL	95% UL	aIRR	95% LL	95% UL
<b>Race and ethnicity</b>						
White, non-Hispanic	Reference	--	--	Reference	--	--
Black, non-Hispanic	1.7	1.4	2.0	1.2	1.0	1.5
Hispanic	1.2	1.0	1.5	0.8	0.7	1.0
Other/unknown	1.1	0.9	1.4	0.9	0.7	1.1
<b>Age group, y</b>						
<30	Reference	--	--	Reference	--	--
30–39	1.5	1.2	1.8	1.7	1.4	2.1
40–49	3.8	3.0	4.9	3.0	2.3	3.9
50+	12.0	8.8	16.5	6.9	4.7	10.1
<b>Service branch</b>						
Army	Reference	--	--	Reference	--	--
Navy	0.8	0.7	0.9	1.0	0.8	1.2
Air Force/Space Force	1.6	1.3	1.8	1.0	0.9	1.2
Marine Corps	0.5	0.3	0.8	0.9	0.7	1.3
<b>Rank</b>						
Junior enlisted (E1-E4)	Reference	--	--	Reference	--	--
Senior enlisted (E5-E9)	0.8	0.6	1.0	0.8	0.7	1.0
Junior officer (O1-O3)	0.7	0.6	1.0	0.6	0.4	0.8
Senior officer (O4-O10)	0.8	0.6	1.1	0.6	0.4	0.8
Warrant officer (W01-W05)	0.8	0.4	1.3	0.8	0.4	1.4
<b>Occupation</b>						
Combat-specific	1.1	0.7	1.9	0.9	0.5	1.6
Armor/motor transport	1.1	0.7	1.7	0.8	0.6	1.3
Pilot/air crew	1.6	0.9	2.8	1.2	0.7	2.5
Repair/engineering	1.1	0.9	1.3	1.1	0.9	1.3
Communications/intelligence	Reference	--	--	Reference	--	--
Health care	1.0	0.9	1.2	1.2	1.0	1.5
Other	1.1	0.9	1.3	1.0	0.8	1.2
<b>Number of prior deployments</b>						
0	Reference	--	--	Reference	--	--
1	0.9	0.8	1.1	0.9	0.7	1.1
2+	1.0	0.9	1.2	1.0	0.8	1.2
<b>Prior risk factor diagnosis<sup>a</sup></b>						
Yes	2.3	1.9	2.7	2.0	1.7	2.3
No	Reference	--	--	Reference	--	--
<b>Prior depressive or anxiety disorder diagnosis</b>						
Yes	1.9	1.7	2.2	1.7	1.5	2.0
No	Reference	--	--	Reference	--	--
<b>Prior PTSD diagnosis</b>						
Yes	1.1	0.9	1.4	1.4	1.1	1.8
No	Reference	--	--	Reference	--	--

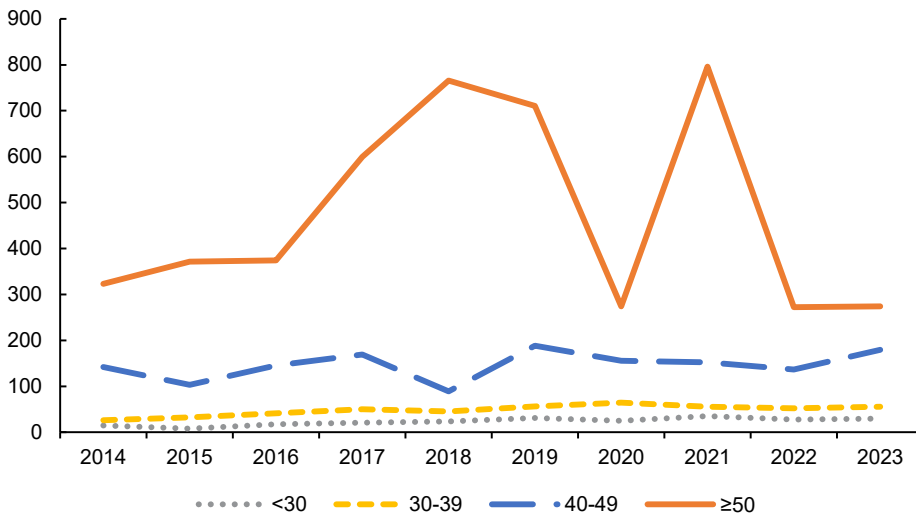
Abbreviations: aIRR, adjusted incidence rate ratio; LL, lower limit; UL, upper limit; y, years; PTSD, post-traumatic stress disorder.

<sup>a</sup>Includes prior diagnosis of hyperlipidemia, hypertension, diabetes or abnormal glucose, obesity, tobacco or nicotine dependence, or sleep apnea.

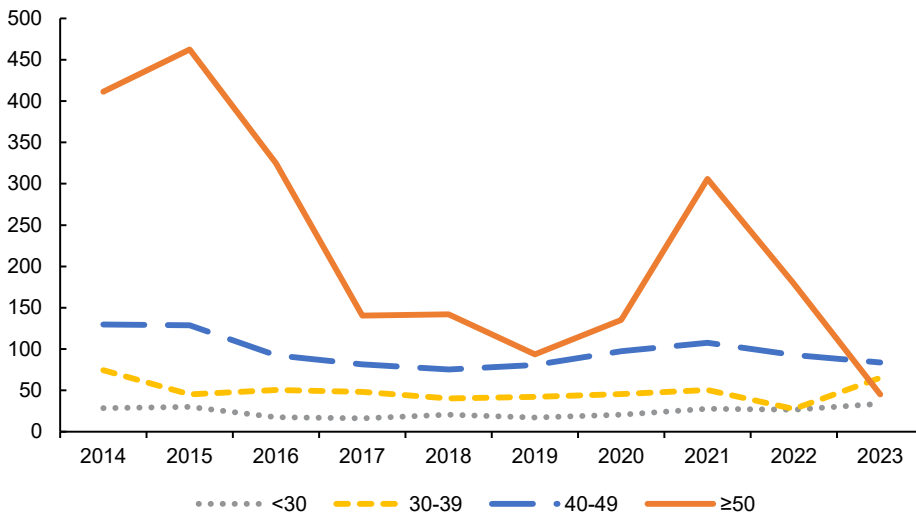
**FIGURE 1.** Incidence of Ischemic Heart Disease and Cerebrovascular Disease, Active Component Service Women, 2014–2023



**FIGURE 2.** Annual Rates of Ischemic Heart Disease, by Age Group



**FIGURE 3.** Annual Rates of Cerebrovascular Disease, by Age Group



After adjustment, non-Hispanic Black service women continued to have a higher rate of cerebrovascular disease when compared to non-Hispanic White service women (1.24 aIRR), and those with a prior diagnosis of PTSD, depression, or anxiety continued to have a significantly increased rate of cerebrovascular disease compared to those without a history of diagnosis for those conditions. Those in pilot or air crews and health care occupations had a non-statistically significant increased rate of cerebrovascular disease (24% and 19%, respectively) when compared to communications and intelligence occupations. Although the crude rate for senior officers was more than double of that of junior enlisted service members, after adjustment senior officers had a 40% lesser rate than junior enlisted members.

## Discussion

### Ischemic Heart Disease

This study found that non-Hispanic Black women and those aged 30 years and older had higher adjusted rates of ischemic heart disease among active component service women. The finding of higher rates among non-Hispanic Black women is consistent with studies published for the U.S. population.<sup>8</sup> It was also noted that the rate increased by 48% in the 30-39-year age range when compared to the under-30 age group, which was similar to findings from the Veterans Administration study by Chen that found increased cardiovascular disease risk starting as early as age 30 years.<sup>9</sup> This is important, as it suggests there is opportunity for intervention at younger ages to prevent risk of developing cardiovascular disease in later life.

The Air Force's increased incidence rate of ischemic heart disease correlates with findings from literature on airline pilots and cockpit crews.<sup>10</sup> Those populations are prone to cardiovascular disease due to prolonged sedentary posture, occupational stress and emotional tension, forced operational speed, acceleration, frequent time zone changes, and noise and unbalanced diets.<sup>10</sup> The Marine Corps, on the other hand, had a significantly lower rate than other services, which may be due to reduced symptom reporting by patients to health services,

as well as a 'healthy-warrior' effect, since the Marine Corps has stringent fitness requirements. Findings from this study also suggest a correlation between socioeconomic status (i.e., pay scale) and risk for heart diseases, because junior enlisted members had higher adjusted rates of both outcomes compared to junior officers.

This study also found that a prior diagnosis of depression or anxiety almost doubled risk of ischemic heart disease among active component service women. Multiple studies have pointed to the link between depression and coronary artery disease, with a stronger association observed in younger women.<sup>3,17</sup> Prior diagnosis of PTSD did not show a statistically significant association with ischemic heart disease. It is possible, however, that the association between PTSD and ischemic heart disease was diminished by adjusting for depressive disorder diagnosis, which could be correlated with PTSD.<sup>11</sup>

### Cerebrovascular Disease

Consistent with other studies,<sup>12</sup> non-Hispanic Black women have increased adjusted rates for cerebrovascular disease when compared to non-Hispanic White women. The junior and senior officer groups have lower adjusted rates when compared to junior enlisted members, which, once again, may indicate a root cause stemming from social determinants of health such as financial stability or lower levels of education. A prior diagnosis of depression, anxiety, or PTSD all present an elevated incidence rate of cardiovascular disease, in accordance with the National Institutes of Health's statement that anxiety, depression, and high stress levels may raise risk of stroke.<sup>13</sup>

Although higher unadjusted rates of ischemic heart disease and cerebrovascular disease were observed among those with multiple deployments, after adjusting for potential confounders this was not the case, which suggests that the crude association may have been confounded by age or other covariates such as depression.

Most of the limitations of this study are due to the use of ICD code diagnoses as the only source of information on the presence of a risk factor or an outcome. Obesity and smoking are likely underrepresented, as risk factor cases are not identified if not documented as a concern during a patient encounter. The addition of periodic health

assessment data would likely result in additional identification of risk factor cases, but these data prior to 2018 are not available in DMSS. Outcomes may be underestimated due to the use of surveillance case definitions that require 2 outpatient encounters within 60 days. Also, female-specific risk factors such as reproductive health (e.g., contraception or pregnancy) were not analyzed. Finally, DMSS lacks Asian/Pacific Islander data for the Air Force, which forced the inclusion of this population in the 'Other' race and ethnicity category.

The risk factors for both ischemic heart disease and cerebrovascular disease are complex and tightly intertwined. A recommendation would be to investigate more thoroughly the effect of each separate mental health diagnosis (e.g., depression, anxiety) with further exploration into the potential association with deployment history, operational PTSD, and development of cardiovascular disease later in life. Cardiovascular diseases are often overlooked among women, but this study identified both military-specific (e.g., service branch, prior depressive disorder diagnosis) and demographic (e.g., race, age) potential risk factors, demonstrating future opportunity for preventive intervention among even this relatively young and healthy population.

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# Percent of Male and Female Cadets with Radiographically-Confirmed Bone Stress Injuries During Basic Cadet Training, U.S. Air Force Academy, 2022–2024

Matthew J. Hogan, DPT; Ellie M. Prinster, DPT; Bridget K. Caulkins, MD; Nathan J. Deming, DPT, PhD; Bryant J. Webber, MD, MPH

Bone stress injuries (BSIs) are injuries from overuse that typically result from repetitive, high-intensity, weight-bearing activities—and therefore may be preventable by risk factor modification.<sup>1</sup> Compared to active component service members, BSIs are more common in military trainees.<sup>2</sup> Basic Cadet Training, an annual 6-week summer program for individuals selected for enrollment at the U.S. Air Force Academy, Colorado, emphasizes physical and mental conditioning and profession of arms indoctrination.

Basic trainees with potential BSIs are managed in the physical therapy and sports medicine clinics according to an algorithm designed for military training environments.<sup>3</sup> Plain film radiograph and magnetic resonance imaging are used for diagnostic confirmation.

A total of 3,331 trainees participated in U.S. Air Force Basic Cadet Training from 2022 through 2024. During the 3 training iterations during that period, 57 radiographically-confirmed BSIs occurred, in 1.7% of trainees. BSIs occurred in the lower leg (n=37; 64.9%), ankle (n=8; 14.0%), foot (n=7; 12.3%), and hip (n=5; 8.8%). Female trainees were over 3 times as likely to experience radiographically-confirmed BSIs than males (percent ratio: 3.35; 95% CI: 1.99, 5.64).

Radiographically-confirmed BSIs declined among both males and females during the surveillance period. While the percentage of cadets with radiologically-confirmed BSIs declined by 76.6% from 2022 to 2024, this descriptive study cannot attribute any particular countermeasure to this decline. Further investigation is warranted to assess the impacts of 2 countermeasures recommended by medical staff that were implemented in latter iterations, as described by the Basic Cadet Training Director of Operations (e-mail communication, Aug. 16, 2024). In 2023, and re-emphasized in 2024, the physical fitness program was modified to establish a more tightly standardized regimen featuring a gradual increase in intensity. Second, in 2024 basic trainees were provided more time to ‘break in’ their combat boots before their use in formation running.

Surveillance and work-up biases are unlikely, as medical access and clinical evaluation were unchanged during this period. Likewise, the preparatory fitness program detailed in the U.S. Air Force Academy Appointee Handbook did not change. These data suggest that modifications to the fitness training regimen may reduce BSIs during Basic Cadet Training at a military service academy.

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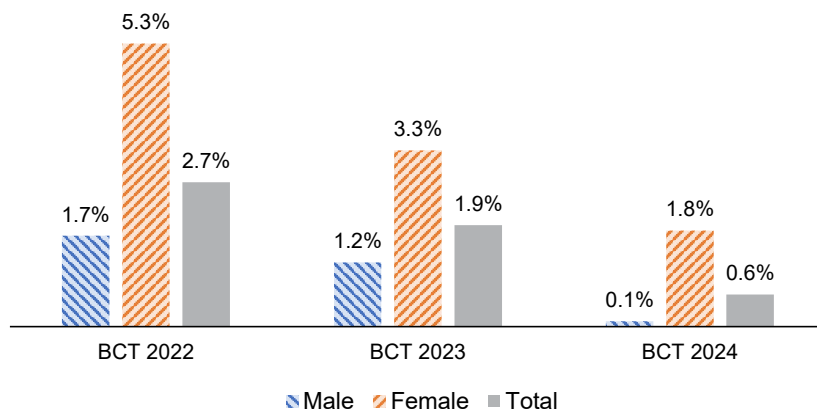
### Disclaimer

The views expressed in this research are those of the authors and do not necessarily reflect the official policy nor position of the Department of the Air Force, Department of Defense, or the U.S. Government.

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**FIGURE.** Percent of Radiographically-Confirmed<sup>a</sup> Bone Stress Injuries Among Male and Female Cadets During Basic Training, U.S. Air Force Academy, 2022–2024



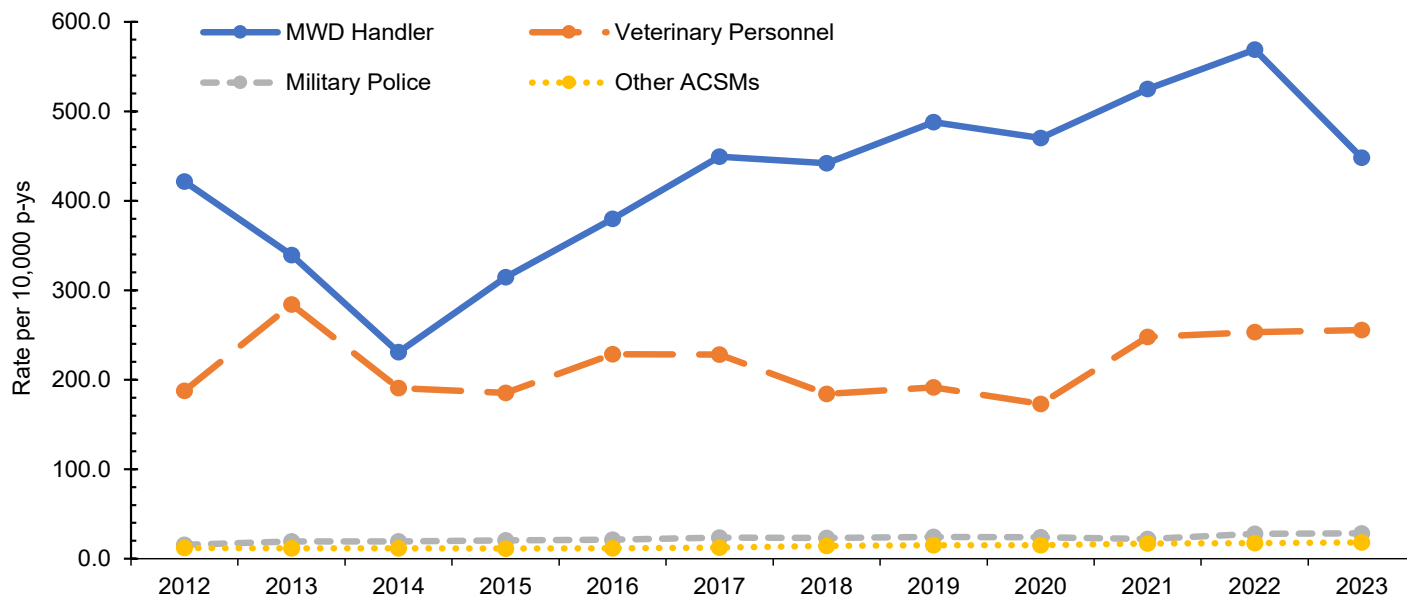
Abbreviation: BCT, Basic Cadet Training.

<sup>a</sup>Includes those confirmed by plain film or magnetic resonance imaging.

# Incidence of Dog Bites Among Military Working Dog Handlers, 2012–2023

Sithembile L. Mabila, PhD, MSc; Jessica H. Murray, MPH; Shauna L. Stahlman, PhD, MPH; Edward A. Sheriff, PhD, MPH; Alexis A. McQuistan, MPH

**FIGURE.** Rate of Active Component Service Members with an Incident Diagnosis of Dog Bite Injury<sup>a</sup>, 2012–2023



Military Occupation	MWD Handler	Veterinary Personnel <sup>b</sup>	Military Police	Other ACSMs <sup>c</sup>
Overall Rate <sup>d</sup>	422.9	216.1	22.5	13.9

Abbreviations: MWD, military working dog; ACSMs, active component service members; p-yrs, person-years.  
<sup>a</sup> Dog bite injuries counted once per year  
<sup>b</sup> Only Army personnel are included as veterinarian medicine is centralized to the Army service.  
<sup>c</sup> Includes all other ACSMs, excluding MWD handlers, veterinary personnel, and military police.  
<sup>d</sup> Rate per 10,000 p-yrs.

Working with Military Working Dogs (MWDs) involves the risk of dog bites, some of which can be debilitating or cause permanent disability.<sup>1</sup> Dogs working in law enforcement are specially trained to exert a higher bite force compared to domestic dogs.<sup>2,3</sup> Among military personnel, severe dog bites inflict a significant medical and logistical burden in the form of emergency evacuations, antibiotic treatments, and lost duty time.<sup>1</sup> Risk of dog bites may vary depending on military occupation. The objective of this analysis was to compare incidence of dog bites among active component service members (ACSMs) in mutually exclusive occupation groups: MWD handlers, veterinary personnel, military police, and other ACSMs.

Dog bites were defined by having an in-theater, ambulatory, or inpatient encounter in the Defense Medical Surveillance System (DMSS) with a defining diagnosis in any diagnostic position.<sup>4</sup> A dog bite was counted once per year. Person-time contributions for each service member were determined from January 1, 2012 through December 31, 2023. Person-time was calculated for the time in which service members were in the occupation of interest. Person-time was censored when a service member left a designated occupation, left the active component service, or at the end of surveillance period, whichever occurred first. Incident dog bite cases were determined, and crude incidence rates (IRs) were calculated per 10,000 person-years (p-yrs). All analyses were conducted using SAS-Enterprise Guide (version 8.3).

During the surveillance period, there were 1,186 dog bites among 990 MWD handlers, 263 dog bites among 236 veterinary personnel, 1,473 dog bites among 1,411 military police and 20,837 dog bites among 20,322 all other ACSMs (data not shown). Repeated bites were more common among MWD handlers (16.7%) and veterinary personnel (10.6%) than among military police (4.5%) and all other ACSMs (2.5%). Overall, the incidence rate of dog bites was more than 20 times higher among MWD handlers (422.9 cases per 10,000 p-yrs) compared to military police (22.5 cases per 10,000 p-yrs) and other ACSM (13.9 cases per 10,000 p-yrs) (**Figure**). Veterinary personnel had the second highest incidence of dog bites with 216.1 dog bites per 10,000 person-yrs. (**Figure**). Dog bite incidence rates among MWD handlers ranged from 421.4 cases per 10,000 p-yrs in 2012 to 448.3 cases per 10,000 p-yrs in 2023, where 2022 accounted for highest incident rate (569.0 cases per 10,000 person-yrs.) (**Figure**). Comparatively, dog bite incidence rates among veterinary personnel ranged from 187.5 cases per 10,000 p-yrs in 2012 to 255.5 cases per 10,000 p-yrs in 2023 (**Figure**).

MWD handlers had a dog bite incidence rate that was more than 20 times higher compared to military police and other ACSMs. Moreover, veterinary personnel had a 10 times higher dog bite incidence compared to military police and other ACSMs. MWD handlers and veterinary personnel may interact with MWDs in times of stress for the animals, which may increase their risk of bites. Training MWDs and providing veterinary care to MWDs may put MWD handlers and veterinary personnel at a higher risk of dog bites requiring medical care compared to service members in other occupations. The higher incidence of dog bites highlights the importance of proper training and protective measures for service members working with dogs.

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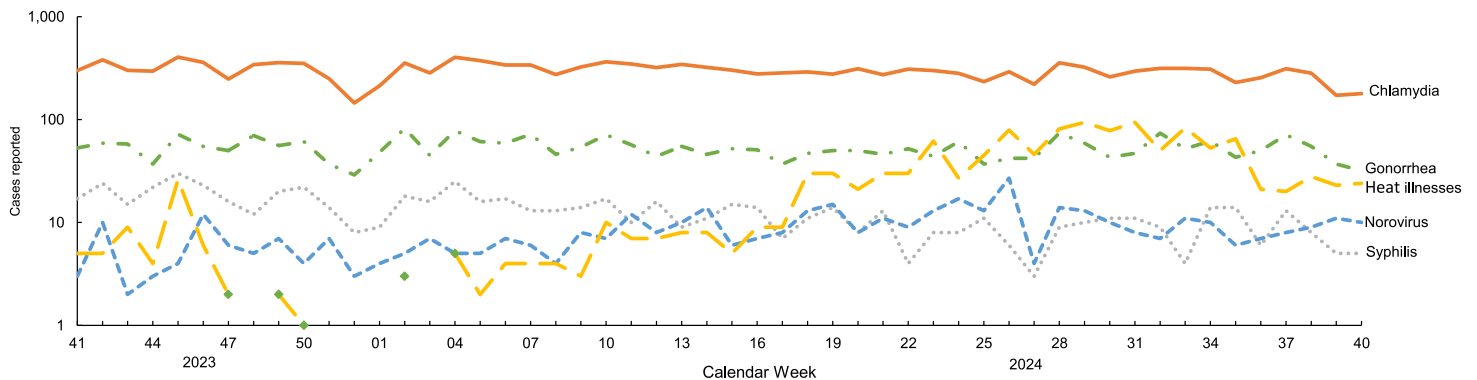
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# Reportable Medical Events at Military Health System Facilities Through Week 40, Ending October 5, 2024

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

## TOP 5 REPORTABLE MEDICAL EVENTS BY CALENDAR WEEK, ACTIVE COMPONENT (SEPTEMBER 3, 2023 - OCTOBER 5, 2024)



Abbreviation: RMEs, reportable medical events.

\*Cases are shown on a logarithmic scale.

Note: There were 0 heat illness cases in the following weeks in 2023: 48, 51-52, and weeks 1 and 3 in 2024. Markers added to represent instances of heat illnesses that were not visible on the logarithmic scale graph.

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

Total active component cases reported per week are displayed for the top 5 RMEs for the previous year. Each month, the graph is updated with the top 5 RMEs, and is presented with the current month's (September 2024) top 5 RMEs, which may differ from previous months. COVID-19 is excluded from these graphs due to changes in reporting and case definition updates in 2023.

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

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**TABLE. Reportable Medical Events, Military Health System Facilities, Week Ending October 5, 2024 (Week 40)<sup>a</sup>**

Reportable Medical Event <sup>b</sup>	Active Component <sup>c</sup>					MHS Beneficiaries <sup>d</sup>
	August 2024	September 2024	YTD 2024	YTD 2023	Total 2023	September 2024
	No.	No.	No.	No.	No.	No.
Amebiasis	1	1	9	12	15	0
Arboviral diseases, neuroinvasive and non-neuroinvasive	1	1	3	2	2	1
Brucellosis	1	0	1	0	0	0
COVID-19-associated hospitalization and death <sup>e</sup>	11	2	38	84	113	39
Campylobacteriosis	28	27	255	223	270	10
Chikungunya virus disease	0	0	0	2	2	0
Chlamydia trachomatis	1,272	1,067	11,728	13,435	17,510	151
Cholera	0	0	2	4	4	0
Coccidioidomycosis	2	0	42	20	36	0
Cold weather injury <sup>f</sup>	1	1	135	103	152	N/A
Cryptosporidiosis	12	8	70	59	67	7
Cyclosporiasis	1	1	9	15	15	1
Dengue virus infection	2	0	11	6	7	0
<i>E. coli</i> , Shiga toxin-producing	10	5	64	59	69	4
Ehrlichiosis / anaplasmosis	1	0	2	28	28	0
Giardiasis	9	9	78	60	78	5
Gonorrhea	243	224	2,107	2,080	2,763	26
<i>Haemophilus influenzae</i> , invasive	0	0	3	1	1	1
Hantavirus disease	0	0	0	1	2	0
Heat illness <sup>f</sup>	302	94	1,180	1,179	1,254	N/A
Hepatitis A	0	0	5	7	8	0
Hepatitis B, acute and chronic	10	5	81	118	155	3
Hepatitis C, acute and chronic	6	3	27	41	52	2
Influenza-associated hospitalization <sup>g</sup>	1	1	38	7	29	2
Lead poisoning, pediatric <sup>h</sup>	N/A	N/A	N/A	N/A	N/A	7
Legionellosis	1	0	4	3	5	1
Leishmaniasis	0	0	0	1	1	0
Leprosy	0	0	0	2	2	0
Leptospirosis	0	0	0	3	4	0
Lyme disease	14	10	84	58	70	5
Malaria	5	4	16	19	28	1
Meningococcal disease	0	0	0	2	4	0
Mpox	0	1	10	0	5	0
Norovirus	37	40	372	349	420	27
Pertussis	3	2	20	5	15	6
Post-exposure prophylaxis against Rabies	47	44	459	469	598	31
Q fever	0	1	1	2	2	0
Rubella	0	0	0	2	2	0
Salmonellosis	20	16	109	84	129	31
Shigellosis	5	4	41	56	59	4
Spotted Fever Rickettsiosis	5	1	18	30	31	2
Syphilis (all)	46	35	443	705	945	10
Toxic shock syndrome	0	0	2	1	2	0
Trypanosomiasis	0	0	2	1	1	0
Tuberculosis	0	0	2	9	11	0
Tularemia	0	0	1	1	1	0
Typhoid fever	1	0	1	2	2	0
Typhus fever	0	0	1	3	3	0
Varicella	1	0	11	9	12	9
Zika virus infection	0	0	1	0	0	0
Total case counts	2,099	1,607	17,486	19,362	24,984	386

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

<sup>a</sup> RMEs reported through the DRSi as of Oct. 09, 2024 are included in this report. RMEs were classified by date of diagnosis or, where unavailable, date of onset. Monthly comparisons are displayed for the period of Aug. 1, 2024–Aug. 31, 2024 and Sep. 1, 2024–Sep. 30, 2024. YTD comparison is displayed for the period of Jan. 1, 2024–Sep. 30, 2024 for MHS facilities. Previous year counts are provided as the following: previous YTD, Jan. 1, 2023–Sep. 30, 2023; total 2023, Jan. 1, 2023–Dec. 31, 2023.

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

<sup>c</sup> Service branches included in this report include the Army, Navy, Air Force, Marine Corps, Coast Guard, and Space Force, including personnel classified as FMP 20 with duty status of Active Duty, Recruit, or Cadet in DRSi.

<sup>d</sup> Beneficiaries included the following: individuals classified as FMP 20 with duty status of Retired and individuals with all other FMPs except 98 and 99. Civilians, contractors, and foreign nationals were excluded from these counts.

<sup>e</sup> Only cases reported after case definition update on May 4, 2023. Includes only cases resulting in hospitalization or death. Does not include cases of hospitalization or death reported under the previous COVID-19 case definition.

<sup>f</sup> Only reportable for service members.

<sup>g</sup> Influenza-associated hospitalization is reportable only for individuals under 65 years of age.

<sup>h</sup> Pediatric lead poisoning is reportable only for children aged 6 years or younger.





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