Update: Cold Weather Injuries, Active and Reserve Components, U.S. Armed Forces, July 2014–June 2019

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From July 2018 through June 2019, a total of 513 members of the active (n=446) and reserve (n=67) components had at least 1 medical encounter with a primary diagnosis of cold injury. The crude overall incidence rate of cold injury for all active component service members in 2018–2019 (36.5 per 100,000 person-years [p-yrs]) was slightly higher than the rate for the 2017–2018 cold season (35.8 per 100,000 p-yrs) and was the highest rate during the 5-year surveillance period. In 2018–2019, frostbite was the most common type of cold injury among active component service members in all 4 services. Among active component members during the 2014–2019 cold seasons, overall rates of cold injuries were generally highest among males, non-Hispanic black service members, the youngest (less than 20 years old), and those who were enlisted. As noted in prior *MSMR* updates, the rate of all cold injuries among active component Army members was higher in women than in men because of a much higher rate of frostbite among female soldiers. The number of cold injuries associated with overseas deployments during the 2018–2019 cold season (n=24) was the highest count during the 5-year surveillance period.

WHAT ARE THE NEW FINDINGS?

For all active component service members, the rate of cold weather injuries in 2018–2019 was the highest of the last 5 seasons. Cold injury rates were much higher among members of the Marine Corps and Army. Cold injuries associated with deployment during 2018–2019 were much more numerous than any of the previous 4 years; frostbite accounted for most such injuries.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

U.S. military forces will likely be deployed in cold, northern latitudes for peacekeeping and national security operations because of the opening of new shipping lanes in the Arctic Ocean. Such operations will require renewed emphasis on effective cold weather injury prevention strategies and adherence to the policies and procedures in place to protect service members against such injuries.

Cold weather injuries are of significant military concern because of their adverse impact on operations and the high financial costs of treatment and disability.[1,2] In response, the U.S. Armed Forces have developed and improved training, doctrine, procedures, and protective equipment and clothing to counter the threat from cold environments.[3–8] Although these measures are highly effective, cold injuries have continued to affect hundreds of service members each year because of exposure to cold and wet environments.[9]

The term cold weather injuries is used to describe injuries that have a central effect, such as hypothermia, as well as those that primarily affect the peripheries of the body, such as frostbite and immersion injuries. The human physiologic response to cold exposure is to retard heat loss and preserve core body temperature, but this response may not be sufficient to prevent hypothermia if heat loss is prolonged.[9] Moreover, the response includes constriction of the peripheral (superficial) vascular system, which may result in non-freezing injuries or hasten the onset of actual freezing of tissues (frostbite).[9]

Hypothermia occurs when the core temperature of the body falls below 95°F.[7] The most common mechanisms of accidental hypothermia are convective heat loss to cold air and conductive heat loss to water.[10] Freezing temperatures are not required to produce hypothermia.[10] In response to cold stress, peripheral blood vessels constrict and the hypothalamus stimulates heat production through shivering and elevated thyroid, adrenal, and catecholamine activity.[10] The sympathetic nervous system mediates further vasoconstriction to minimize heat loss by reducing blood flow to the extremities, where the most cooling occurs.[10] As the body's basal metabolic rate decreases, core temperature falls, body functions slow down, and muscular and cerebral functions are impaired.[10] Neurologic functioning begins declining even above a core body temperature of 95°F.[11] Severe hypothermia can lead to pulmonary edema, reduced heart rate, coma, ventricular arrhythmias (including ventricular fibrillation), and asystole.[10–12]

Cold injuries affecting the body's peripheries can be classified as freezing and non-freezing injuries.[13] Freezing peripheral injury is defined as the damage sustained by tissues when exposed to temperatures below freezing.[13] The tissue damage of frostbite is the result of both direct cold-induced cell death and the secondary effects of microvascular thrombosis and subsequent ischemia.[14] Rapid freezing generally results in extra- and intracellular ice crystal formation.[15] These crystals cause direct injury to the cell membrane that results in cellular dehydration, lipid derangement, electrolyte fluxes, membrane lysis, and cell death.[14–16] An inflammatory process follows, resulting in tissue ischemia and additional cell death.[15] The initial cellular damage and the ensuing inflammatory processes are worsened with thawing of the affected area.[15,16] With rewarming, edema from melting ice

crystals leads to epidermal blister formation and ischemia-reperfusion injury may be initiated[14–16]; vasoconstriction and platelet aggregation caused by inflammatory mediators, prostaglandins, and thromboxanes exacerbate ischemia.[17] The areas of the body most frequently affected by frostbite include the ears, nose, cheeks, chin, fingers, and toes.[18,19] A substantial proportion of patients with peripheral frostbite experience permanent changes in their microcirculation and disruption of local neurological functions (e.g., reduced sensation in the affected area).[19] Although most frostbite damage is minor, severe injury may lead to impaired functioning and ability to work because of cold hypersensitivity, chronic ulceration, vasospasm, localized osteoarthritis, and/or chronic pain.[14,19]

Non-freezing peripheral cold injury includes a spectrum of localized injuries to the soft tissues, nerves, and vasculature of distal extremities that result from prolonged exposure (12 to 48 hours) to wet, cold (generally 32 to 59°F) conditions; the injury process generally happens at a slower rate in warmer water.[13,20] Although non-freezing peripheral cold injuries most often involve feet (immersion foot), any dependent body part can be affected by the condition, including the hands.[21] Immersion foot generally presents as waterlogging of the feet, with the most marked effect occurring in the soles.[17,20] The foot becomes hyperemic (increased blood flow), painful, and swollen with continuous exposure; progression to blistering, decreased blood flow, ulceration, and gangrene is gradual.[17,20] Long-term complications of non-freezing cold injury such as immersion foot are similar to (e.g., hypersensitivity to cold, chronic pain) and as debilitating as (e.g., severe pain provoked by walking) those produced by frostbite.[14,16,17,20]

Factors that increase the risk of cold weather injuries include outdoor exposure, inadequate and/or wet clothing, cold water submersion, older age, exhaustion, dehydration, inadequate caloric intake, alcohol use, smoking (frostbite), previous cold injury (frostbite or immersion foot), chronic disease (e.g., peripheral vascular disease, diabetes), and medications that impair compensatory responses (e.g., oral antihyperglycemics, beta-blockers, general anesthetic agents).[12–14,17–19] Situational factors that increase risk of immersion foot include immobility, wet socks, and constricting boots.[17,22]

Traditional measures to counter the dangers associated with cold environments include minimizing loss of body heat and protecting superficial tissues through means such as protective clothing, shelter, physical activity, and nutrition. However, military training or mission requirements in cold and wet weather may place service members in situations where they may be unable to be physically active, find warm shelter, or change wet or damp clothing.[2–4]

For the military, continuous surveillance of cold weather injuries is essential to inform steps to reduce their impact as well as to remind leaders of this predictable threat. Since 2004, the *MSMR* has published annual updates on the incidence of cold weather injuries that affected U.S. military members during the 5 most recent cold seasons.[23] The content of this 2019 report addresses the occurrence of such injuries during the cold seasons from July 2014 through June 2019. The timing of the 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.

METHODS

The surveillance period was 1 July 2014 through 30 June 2019. The surveillance population included all individuals who served in the active or reserve component of the U.S. Armed Forces at any time during the surveillance period. For analysis purposes, "cold years" or "cold seasons" were defined as 1 July through 30 June intervals so that complete cold weather seasons could be represented in year-to-year summaries and comparisons.

Because cold weather injuries represent a threat to the health of individual service members and to military training and operations, the U.S. Armed Forces require expeditious reporting of these reportable medical events (RMEs) via one of the service-specific electronic reporting systems; these reports are routinely incorporated into the Defense Medical Surveillance System (DMSS). For this analysis, the DMSS and the Theater Medical Data Store (which maintains electronic records of medical encounters of deployed service members) were searched for records of RMEs and inpatient and outpatient care for the diagnoses of interest (frostbite, immersion injury, and hypothermia). A case was defined by the presence of an RME or of any qualifying International Classification of Diseases, 9th or 10th Revision (ICD-9 and ICD-10, respectively) code in the first diagnostic position of a record of a healthcare encounter **(Table 1)**. The Department of Defense guidelines for RMEs require the reporting of cases of hypothermia, freezing peripheral injuries (i.e., frostbite), and non-freezing peripheral injuries (i.e., immersion injuries, chilblains).[24] Cases of chilblains are not included in this report because the condition is common, infrequently diagnosed, usually mild in severity, and thought to have minimal medical, public health, or military impacts. Because of an update to the Disease Reporting System internet (DRSi) medical event reporting system in July 2017, the type of RMEs for cold injury (i.e., frostbite, immersion injury, hypothermia) could not be distinguished using RME records in DMSS data. Instead, information on the type of RME for cold injury between July 2017 and June 2019 were extracted from the DRSi and then combined with DMSS data.

To estimate the number of unique individuals who suffered a cold injury each cold season and to avoid counting follow-up healthcare encounters after single episodes of cold injury, only 1 cold injury per

TABLE 1. ICD-9/ICD-10 diagnostic codes for cold weather injuries

	ICD-9	ICD-10[a]
Frostbite	991.0, 991.1, 991.2, 991.3	T33.*, T34.*
Immersion hand and foot	991.4	T69.0*
Hypothermia	991.6	T68.*

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

individual per cold season was included. A slightly different approach was taken for summaries of the incidence of the different types of cold injury diagnoses. In counting types of diagnoses, 1 of each type of cold injury per individual per cold season was included. For example, if an individual was diagnosed with immersion foot at one point during a cold season and then with frostbite later during the same cold season, each of those different types of injury would be counted in the tally of injuries. If a service member had multiple medical encounters for cold injuries on the same day, only 1 encounter was used for analysis (hospitalizations were prioritized over ambulatory visits, which were prioritized over RMEs).

Annual incidence rates of cold injuries among active component service members were calculated as incident cold injury diagnoses per 100,000 person-years (p-yrs) of service. Annual rates of cold injuries among reservists were calculated as cases per 100,000 persons using the total number of reserve component service members for each year of the surveillance period. Counts of persons 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 was not available.

The numbers of cold injuries were summarized by the locations at which service members were treated for these injuries as identified by the Defense Medical Information System Identifier (DMIS ID) recorded in the medical records of the cold injuries. Because such injuries may be sustained during field training exercises, temporary duty, or other instances for which a service member may not be located at his/her usual duty station, DMIS ID was used as a proxy for the location where the cold injury occurred.

The new electronic health record for the Military Health System, MHS GENESIS, was implemented at several military treatment facilities during 2017. Medical data from sites using MHS GENESIS are not available in the DMSS. These sites include Naval Hospital Oak Harbor, Naval Hospital Bremerton, Air Force Medical Services Fairchild, and Madigan Army Medical Center. Therefore, medical encounter and person-time data for individuals seeking care at any of these facilities during 2017–30 June 2019 were not included in this analysis.

RESULTS

2018–2019 cold season

From July 2018 through June 2019, a total of 513 members of the active (n=446) and reserve (n=67) components had at least 1 medical encounter with a primary diagnosis of cold injury **(Table 2)**. The Army contributed almost three-fifths (59.6%; n=266) of all cold injury diagnoses in the active component during the 2018–2019 cold season. Across the services during this period, the rate of cold injury diagnoses was highest among active component Marine Corps members (62.2 per 100,000 p-yrs). The 115 members of the Marine Corps diagnosed with a cold injury represented more than one-quarter (25.8%) of all affected active component service members. Navy service members (n=20) had the lowest service-specific rate of cold injuries (7.1 per 100,000 p-yrs) **(Table 2, Figure 1)**.

This update for 2018–2019 represents the third time that annual rates of cold injuries for members of the reserve component were estimated. Army personnel (n=46) accounted for more than two-thirds

TABLE 2. Any cold injury (1 per person per year), by service and component, July 2014–June 2019

	Army		Navy		Air Force		Marine Corps		All services	
Active component	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
All years (2014–2019)	1,189	51.0	147	9.7	213	13.6	460	49.9	2,009	31.7
Jul 2014–Jun 2015	208	41.9	35	10.9	50	16.1	116	62.4	409	31.1
Jul 2015–Jun 2016	233	48.5	30	9.2	31	10.0	72	39.1	366	28.2
Jul 2016–Jun 2017	202	43.6	35	11.0	42	13.5	71	38.8	350	27.4
Jul 2017–Jun 2018	280	62.4	27	9.8	45	14.3	86	46.8	438	35.8
Jul 2018–Jun 2019	266	60.2	20	7.1	45	14.2	115	62.2	446	36.5
Reserve component										
All years (2014–2019)	216		10		36		59		321	
Jul 2014–Jun 2015	45	20.1	3	4.6	13	16.8	10	21.2	71	17.1
Jul 2015–Jun 2016	33	14.6	2	3.1	4	5.3	7	15.1	46	11.1
Jul 2016–Jun 2017	38	17.0	1	1.5	8	10.5	11	23.8	58	14.1
Jul 2017–Jun 2018	54	25.1	3	4.6	5	6.6	17	36.8	79	19.6
Jul 2018–Jun 2019	46	22.1	1	1.6	6	8.1	14	30.8	67	17.1
Overall, active and reserve components										
All years (2014–2019)	1,405		157		249		519		2,330	
Jul 2014–Jun 2015	253		38		63		126		480	
Jul 2015–Jun 2016	266		32		35		79		412	
Jul 2016–Jun 2017	240		36		50		82		408	
Jul 2017–Jun 2018	334		30		50		103		517	
Jul 2018–Jun 2019	312		21		51		129		513	

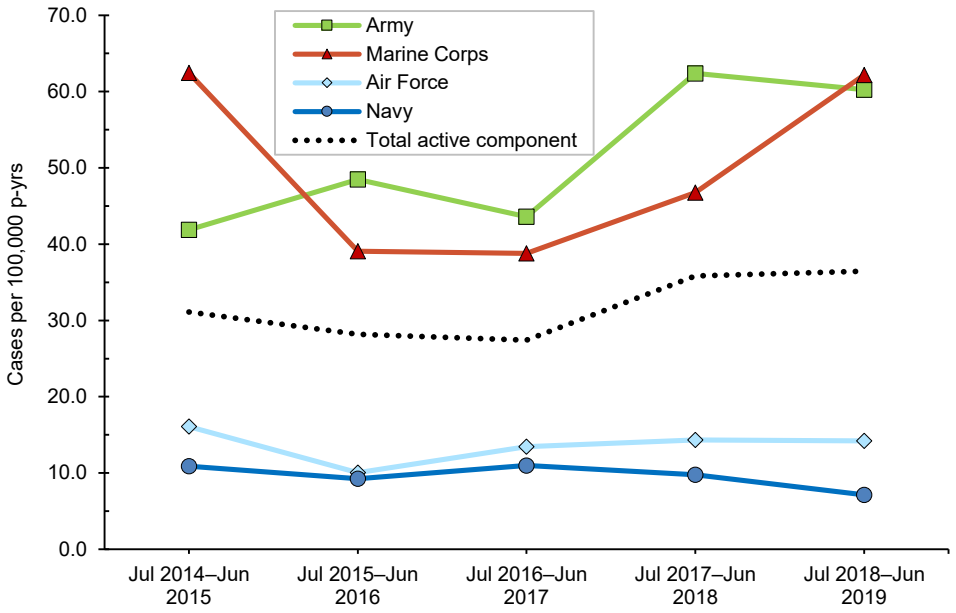
[a]For active component, rate is per 100,000 person-years. For reserve component, rate is per 100,000 persons.
No., number.

(68.7%) of all reserve component service members (n=67) affected by cold injuries **(Table 2)**. During this period, the rate of cold injury diagnoses was highest among reserve component Marine Corps members (30.8 per 100,000 persons) and lowest among reserve component Navy members (1.6 per 100,000 persons).

The overall rate of cold injuries for the reserve component and the rates for each of the services except the Air Force were lower than in the 2017–2018 season. Among reserve component members, the most pronounced decrease in service-specific rates of cold injuries between the 2017–2018 and 2018–2019 seasons was seen in the Marine Corps.

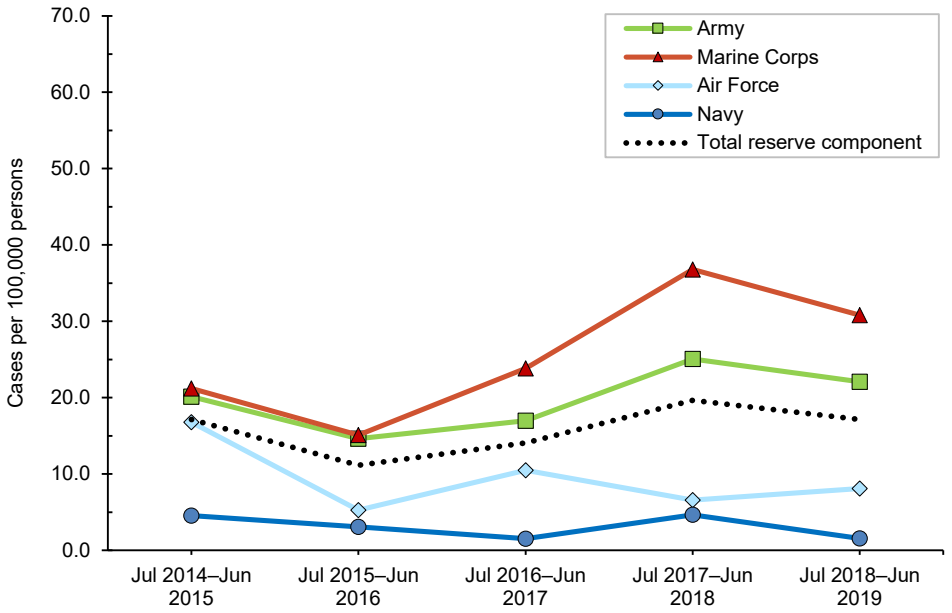
When all injuries were considered, not just the numbers of individuals affected, frostbite was the most common type of cold injury (n=241; 52.3% of all cold injuries) among active component service members in 2018–2019 **(Tables 3a–3d)**. In the Air Force and Navy, 84.8% and 70.0%, respectively, of all cold injuries were frostbite, whereas the proportions in the Army (48.7%) and Marine Corps (44.8%) were much lower. Among active component Marine Corps members, the number and rate of frostbite injuries were the highest of the past 5 years. For all active component service members, the proportions of total cold weather injuries that were hypothermia and immersion injuries were 17.4% and 30.4%, respectively **(data not shown)**. Among active component Navy members, the number and rate of immersion injuries in 2018–2019 were the lowest of the 5-year surveillance period **(Table 3b)**. The rate of immersion injury cases in the Army was 41.4% higher than the rate for the 2017–2018 cold season **(Table 3a)**.

FIGURE 1. Annual incidence rates of cold injuries (1 per person per year), by service, active component, U.S. Armed Forces, July 2014–June 2019



P-yrs, person-years.

FIGURE 2. Annual incidence rates of cold injuries (1 per person per year), by service, reserve component, U.S. Armed Forces, July 2014–June 2019



Five cold seasons: July 2014–June 2019

The crude overall incidence rate of cold injury for all active component service members in 2018–2019 (36.5 per 100,000 p-yrs) was slightly higher than the rate for the 2017–2018 cold season (35.8 per 100,000 p-yrs) and was the highest rate during the 5-year period **(Table 2, Figure 1)**. Throughout the surveillance period, the cold injury rates were consistently higher among active component members of the Army and the Marine Corps than among those in the Air Force and Navy **(Figure 1)**. In 2018–2019, the service-specific incidence rate for active component Army members (60.2 per 100,000 p-yrs) was slightly lower than the 2017–2018 Army rate (62.4 per 100,000 p-yrs). For the Marine Corps, the active component rate for 2018–2019 was 28.1% higher than the rate for the previous season and 60.6% higher than the rate for the 2015–2016 season. As was true for the active component, service-specific annual rates of cold injuries among reserve component members were consistently higher among those in the Army and Marine Corps than among those in the Air Force

TABLE 3a. Counts and incidence rates of cold injuries (1 per type per person per year), active component, U.S. Army, July 2014–June 2019

	Frostbite		Immersion foot		Hypothermia		All cold injuries	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	699	30.0	302	13.0	218	9.4	1,219	52.3
Sex								
Male	565	28.4	273	13.7	192	9.6	1,030	51.7
Female	134	39.5	29	8.5	26	7.7	189	55.7
Race/ethnicity								
Non-Hispanic white	246	18.6	124	9.4	122	9.2	492	37.2
Non-Hispanic black	328	66.3	112	22.6	53	10.7	493	99.7
Other/unknown	125	24.3	66	12.8	43	8.3	234	45.4
Age group (years)								
<20	53	31.9	40	24.1	33	19.9	126	75.9
20–24	300	43.2	138	19.9	106	15.2	544	78.3
25–29	149	28.2	72	13.6	53	10.0	274	51.9
30–34	101	26.7	28	7.4	17	4.5	146	38.7
35–39	53	18.9	19	6.8	5	1.8	77	27.5
40–44	22	13.1	3	1.8	3	1.8	28	16.7
45+	21	18.0	2	1.7	1	0.9	24	20.5
Rank								
Enlisted	620	33.1	274	14.6	197	10.5	1,091	58.3
Officer	79	17.2	28	6.1	21	4.6	128	27.9
Military occupation								
Combat-specific[b]	231	39.8	131	22.6	108	18.6	470	80.9
Motor transport	35	48.8	9	12.5	8	11.1	52	72.4
Repair/engineering	114	23.9	51	10.7	27	5.7	192	40.3
Communications/ intelligence	180	31.2	63	10.9	50	8.7	293	50.8
Healthcare	37	15.4	13	5.4	7	2.9	57	23.7
Other/unknown	102	26.6	35	9.1	18	4.7	155	40.4
Cold year (July–June)								
2014–2015	136	27.4	19	3.8	55	11.1	210	42.3
2015–2016	126	26.2	73	15.2	42	8.7	241	50.2
2016–2017	133	28.7	33	7.1	37	8.0	203	43.8
2017–2018	168	37.4	74	16.5	44	9.8	286	63.7
2018–2019	136	30.8	103	23.3	40	9.1	279	63.2

[a]Rate per 100,000 person-years.
[b]Infantry/artillery/combat engineering/armor.
No., number.

or Navy **(Figure 2)**. The most pronounced increase (143.8%) in rates was seen among reserve component Marine Corps members between the 2015–2016 and 2017–2018 seasons.

During the 5-year surveillance period, the rates of cold injuries among members of the active components of the Navy, Air Force, and Marine Corps were higher among men than women. Among active component Army members, the overall rate among women (55.7 per 100,000 p-yrs) was 7.7% higher than the rate among men (51.7 per 100,000 p-yrs). In all of the services during 2014–2019, women had lower rates of immersion injury and hypothermia than did males but higher rates of frostbite (except in the Navy and Air Force) **(Tables 3a–3d)**. For active component service members in all 4 services combined, the overall rate of cold injury was 31.4% higher among males (33.6 per 100,000 p-yrs) than among females (25.6 per 100,000 p-yrs) **(data not shown)**.

In all of the services, overall rates of cold injuries were higher among non-Hispanic black service members than among those of the other race/ethnicity groups. In particular, within the Marine Corps and Army and for all services combined, rates of cold injuries were more than twice as high among non-Hispanic black service members than among either non-Hispanic white service members or those in the "other/unknown" race/ethnicity group **(Tables 3a–3d)**. The major underlying factor in these differences is that the rate of frostbite among non-Hispanic black members from all services combined was more than 3 times that of the other race/ethnicity groups, with the biggest differences apparent in the Marine Corps (more than 5 times) and the Army (more than 2 times) **(data not shown)**. Additionally, across the active components of all services during 2014–2019, non-Hispanic black service members had incidence rates of cold injuries greater than the rates of other race/ethnicity groups in nearly every military occupational category **(data not shown)**.

Across the services, rates of cold injuries were generally highest among the youngest service members (less than 20 years old) and tended to decrease with increasing age **(Tables 3a–3d)**. Enlisted

TABLE 3b. Counts and incidence rates of cold injuries (1 per type per person per year), active component, U.S. Navy, July 2014–June 2019

	Frostbite		Immersion foot		Hypothermia		All cold injuries	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	60	3.9	48	3.2	39	2.6	147	9.7
Sex								
Male	51	4.1	44	3.6	35	2.8	130	10.5
Female	9	3.1	4	1.4	4	1.4	17	5.9
Race/ethnicity								
Non-Hispanic white	25	3.2	20	2.6	22	2.8	67	8.6
Non-Hispanic black	13	5.6	8	3.4	9	3.9	30	12.9
Other/unknown	22	4.3	20	3.9	8	1.6	50	9.8
Age group (years)								
<20	8	9.2	6	6.9	6	6.9	20	23.0
20–24	10	2.2	21	4.6	13	2.8	44	9.6
25–29	25	6.5	12	3.1	15	3.9	52	13.5
30–34	7	2.7	5	2.0	2	0.8	14	5.5
35–39	7	3.9	3	1.7	3	1.7	13	7.3
40–44	1	1.0	1	1.0	0	0.0	2	2.1
45+	2	3.2	0	0.0	0	0.0	2	3.2
Rank								
Enlisted	52	4.1	46	3.7	38	3.0	136	10.8
Officer	8	3.1	2	0.8	1	0.4	11	4.2
Military occupation								
Combat-specific[b]	10	10.5	0	0.0	3	3.2	13	13.7
Motor transport	5	8.3	5	8.3	10	16.6	20	33.1
Repair/engineering	17	2.6	23	3.5	8	1.2	48	7.3
Communications/ intelligence	6	2.5	4	1.7	4	1.7	14	5.8
Healthcare	10	5.6	4	2.2	5	2.8	19	10.7
Other/unknown	12	4.1	12	4.1	9	3.1	33	11.4
Cold year (July–June)								
2014–2015	16	5.0	13	4.0	7	2.2	36	11.2
2015–2016	8	2.5	11	3.4	10	3.1	29	8.9
2016–2017	7	2.2	15	4.7	13	4.1	35	11.0
2017–2018	15	5.4	8	2.9	4	1.4	27	9.8
2018–2019	14	5.0	1	0.4	5	1.8	20	7.1

[a]Rate per 100,000 person-years.
[b]Infantry/artillery/combat engineering/armor.
No., number.

members of all 4 services had higher rates than officers. In the Army, Navy, and Air Force, rates of all cold injuries combined were highest among service members in combat-specific (infantry/artillery/combat engineering/armor) and motor transport occupations **(Tables 3a–3c)**.

During the 5-year surveillance period, the 2,330 service members who were affected by any cold injury included 2,009 (86.2%) from the active component and 321 (13.8%) from the reserve component. Of all affected reserve component members, 67.3% (n=216) were members of the Army **(Table 2)**. Overall, soldiers accounted for slightly more than three-fifths (60.3%) of all cold injuries affecting active and reserve component service members **(Table 2, Figure 3)**.

Of all active component service members who were diagnosed with a cold injury (n=2,009), 190 (9.5% of the total) were affected during basic training. The Army (n=72) and Marine Corps (n=109) accounted for 95.3% of all basic trainees affected by cold injuries **(data not shown)**. Additionally, during the surveillance period, 71 service members who were diagnosed with cold injuries (3.5% of the total) were hospitalized, and the vast majority (90.1%) of the hospitalized cases were members of either the Army (n=41) or Marine Corps (n=23) **(data not shown)**.

Cold injuries during deployments

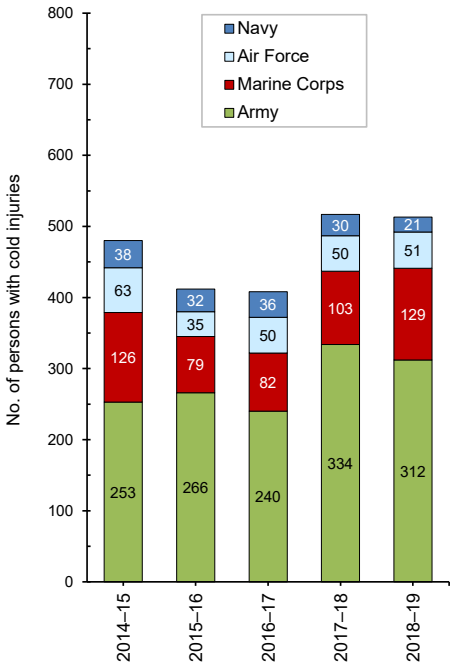
During the 5-year surveillance period, a total of 76 cold injuries were diagnosed and treated in service members deployed outside of the U.S. **(data not shown)**. Of these, 32 (42.1%) were frostbite, 35 (46.1%) were immersion injuries, and 9 (11.8%) were hypothermia. Of these 76 cold injuries, slightly less than one-third (31.6%) occurred in the most recent cold season. There were 24 cold injuries during the 2018–2019 cold season but only 13 during 2014–2015, 11 each during 2015–2016 and 2016–2017, and 17 during 2017–2018 **(data not shown)**. Frostbite accounted for more than half (n=13; 54.2%) of the cold weather injuries diagnosed and treated in service members deployed outside of the U.S. during the 2018–2019 cold season. The vast majority of these frostbite cases were male (84.6%) and almost half (47.2%)

TABLE 3c. Counts and incidence rates of cold injuries (1 per type per person per year), active component, U.S. Air Force, July 2014–June 2019

	Frostbite		Immersion foot		Hypothermia		All cold injuries	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	170	10.9	18	1.2	28	1.8	216	13.8
Sex								
Male	144	11.5	16	1.3	24	1.9	184	14.7
Female	26	8.5	2	0.7	4	1.3	32	10.4
Race/ethnicity								
Non-Hispanic white	96	9.8	12	1.2	18	1.8	126	12.9
Non-Hispanic black	35	16.7	3	1.4	6	2.9	44	21.0
Other/unknown	39	10.4	3	0.8	4	1.1	46	12.3
Age group (years)								
<20	12	15.7	3	3.9	5	6.5	20	26.1
20–24	77	17.9	5	1.2	8	1.9	90	20.9
25–29	40	10.0	5	1.2	6	1.5	51	12.7
30–34	21	7.1	4	1.4	1	0.3	26	8.8
35–39	11	5.3	1	0.5	5	2.4	17	8.2
40–44	5	4.9	0	0.0	1	1.0	6	5.9
45+	4	8.1	0	0.0	2	4.0	6	12.1
Rank								
Enlisted	151	12.0	17	1.4	24	1.9	192	15.3
Officer	19	6.2	1	0.3	4	1.3	24	7.9
Military occupation								
Combat-specific[b]	5	46.1	0	0.0	0	0.0	5	46.1
Motor transport	3	27.5	0	0.0	0	0.0	3	27.5
Repair/engineering	64	13.0	6	1.2	4	0.8	74	15.1
Communications/ intelligence	31	8.9	1	0.3	5	1.4	37	10.6
Healthcare	12	8.0	1	0.7	1	0.7	14	9.4
Other/unknown	55	10.0	10	1.8	18	3.3	83	15.1
Cold year (July–June)								
2014–2015	42	13.5	4	1.3	4	1.3	50	16.1
2015–2016	19	6.2	4	1.3	8	2.6	31	10.0
2016–2017	32	10.3	6	1.9	6	1.9	44	14.1
2017–2018	38	12.1	2	0.6	5	1.6	45	14.3
2018–2019	39	12.3	2	0.6	5	1.6	46	14.5

[a]Rate per 100,000 person-years.
[b]Infantry/artillery/combat engineering/armor.
No., number.

FIGURE 3. Numbers of service members who had a cold injury (1 per person per year), by service and cold season, active and reserve components, U.S. Armed Forces, July 2014–June 2019



No., number.

were 24 years old or younger **(data not shown)**. Army members accounted for more than two-fifths (46.2%) of the frostbite cases diagnosed among service members deployed outside of the U.S. Afghanistan was recorded as the location of diagnosis for 4 of these frostbite cases; information on the locations where the diagnoses were made was unavailable for 7 of these 13 frostbite cases **(data not shown)**.

Cold injuries by location

During the 5-year surveillance period, 21 military locations had at least 25 incident cold injuries among active and reserve component service members **(Figure 4)**. Among these locations, those with the highest 5-year counts of incident injuries were Fort Wainwright, AK (n=152); Army Health Clinic Vilseck, Germany (n=141); Marine Corps Recruit Depot Parris Island/ Beaufort, SC (n=97); Naval Medical Center San Diego, CA (n=75); Fort Drum, NY (n=74); and Fort Campbell, KY (n=73) **(data not shown)**. During the 2018–2019

TABLE 3d. Counts and incidence rates of cold injuries (1 per type per person per year), active component, U.S. Marine Corps, July 2014–June 2019

	Frostbite		Immersion foot		Hypothermia		All cold injuries	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	158	17.1	185	20.1	124	13.4	467	50.7
Sex								
Male	145	17.1	183	21.6	119	14.1	447	52.8
Female	13	17.3	2	2.7	5	6.7	20	26.6
Race/ethnicity								
Non-Hispanic white	61	10.8	134	23.8	60	10.7	255	45.3
Non-Hispanic black	64	69.1	14	15.1	27	29.2	105	113.4
Other/unknown	33	12.4	37	13.9	37	13.9	107	40.1
Age group (years)								
<20	23	18.1	101	79.4	42	33.0	166	130.5
20–24	90	20.6	69	15.8	61	13.9	220	50.2
25–29	24	14.9	11	6.8	17	10.6	52	32.3
30–34	11	12.1	2	2.2	2	2.2	15	16.5
35–39	8	13.4	2	3.4	2	3.4	12	20.1
40–44	1	3.3	0	0.0	0	0.0	1	3.3
45+	1	6.6	0	0.0	0	0.0	1	6.6
Rank								
Enlisted	130	15.9	178	21.8	118	14.4	426	52.2
Officer	28	26.6	7	6.6	6	5.7	41	38.9
Military occupation								
Combat-specific[b]	69	34.7	16	8.0	45	22.6	130	65.4
Motor transport	3	7.6	4	10.2	5	12.7	12	30.5
Repair/engineering	11	4.8	13	5.7	7	3.0	31	13.5
Communications/ intelligence	32	15.5	6	2.9	10	4.9	48	23.3
Healthcare	0	0.0	0	0.0	0	0.0	0	0.0
Other/unknown	43	17.3	146	58.8	57	23.0	246	99.1
Cold year (July–June)								
2014–2015	18	9.7	76	40.9	23	12.4	117	63.0
2015–2016	22	11.9	20	10.8	30	16.3	72	39.1
2016–2017	32	17.5	23	12.6	17	9.3	72	39.3
2017–2018	34	18.5	32	17.4	24	13.1	90	49.0
2018–2019	52	28.1	34	18.4	30	16.2	116	62.7

[a]Rate per 100,000 person-years.
[b]Infantry/artillery/combat engineering/armor.
No., number.

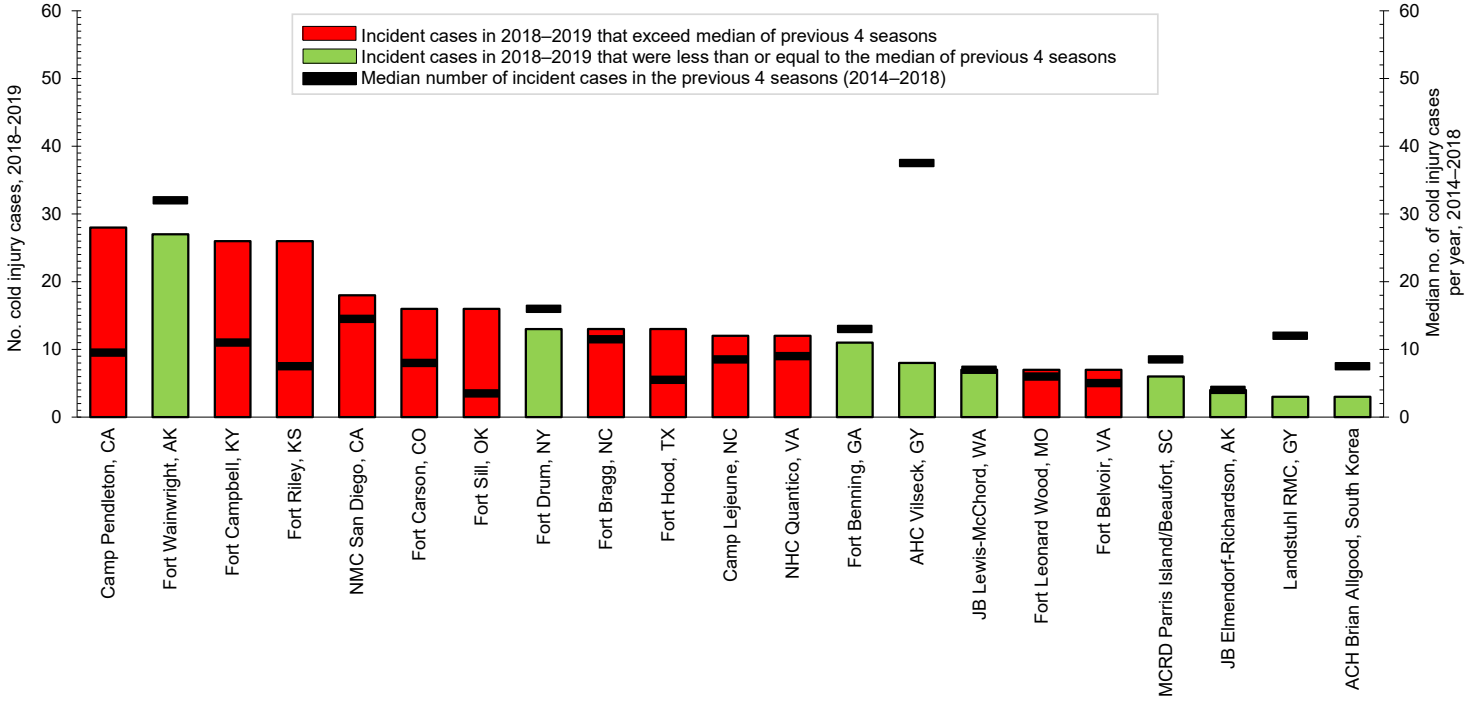
cold season, the numbers of incident cases of cold injuries were higher than the counts for the previous 2017–2018 cold season at 10 of the 21 locations **(data not shown)**. The most noteworthy increases were observed at the Marine Corps' Camp Pendleton and the Army's Fort Riley and Fort Sill, where there were 28, 26, and 16 total cases diagnosed at each location in 2018–2019, respectively, compared to just 13, 11, and 5, respectively, the year before **(data not shown)**. **Figure 4** shows the numbers of cold injuries during 2018–2019 and the median numbers of cases for the previous 4 years for those locations that had at least 25 cases during the surveillance period. For 9 of the 21 installations, the numbers of cases in 2018–2019 were equal to or less than the median counts for the previous 4 years.

EDITORIAL COMMENT

Between the 2017–2018 and 2018–2019 cold seasons, there was a slight increase in the crude overall incidence rate of cold injuries among U.S. active component service members; the overall rate among reserve component members decreased slightly during this period. For active component service members in the Marine Corps, the rate of all cold injuries in 2018–2019 was the highest since the 2014–2015 season.

In 2018–2019, frostbite was the most common type of cold injury among active component service members. Factors associated with increased risk of cold injury in previous years were again noted during the most recent cold season. Compared to their respective counterparts, males, non-Hispanic black service members, the youngest (less than 20 years old), and those who were enlisted had higher overall rates of cold injuries. Increased rates of cold injuries affected nearly all enlisted and officer occupations among non-Hispanic black service members. Of note, rates of frostbite were markedly higher among non-Hispanic blacks compared to non-Hispanic whites and those in the other/unknown race/ethnicity group. These differences have been noted in prior *MSMR* updates, and the results of several studies suggest that other factors (e.g., physiologic

FIGURE 4. Annual numbers of cold injuries (cold season 2018–2019) and median numbers of cold injuries (cold seasons 2014–2018) at locations with at least 25 cold injuries during the surveillance period, active component, U.S. Armed Forces, July 2014–June 2019



No., number; NMC, Naval Medical Center; NHC, Naval Health Clinic; AHC, Army Health Clinic; GY, Germany; JB, Joint Base; MCRD, Marine Corps Recruit Depot; RMC, Regional Medical Center; ACH, Army Community Hospital.

differences and/or previous cold weather experience) are possible explanations for increased susceptibility.[9,14,25–27] The number of cold injuries associated with deployment during 2018–2019 was more than the number in any other year during the surveillance period; frostbite accounted for the majority of the cold weather injuries in service members deployed outside of the U.S during the 2018–2019 cold season.

The opening of sea lanes in the Arctic Ocean increases the likelihood that U.S. military forces will be deployed in the cold, northern latitudes for peacekeeping and national security operations.[28–31] This shift will require renewed emphasis on effective cold weather injury prevention strategies and increased focus on adherence to the policies and procedures in place to protect service members against such injuries. It should be noted that this analysis of cold injuries was unable to distinguish between injuries sustained during official military duties (training or operations) and injuries associated with personal activities not related to official duties. RMEs for non-freezing peripheral injuries were excluded if "chilblains" was listed in the case comments; however, there may have been some RMEs for chilblains that were misclassified as immersion injury if chilblains was not listed in the case comments. To provide for all circumstances that pose the threat of cold weather injury, service members should know well the signs of cold injury and how to protect themselves against such injuries whether they are training, operating, fighting, or recreating under wet and freezing conditions.

The most current cold injury prevention materials are available at https://phc.amedd.army.mil/topics/discond/cip/Pages/Cold-Weather-Casualties-and-Injuries.aspx.

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Key points

- The crude overall incidence rate of cold injury for all active component service members in 2017–2018 (36.5 per 100,000 person-years [p-yrs]) was slightly higher than the rate for the 2017–2018 cold season (35.8 per 100,000 p-yrs) and was the highest rate during the 5-year period. Among active component members during the 2014–2019 cold seasons, subgroup-specific overall rates of cold injuries were generally highest among males, non-Hispanic black service members, the youngest (less than 20 years old), and those who were enlisted.
- In 2018–2019, frostbite was the most common type of cold injury among active component service members in all 4 services; among active component Marine Corps members, the number and rate of frostbite injuries in the 2018–2019 cold season was the highest of the 5-year surveillance period.
- The number of cold injuries associated with deployment during 2018–2019 was the highest count during the surveillance period; frostbite accounted for the majority of the cold weather injuries in service members deployed outside of the U.S during the 2018–2019 cold season.

Learning objectives

- The reader will analyze recent trends in the rates of incident cold weather injury diagnoses among active and reserve component service members.
- The reader will compare overall incidence rates of cold weather injury diagnoses among different demographic and military subgroups of active component service members.
- The reader will explain the pathophysiology of hypothermia, frostbite, and immersion foot as well as summarize the risk factors for these conditions.

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