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<p>13. ABSTRACT (Maximum 200 words) Background Cold weather injuries (CWI) are of great military concern due to their wide-ranging impact on military readiness. Previous short-term studies have identified CWI to be more prevalent in African-Americans, infantrymen, and lower ranking soldiers. The purpose of this cross-sectional study was to determine the occurrence of CWI hospitalizations in the U.S. Army from 1980-1999, and to identify possible trends, high-risk groups and/or activities.</p> <p>Methods The USARIEM TAIHOD was searched for hospitalizations with ICD-9-CM codes for frostbite, hypothermia, immersion foot, chilblains, and other. Information concerning each soldier included: gender, age, ethnicity, rank, occupation, type of injury, home of record, duty station, principle diagnosis, trauma code, and cause of injury. Data was available on the demographic composition of the Army, by year, and was used as the denominator when calculating the frequency of occurrence.</p> <p>Results During the study period there were 2,143 hospitalizations due to CWI. African-American men and women were injured ~4 times and ~2.2 times as often as their Caucasian counterparts, respectively. Trauma and cause of injury codes indicate that ~80% of all CWI hospitalizations result on-duty and during organized training. The yearly rate of CWI hospitalization has declined from 38.2/100,000 in 1985 to 0.2/100,000 in 1999.</p> <p>Conclusions Our data are consistent with previous research concerning the increased rate of CWI among African-Americans though further investigation appears warranted. The occurrence of most CWI during on-duty training suggests preventability. The decline in the overall rate of CWI hospitalizations is multifactorial.</p>				
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Epidemiology of U.S. Army Cold Weather Injuries, 1980-1999

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Background: Cold weather injuries (CWI) are of great military concern due to their wide-ranging impact on military readiness. Previous short-term studies have identified CWI to be more prevalent in African-Americans, infantrymen, and lower-ranking soldiers. The purpose of this cross-sectional study was to determine the occurrence of CWI hospitalizations in the U.S. Army from 1980 to 1999, and to identify possible trends, high-risk groups and/or activities. **Methods:** The U.S. Army Research Institute of Environmental Medicine Total Army Injury and Health Outcomes Database was searched for hospitalizations with ICD-9-CM codes for frostbite, hypothermia, immersion foot, chilblains, and other. Information concerning each soldier included: gender, age, ethnicity, rank, occupation, type of injury, home of record, duty station, principle diagnosis, trauma code, and cause of injury. Data was available on the demographic composition of the Army, by year, and was used as the denominator when calculating the frequency of occurrence. **Results:** During the study period there were 2143 hospitalizations due to CWI. African-American men and women were injured approximately 4 times and 2.2 times as often as their Caucasian counterparts, respectively. Trauma and cause of injury codes indicate that about 80% of all CWI hospitalizations result on-duty and during organized training. The yearly rate of CWI hospitalization has declined from 38.2/100,000 in 1985 to 0.2/100,000 in 1999. **Conclusions:** Our data are consistent with previous research concerning the increased rate of CWI among African-Americans though further investigation appears warranted. The occurrence of most CWI during on-duty training suggests preventability. The decline in the overall rate of CWI hospitalizations is multifactorial. **Keywords:** wounds and injuries, frostbite, hypothermia, immersion foot, cold climate, database, TAIHOD.

COLD WEATHER INJURIES (CWI), including hypothermia, chilblains, immersion foot, and frostbite, are of great military concern because of their adverse impact on military operations, field logistical and medical demands, and high financial costs of treatment and disability (7). In addition, human suffering associated with CWI is well chronicled throughout military history (16). CWI have been a problem during modern warfare as they accounted for approximately 10% of all non-battle injuries during World War II and the Korean conflict. More recently, nearly 5% of British forces were evacuated for CWI in the Falkland Islands and in Afghanistan about 20% of Soviet troops suffered CWI with 5% of those requiring amputations. Historical records of operationally significant hypothermia are plentiful (e.g., Korean Chosin Reservoir battle approximately 7000 U.S. and British deaths) and can also occur in training as evidenced by recent Army Ranger deaths (22). Immersion foot is believed to mostly occur in

combat (e.g., Falkland Islands, World War I) when proper foot hygiene is either not practiced or not possible. Frostbite also occurs operationally both during training and during military conflicts. CWI occur during military operations and training because of prolonged climatic exposure combined with physical exhaustion and multiple stressors (10).

Beliefs of when and how these military CWI injuries occur are based on fragmented information, not comprehensive epidemiological studies, as previous studies of CWI among U.S. military forces have been conducted on relatively small populations, during specific operations and limited to certain geographic areas (8,14,15,19). Data from the Korean conflict were the first to indicate that African-Americans, lower-ranking soldiers, and infantrymen at a greater risk of CWI (15). Two studies from military installations in Alaska have also indicated a higher risk for African-Americans (8,14). Additionally, data from soldiers stationed in Germany reported that a majority of injuries occurred during general field training (19). In general, CWI appears to be more prevalent in African-Americans, infantrymen, lower-ranking soldiers, and during general field duty (8,14,15,19). We are aware of no reports involving a time period longer than 5 yr, making long-term trends in CWI incidence difficult to identify. Knowledge of high-risk activities and demographic characteristics of susceptible individuals can result in opportunities to reduce risk of CWI. For example, during World War I the British recorded 115,361 total cases of immersion foot and frostbite (20). After the first winter of the war, the British instituted education programs that reduced the CWI rate from 33.9 to 3.8 cases per 1000 man-years by the end of the war.

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During the last 20 yr, several external factors may have effected the frequency of occurrence of CWI. Among these are improvements in individual soldier equipment, changes in operational tempo in various parts of the world, and changes in hospital administration procedures. The effects, if any, of these factors is unknown. The purpose of this cross-sectional study is to determine the frequency of occurrence of hospitalizations due to CWI in the U.S. Army from 1980 to 1999, and to identify trends, high-risk groups, and specific activities so that targeted prevention strategies might be developed specifically for U.S. Forces.

METHODS

Data were obtained from the U.S. Army Research Institute of Environmental Medicine (USARIEM) Total Army Injury and Health Outcomes Database (TAIHOD) (4). This database incorporates information from, among numerous sources, the Defense Manpower Data Center and the Individual Patient Data System. The TAIHOD captures data from virtually all hospitalizations worldwide of active duty Army soldiers in military hospitals, as well as a high proportion of Army soldiers hospitalized in civilian facilities. CWI treated on an outpatient basis or at a battalion aid station without hospital admission are not included in this study, nor are cases among non-active duty soldiers.

The TAIHOD was searched for hospitalizations due to the following ICD-9-CM diagnosis codes (12): 991.0, frostbite of the face; 991.1, frostbite of the hand; 991.2, frostbite of the foot; 991.3, frostbite, other and unspecified sites; 991.4, immersion foot; 991.5 chilblains; 991.6, hypothermia; 991.8, other specified effects of reduced temperature; and 991.9, unspecified effects of reduced temperature. Any individual whose hospital record contained any of the above diagnosis codes was included in the study. If a record included two or more CWI diagnosis it still represents one hospitalization. Alternatively, if a soldier was hospitalized on two separate occasions for two causes, this was considered two hospitalizations. NATO Standardization Agreement (STANAG) codes 810–819 (2,3) were searched for injuries due to "excessive cold," in an effort to detect any cases that were not found during the ICD-9-CM search. The STANAG codes also defined where an injury occurred (i.e., firing range, drill field, obstacle course, barracks, etc).

The following information was available concerning each injured soldier: gender, age, ethnicity, rank, military occupational specialty (MOS), injury type, date of admission, date of disposition (used as date of discharge), home of record, duty station (after July 1985), time in service, principle diagnosis, 2nd–8th diagnosis (when applicable), trauma code (intent and duty-relatedness), and cause of injury (STANAG code). Due to the large number of MOSs in the Army, injured soldiers were grouped according to career management field (CMF) that encompasses multiple related MOSs, such as infantry and field artillery. The home of record generally, but not always, is the state the individual resided in when they joined the Army, though it is not neces-

sarily the state where they were raised. Soldier origin was defined as southern if their state home of record was at or below 36° latitude (14). Trauma codes provided information as to the duty status of an injured soldier and/or the intent of the injury (note: intent is not as relevant for CWI as it might be for other injuries, i.e., gunshot wounds). Trauma codes indicate duty status in the following way: battle wound or injury, intentionally inflicted non-battle injury, accidental injury (includes code for off duty, schemes and exercises, other scheduled training, on duty, and unknown duty status) (3).

Data from the Defense Manpower Data Center component of the TAIHOD provided information on the composition of the Army, by year, in regards to gender, ethnicity, age, education level, CMF, and rank. These data were used as the denominator when calculating occurrence rates, which are expressed as cases per 100,000 soldiers per year. Data files were available for June and December of each year, with December files being used for analysis, as they represent the mid-point of a winter season. It was assumed that the demographics of cold exposed soldiers for rank, MOS, age, etc. were comparable to the total Army. Before data analysis, each case was coded by year. A year was defined as the period from 1 July to 30 June, so that cold seasons were not fragmented. Data were available from July 1980 through June 1999, resulting in 19 winter seasons for analysis.

Statistical analysis was conducted using Statistica V6.0 (Statsoft, Inc, Tulsa, OK). Odds ratios and 95% confidence intervals were calculated to assess risk between genders and ethnic groups, and between CMFs. When calculating odds ratios for ethnicity, the reference group was Caucasians. Frequency of occurrence is expressed as cases per 100,000 soldiers per year.

RESULTS

During the period July 1980 to June 1999, there were 2143 hospitalizations due to CWI, Army-wide. A CWI was the principal diagnosis in 2063 cases, the second diagnosis in 102 cases, and the third diagnosis in 17 cases, (some records contained multiple CWI diagnoses).—An independent STANAG code search identified eight injuries due to "excessive cold" that lacked the ICD-9-CM codes listed above. Those eight cases had the following ICD-9-CM codes: 992.5, heat exhaustion, unspecified; 994.9, other effects of external causes (2 cases); 995.1, certain adverse events not elsewhere classified (4 cases); and 1 case without an ICD-9-CM code. Whether the ICD-9-CM code or the STANAG code is correct is unknown. Overall frequency of occurrence for the study period was 13.8 per 100,000 soldiers.

Table I provides the CWI rate by gender and ethnicity for all years. The injury rates for men and women were virtually identical (13.9 and 13.3/100,000, respectively; $p = 0.88$). African-American men were injured approximately 4 times as often, and African-American women were injured 2.2 times as often as their Caucasian counterparts. The highest incidence rates were in American Indian/Alaskan males; however, the number of cases was low ($n = 20$) and the 95% CI was fairly

COLD WEATHER INJURY—DEGROOT ET AL.

TABLE I. FREQUENCY OF OCCURRENCE OF CWI AMONG ACTIVE-DUTY ARMY SOLDIERS, BY RACE AND GENDER, 1980-1999.

	Men			Women		
	Cases/100,000	Cases	Odds Ratio (95% CI)	Cases/100,000	Cases	Odds Ratio (85% CI)
Caucasian	8.8	723		9.3	76	
African-American	31.2	1075	3.7 (3.4, 4.1)	21.7	131	2.2 (1.6, 2.9)
Hispanic	10.9	57	1.2 (0.9, 1.5)	4.3	2	0.4 (0.1, 1.6)†
Asian/Pacific Islander	2.1	4	0.2 (0.1, 0.6)†	11.6	2	0.8 (0.1, 3.2)†
Indian/Alaskan	35.8	20	3.8 (2.4, 6.0)	0.0	0	Undefined
Other	11.7	31	1.2 (0.8, 1.8)	3.5	1	0.3 (0.3, 2.0)†
Missing or unknown	0.0	1	1.1 (cannot calculate)	0.0	0	Undefined
Total	13.9	1911*		13.3	212*	

* There were 20 cases that did not specify gender and are not included in this table.

† Indicates unreliable confidence intervals due to low frequency of occurrence.

large (Table I). In an effort to determine if an uneven geographic distribution of soldiers by race could explain these findings, the ethnic distribution of the Army, by unit ZIP code, was analyzed. There was no statistical difference between the percent of Caucasians vs. African-Americans assigned to duty stations in the north vs. the south, defined as above or below 36° latitude (data not shown). Due to the low frequency of occurrence for the Hispanic, Asian/Pacific Islander, Indian/Alaskan, and Other ethnic groups, and the resulting unreliable confidence intervals, further analysis of ethnicity was limited to Caucasians and African-Americans.

Enlisted personnel accounted for 96% of all injuries, suffering CWI at a rate of 12.1 per 100,000 per year with junior enlisted (rank of E4 and below) accounting for 77% of all CWI. Commissioned officers accounted for the remaining 4%, at a rate of 6.2 per 100,000. In general, an increase in rank was associated with a decrease in CWI. Similarly, the youngest age group (17-21 yr) had the highest frequency and rate. Consistent with this finding, 80% of injured soldiers had less than 5 yr of military service. Of the injured soldiers, 90.5% were high school graduates, 3.7% were college graduates, and the remainder had some college education.

In an effort to clarify the potential interaction between ethnicity and CMF on CWI susceptibility, the frequency of occurrence of CWI by ethnicity, grouped

by CMF, was calculated for enlisted personnel (Table II). To calculate this frequency of occurrence, for example, the number of cases among African-Americans in the infantry/gun crews CMF was compared with the total number of African-Americans in this CMF. Regardless of CMF, African-Americans were hospitalized for CWI at 3.3 times the rate of Caucasians (95% confidence interval 3.1, 3.7). The infantry and gun crews CMF had the highest proportion of CWI, accounting for 48% of all cases. The communications/intelligence and service/supply CMFs each accounted for 10% of all CWI hospitalizations.

Fig. 1 depicts the CWI hospitalization frequency and cases per 100,000 soldiers by year during the 19 winter seasons. The frequency of occurrence of CWI has continually declined from > 30 cases per 100,000 soldier years to almost zero. There were dramatic declines between winter season 9 and 10 and between 16 and 17. The majority of hospitalizations (86% of all cases) occurred during the months of Dec-Mar within any winter season.

The most frequently occurring CWI was frostbite (43.8% of all cases), followed by other cold injury (20.3%), and unspecified CWI (16.2%). The remaining diagnosis categories each accounted for less than 10% of the total number of cases. Fig. 2 depicts the rate, by year, of the different sites of frostbite. With the exception of the third year, the most commonly occurring

TABLE II. FREQUENCY OF OCCURRENCE OF CWI AMONG ACTIVE-DUTY ENLISTED ARMY SOLDIERS, BY RACE AND CMF, 1980-1999.

Career Management Field	Caucasians Cases/100,000	African-Americans Cases/100,000	Odds ratio (95% CI)
Infantry/Gun Crews	17.7	62.4	4.1 (3.6, 4.6)
Electrical Equipment Repair	2.1	11.9	4.9 (2.2, 11.3)
Communications/Intelligence	8.5	27.5	3.6 (2.7, 4.7)
Health Care	4.9	14.8	3.0 (1.8, 5.1)
Technical/Allied Special	7.1	19.3	2.6 (1.3, 5.3)
Support/Administration	5.5	14.6	2.4 (1.8, 3.3)
Electrical/Mechanical			
Equipment Repair	5.8	17.1	2.9 (2.2, 4.0)
Craftworkers	8.1	20.3	2.4 (1.2, 4.9)
Service/Supply	9.7	23.1	2.2 (1.7, 2.9)
Non-Occupational*	2.9	42.4	8.0 (0.0, 291.1)
All CMF	7.2	25.3	3.3 (3.1, 3.7)

* The non-occupational group includes officer candidates, patients, prisoners, and students in civilian schools.

COLD WEATHER INJURY—DEGROOT ET AL.

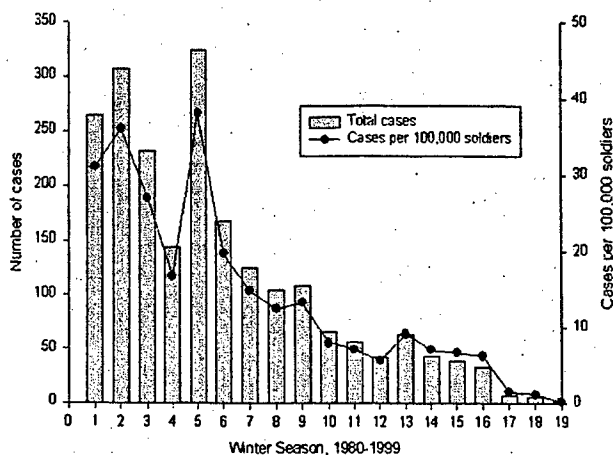


Fig. 1. Frequency of occurrence of hospitalization for CWI among active-duty Army soldiers, by winter season, 1980-1999.

location for frostbite was the feet, followed by the hands and the face, respectively.

Trauma codes were present for 2120 of 2143 cases. Of these, 4 were coded as intentionally inflicted non-battle injury and the remaining 2116 were accidental. Of the accidental injuries, 82.2% took place on duty. STANAG codes were present for 1940 of 2143 cases; however, 1289 of 1940 cases indicated "on land, other, or unspecified" limiting the usefulness of this variable. This leaves 651 cases with quality STANAG coding. Of these 651 cases, 522 (80.2%) occurred "on land and on firing range or drill field." Taken together, the trauma and STANAG codes indicate that approximately 80% of injuries occur on duty and/or during organized training. There was an increase in the proportion of cases occurring at ranges or drill fields from 1983 to 1989; otherwise there was a decline at all locations that mirrored the decline in the overall injury rate (data not shown).

The average hospitalization time for all causes was 6.0 d. Due to the presence of other, more serious diagnoses in several cases, the mean hospitalization time was artificially inflated. The median hospitalization time was 2.8 d.

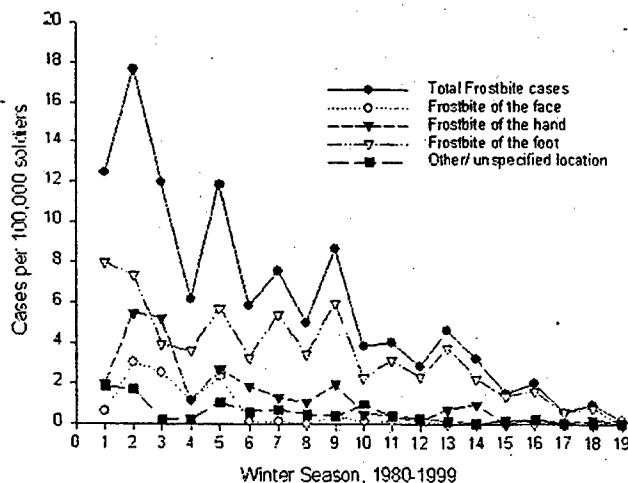


Fig. 2. Frequency of occurrence of hospitalization for frostbite among active-duty Army soldiers, all cases and by body part affected, 1980-1999.

TABLE III. FREQUENCY OF CWI AMONG ACTIVE-DUTY ARMY SOLDIERS, BY DUTY STATION, 1980-1999 (N = 1116).

Location	Cases	Percent
Germany	285	25.5
Kentucky	109	9.8
Alaska	98	8.8
Kansas	75	6.7
Colorado	64	5.7
North Carolina	59	5.4
Texas	49	4.4
Georgia	47	4.2
Virginia	38	3.4
Washington	36	3.2
Korea	34	3.0
California	26	2.3
Louisiana	24	2.2
New York	20	1.8
Hawaii	17	1.5
Alabama	16	1.4
Oklahoma	12	1.1
All other states/countries	107	9.6
Total	1116	100.0

Home of record data indicates that 54.6% of injured soldiers were from the south, defined as those states at or below the 36th parallel. Data from the U.S. Census Bureau shows that as of the 2000 census, 42.7% of the U.S. population resides in the southern states. During the study period, African-Americans comprised 27.4% of the Army, 12.3% of the U.S. population (2000 Census), but 58.6% of the CWI cases. Table III presents Army duty locations with the highest number of cases of CWI during the study period. Due to limitations in data quality, duty location data of 1007 cases from July 1980 to June 1985 are excluded, representing 47% of all CWI during the study period. It should be noted that injuries might not have necessarily occurred at that particular duty station, as it is possible that the soldier's unit was deployed to another location for mission or training purposes.

DISCUSSION

The purpose of the present study was to identify the frequency of occurrence of cold-weather injury hospitalizations, U.S. Army-wide, from 1980-1999. This study is the first to systematically examine the interaction of race, gender, location, and occupational specialty over a long-term period. The key findings of this study are the higher occurrence of CWI among African-Americans compared with Caucasians, the high occurrence on the firing range/drill field, and the dramatic two-decade decline in overall occurrence of CWI hospitalizations among Army personnel.

The finding that African-American men suffer cold injury hospitalization at 3.3 times the rate of Caucasians is in agreement with previous studies. The study of cold injured soldiers in Korea during 1950-51 (15) was one of the first to identify that African-Americans, lower-ranking soldiers, and infantrymen are at an increased risk for CWI. That study did not calculate incidence rates but rather reported the percent distribution between African-Americans and Caucasians admitted for CWI. The authors noted that since all-African-American

units were compared with all-Caucasian units, differences in exposure, training, and personal hygiene might have influenced the findings. Miller and Bjornson (14) showed that both African-American men and southern-born men (regardless of race) were at greater CWI risk, while stationed in Alaska. Candler and Ivey, in a more recent report of soldiers in Alaska (8), showed African-Americans to be at four times the relative risk of suffering frostbite to the hands and feet as their Caucasian counterparts. A report of peacetime training CWI in Germany showed that 64% of the injured soldiers were African-Americans, while they comprised 28% of the Army population during the 4-yr study period (19). The study population was only those soldiers suffering CWI, and the racial distribution of all the soldiers in Germany at the time was not considered. In comparison, African-Americans account for 58.6% of the CWI in our 19-yr study period, were 27.4% of the Army, and made up 12% of the U.S. population. Except for one of the above-mentioned previous reports, none of the papers identified the rate of CWI for females, regardless of ethnicity. Candler and Ivey (8) only state that the "sex distribution of individuals injured was consistent with the population profiles for each year studied." To our knowledge, our study is the first to report the frequency of occurrence of CWI in females and suggests that African-American women have a greater CWI risk than Caucasian women. The high number of cases/100,000 soldiers, and the correspondingly high odds ratio, for Indian/Alaskan males deserves comment. While combining these ethnic groups together is sensible for other epidemiology studies, in determining susceptibility to CWI, this grouping presents difficulties. Intuitively, one might expect an Alaskan to have a lower relative risk of CWI, due to physiological and/or behavioral factors, that may or may not be the case for Indians. Unfortunately, we cannot sub-divide this group, and further analysis into this surprising result is not possible. Furthermore, the low number of cases ($n = 20$) over 19 yr, and the large 95% confidence interval suggests that the odds ratio should be interpreted with caution.

Why are African-Americans at a greater risk for CWI? In an effort to determine the effect of occupational factors, an analysis of CWI frequency by CMF and ethnicity was carried out (Table II). While there was considerable variation in the rate of CWI between CMFs, the ratio between African-Americans and Caucasians was fairly consistent, with the exception of the "non-occupational" CMF. The "non-occupational" group is mostly comprised of individuals in training status, representing a small portion of the Army. One Caucasian male and one African-American female in the non-occupational CMF were injured during the study period, which combined with the small denominator for African-Americans led to an artificially large incidence rate and extremely large confidence intervals (Table II). Thus, regardless of CMF African-Americans suffer CWI hospitalizations at a rate 4 times greater than their Caucasian counterparts. From these results we can conclude that while occupational exposure is a risk factor for CWI, it does not account for the observed differences between ethnic groups. Possible factors in-

clude previous cold weather experience (8), southern or northern born and raised (14,15), proper use of clothing and equipment, provider bias in the decision to admit patients to the hospital, and physiological differences between ethnic groups (8).

The use of STANAG external cause of injury codes and trauma codes is unique to this study, and provides evidence as to the preventable nature of many of these CWI. The last digit of the STANAG external cause of injury code provides a geographical description of the injury location. Unfortunately, 66% of the cases in our cohort were coded "on land, other, or unspecified," which may reflect a limitation of the usefulness of this particular code as it is impossible to be certain whether the use of this code is appropriate based on the place of occurrence not being one of the other potential choices (e.g., on aircraft, ship, airfield, dock, at home, etc.) or whether the place of occurrence really was one of these locations but not coded with the specificity available within the STANAG codes. However, 80.2% of the remaining cases were coded for "on land and on firing range or drill field," which implies an on-duty training injury. This is confirmed by the trauma codes, which are used to indicate, in general terms, the type of injury incurred, such as "direct result of action by or against an organized enemy," "occurring while off duty," and "schemes (maneuvers)/exercises." Our previous work has indicated that hospital coders may not always utilize the available detail of the STANAG coding system, but when a specific location or duty status is indicated that information is generally accurate (2,3). Taken together, these data suggest that as many as 80% of CWI were preventable, as they occurred on-duty during training. This is in agreement with a recent study of soldiers in Germany (19) that showed that almost 50% of CWI occurred during general field duty, 30% in unheated vehicles, and 8% involving solvents or water. Previous studies have indicated that CWI prevention classes are being given, as between 81% and 94% of injured soldiers in other studies had received CWI prevention training at some time prior to the injury (8,19). Army Regulation 40-5, Preventive Medicine, states that commanders will institute a CWI-prevention training program (5), and there is widely published guidance available (9). The continued occurrence of CWI suggests that the content and/or effectiveness of these programs may need to be reassessed.

The rate of hospitalizations for CWI has dramatically declined from a high of 38.2/100,000 soldiers during the winter of 1985-86 to 0.2/100,000 soldiers in 1998-99 (Fig. 1). We cannot necessarily conclude that CWI has been reduced that dramatically, as the observed reduction in CWI hospitalization may be due to a number of external influences. Among these are the closure or downsizing of Army installations in northern latitudes, and implementation of managed-care procedures and cost-based billing reducing the likelihood of hospital admission for a given severity of injury. Numerous Army installations have been closed or downsized during the study period, including several in Germany, which had the highest frequency of occurrence of CWI, and Ft. Ord, CA, which had the seventh highest fre-

quency of CWI (data not shown). In 1988–89 (winter season 9) there was a significant decline in the rate and frequency of CWI, which corresponds with the fall of the Berlin Wall. Presumably, this would correspond with a decreased operational tempo in Eastern Europe, and a decreased exposure risk due to fatigue and multiple stressors (10). Examination of Fig. 1 shows an approximately 50% decrease in the rate and frequency of CWI when the 3 yr before 1988–89 are compared with the 3 yr after. Additionally, analysis of assignment patterns of African-American and Caucasian soldiers to either northern or southern duty stations showed a dramatic decline in the percentage of both ethnic groups to northern duty stations, and a corresponding increase to southern duty stations, beginning in 1990 (data not shown).

Another dramatic drop in the rate and frequency of CWI occurred after winter season 16, 1995–96. Before 1996, hospitals were reimbursed according to their patient census, so it was not in the financial interest to discharge patients as soon as possible. In 1996 cost-based billing was instituted, and it is now in the best interest of the hospital to only admit patients who absolutely require inpatient care and then discharge them as soon as possible. Evidence of this may be provided by hospitalizations due to chilblain, which despite its benign nature has been responsible for 98 hospitalizations, only 2 of which were after 1996. In both cases, the primary diagnosis was frostbite of the face, and chilblain was a secondary diagnosis. These changes in hospital administration may lead to an increase in patients seen solely on an outpatient basis, and this is confirmed by data from the U.S. Army Center for Health Promotion and Preventive Medicine, which reported an increase in outpatient CWI from 1997–2000 (13). Additionally, the rate of all injury hospitalization, Army-wide, has declined during the study period (17,18,21).

The final hypothesis for the decline in the rate and incidence of CWI is an actual reduction due to improvements in soldier education and available equipment. Information for CWI protection is available in at least 10 different publications, including recently updated guidance from our Institute (9). It is likely that the information contained in these publications is being utilized by soldiers in the field and has contributed to, but is not solely responsible for, the decline in CWI. Improvements in individual soldier equipment have also taken place during the study period. In the mid-1980s the extended cold-weather clothing system (ECWCS) was developed, and issued throughout the Army starting in the late 1980s. This is a multi-layer system purported to be operational in both cold-wet and cold-dry environments (11). Additionally, the intermediate cold-weather boot was introduced in 1989, bridging a gap between two existing pieces of footwear, the basic issue black leather boot and the vapor barrier boot for extreme environments.

Army Regulation 40-5, Preventive Medicine, explicitly states that prevention of "climatic injuries" is the responsibility of unit commanders (5). While we know that the British held unit commanders personally responsible for injury prevention as early as World War I

(20), it is unknown when such a doctrinal shift occurred in the U.S. military. However, the "zero-deficit" mentality of the modern military, and the possible negative effects of a CWI suffered by a subordinate on an officer's career, would seem to indicate that prevention is being taken seriously by unit commanders. Without being able to quantify the effects of the improved education and equipment, we are confident that they have played a role in the reduction of CWI during the study period.

Additional research is suggested by our findings. High quality ICD-9-CM-coded outpatient data has been available since late 1997. As time passes, these data may be useful for the study of CWI and in particular the role of ethnicity in risk of CWI. Department of Defense data systems do not yet include cause codes for outpatient records but when this deficiency is remedied, ambulatory data will be even more useful. Additional valuable information could be gleaned from careful review of Army Safety Center reports. These reports, while only available on perhaps 15–25% of CWI, are nonetheless rich in detail and have been used successfully for detailed, mostly qualitative analysis of specific injury problems (1,6).

In conclusion, African-American men and women sustain CWI at a disproportionately higher rate than Caucasians, many of the injuries take place during on-duty training, and there has been a dramatic decline in overall frequency and rate of CWI hospitalizations over time. Previous epidemiological studies of CWI in the U.S. Army have been limited to 5 yr or less, using relatively small populations and either specific operations or geographic areas. In contrast, our findings present 19 yr worth of data, gathered throughout the entire U.S. Army, worldwide, overcoming the limitations of previous research. However, further research into the effects of ethnicity on susceptibility to CWI warrants attention.

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COLD WEATHER INJURY—DEGROOT ET AL.

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