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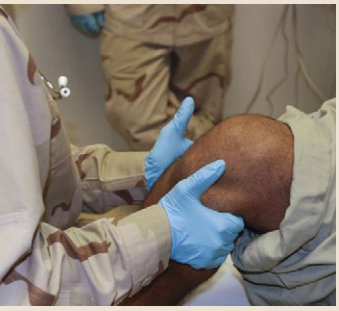

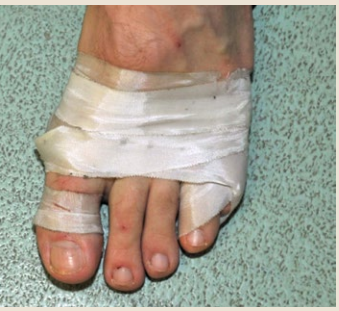

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Identification of Specific Activities Associated with Fall-related Injuries, Active Component, U.S. Army, 2011

Veronique D. Hauschild, MPH; Anna Schuh, PhD; Bonnie J. Taylor, PhD; Michelle Canham-Chervak, PhD, MPH; Bruce H. Jones, MD, MPH (COL, USA, Ret)

Although falls continue to be a leading mechanism of serious injuries among military populations, interventions must target activities or hazards that can be controlled or managed. This project aimed to identify activities most frequently associated with Army soldier fall-related injuries to prioritize prevention strategies for this substantial health burden. Narrative data from Army safety, medical evacuation, and casualty reporting systems were reviewed to select incidents meeting inclusion criteria and assign established codes. Non-deployed (n=988) and deployed (n=254) injury rates were not statistically different (2.20 per 1,000 non-deployed person-years [p-yrs], 2.21 per 1,000 deployed p-yrs, respectively). More than 75% of injuries were temporarily disabling fractures, sprains, and strains, primarily to lower extremities. The most frequent activities associated with non-deployed fall injuries were sports (e.g., snowboarding and basketball; 22%), parachuting (20%), walking/marching (19%), and climbing (15%). Ice and snow were the leading hazard (43%). The most common associated activities among deployed soldiers were occupational tasks (53%), walking/patrolling (24%), climbing (23%), and sports (17%). Specific interventions that target the activities and hazards identified in this investigation are suggested as priorities to reduce Army fall-related injuries.

Slips, trips, and falls—hereafter referred to as simply "falls"—have been consistently reported as one of the most common causes of both inpatient and outpatient musculoskeletal and orthopedic visits in the U.S. military.[1–4] Falls have also been found to be the second leading cause of air evacuations of U.S. Army personnel from deployed settings for non-combat injuries.[5–7] Because impacts to military readiness are substantial, opportunities to reduce these injuries warrant additional attention. However, because the term "falls" only describes the *mechanism* for injuries that occur during a variety of activities, it is difficult to determine effective interventions.[4, 8] To reduce fall-related injuries in the military, interventions must be directed at the specific *activities* which result in falls. Unfortunately, codes that describe the causal activities and associated hazards have not been readily obtainable from military medical surveillance data.[9–11] To help determine actionable intervention measures, this study used narrative data to identify the leading activities and hazards associated with fall-related injuries among active component Army soldiers. The results also serve as a basis for the recommended medical coding of activities and hazards to enable the future assessment of fall-related injury reduction strategies.

METHODS

This investigation used a systematic approach to elicit key details from narrative incident reports for active component Army soldiers in non-deployed and deployed settings.[12] Deployed settings were defined as overseas locations in the combat operational theater of Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn. Incident reports were extracted from the Army accident and mishaps data in the Army Safety Management Information System (ASMIS), medical evacuation data from the Transportation Command Regulating Command and Control Evacuation System, and Central Command deployment casualty data from the Defense Casualty Information Processing System. As recommended by previous efforts,[3,9–11] these incident narratives were considered especially critical information sources because of data gaps and inconsistencies in existing coded variables documented in the selected data sources and in records of healthcare encounters. Because of the detailed nature of the narrative review, the study period was limited to the 2011 calendar year (1 January through 31 December 2011). This period was selected because there was a notable reduction in the amount of deployment injury data from 2012 onward, presumably as a result of the drawdown of forces.

Datasets were merged by unique identifier using IBM SPSS Statistics[13] and exported to Microsoft Excel® 2010 for analysis. A priori codes were used to categorize data elements from each narrative. To minimize subjective biases, narratives were independently reviewed and coded by two investigators. Differences were resolved through verbal consensus. Coded variables included:

- *Injury severity*. Categories were death, permanent disability (from acute injury, e.g., amputation), restricted or lost duty time, or minor injury with only first aid required.

• *Injury types* and *body regions*. Categories were similar to those used in prior injury surveillance reporting.[14]

• *Fall height*. Categories were a fall on same level or a fall from height.

• *Scenario*. Codes described deployment, duty-status, and location in more detail than previous studies. Because possible intervention may be implemented on military property or during events sponsored by the military, military oversight was coded for applicable activities.

• *Activities*. Categories were derived from a review of prior military surveillance and fall-related studies: sports/recreational activities, parachuting, physical training, walking/marching, climbing (e.g., up/down stairs, in/out of vehicle, up/down a hill), military combat training, other military occupational tasks, house cleaning/maintenance, other, and unknown. When a narrative described a combination of two activities, both codes were recorded. Sub-codes were used for type of sport (e.g., basketball) and for type of vehicle.

• *Hazard factors*. Hazard codes reflected prominent occupational hazards or key factors in Army safety coding.[15–17] These included substances on the surface, poor drainage, indoor surface irregularities, outdoor surface irregularities, weather conditions, inadequate lighting, stairs and handrails, ladders/scaffolds/stools, presence of obstacle/object on walking surface, carrying an object, entering/exiting a stationary vehicle, fainting/dizziness, lack of situational awareness, no protective equipment used/failure to adhere to established procedures, alcohol use, fatigue, jumping up, and equipment failure. When incidents described multiple factors, up to three codes were recorded.

Fall-related injury rates were calculated as the number of fall injury incidents per 1,000 person-years (p-yrs) for the selected study year, 2011. The active duty Army person-time in 2011 was 449,132 p-yrs in non-deployed settings and 114,724 p-yrs in deployed settings.[18] The z score and p values for comparing rates were calculated using OpenEpi[19] online. Frequencies and percentages were calculated for activities and hazards. Because the height of a fall has historically been considered a risk factor in injury severity, injury frequencies and types were also evaluated by height.

RESULTS

Of 5,199 injury incidents reported in non-deployed settings, 988 (19.0%) met the established criteria as fall-related injuries. Of the 8,914 original reports from deployed settings, a total of 254 (2.8%) were identified as fall-related injuries. Overall rates of fall-related injuries in non-deployed and deployed settings were not statistically different (p=.93): 2.20 injuries per 1,000 p-yrs and 2.21 injuries per 1,000 p-yrs, respectively. Rates across most demographic groups **(Table 1)** were not remarkably different (p>.05). Some increased risk was noted for personnel who were younger than 25 years of age and junior enlisted (versus officer) (p values <.05).

Injury types and body regions

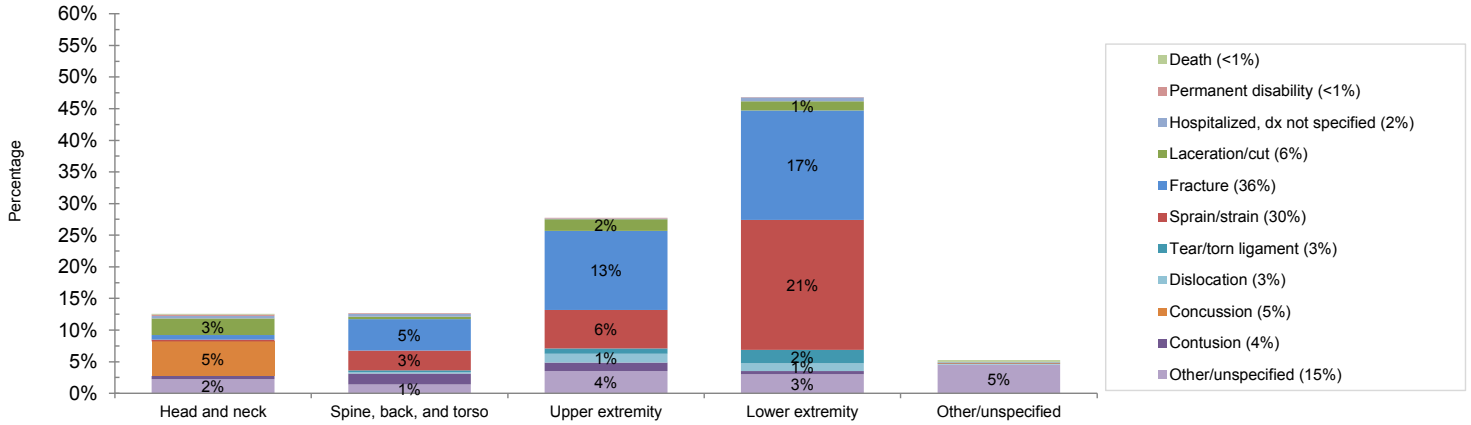
Of the total 1,242 fall-related injury incidents evaluated, the vast majority of the injuries (79%) resulted in restricted or lost duty time. Few deaths or acute permanent disabilities were attributed to these fall incidents (each less than 1%). Fractures were the injury type most frequently associated with temporary restricted duty or lost duty time (33%). Strains and sprains were next most common injury type (22%). Lower extremities were the most commonly injured body region (50%), with the ankle being the predominant body part injured (33%). When combining injury type with

TABLE 1. Fall-related injury rates and distributions by setting type and demographics, active component, U.S. Army, 2011[a]

	Non-deployed fall-related incidents			Deployed fall-related incidents		
	Percentage distribution of incidents (n=988)	Demographic composition of Army non-deployed population[b]	Rate[c]	Percentage distribution of incidents (n=254)	Demographic composition of Army deployed population[b]	Rate[c]
Total	100%	100%	2.20	100%	100%	2.21
Gender						
Male	85%	86%	2.18	90%	90%	2.22
Female	15%	14%	2.26	10%	10%	2.09
Age						
<20	7%	6%	2.61	4%	2%	3.91
20–24	35%	29%	2.67	31%	30%	2.13
25–29	23%	25%	1.97	30%	26%	2.51
30–34	12%	16%	1.66	8%	16%	1.17
30–39	9%	12%	1.54	9%	11%	1.97
≥40	9%	12%	1.69	7%	15%	1.07
Unknown	6%	--	--	12%	--	--
Rank						
Enlisted (E1–E4)	57%	46%	2.75	59%	47%	2.69
Enlisted (E5–E9)	30%	37%	1.78	29%	35%	1.86
Officer	10%	18%	1.25	6%	18%	0.86
Other/unknown	3%	--	--	5%	--	--

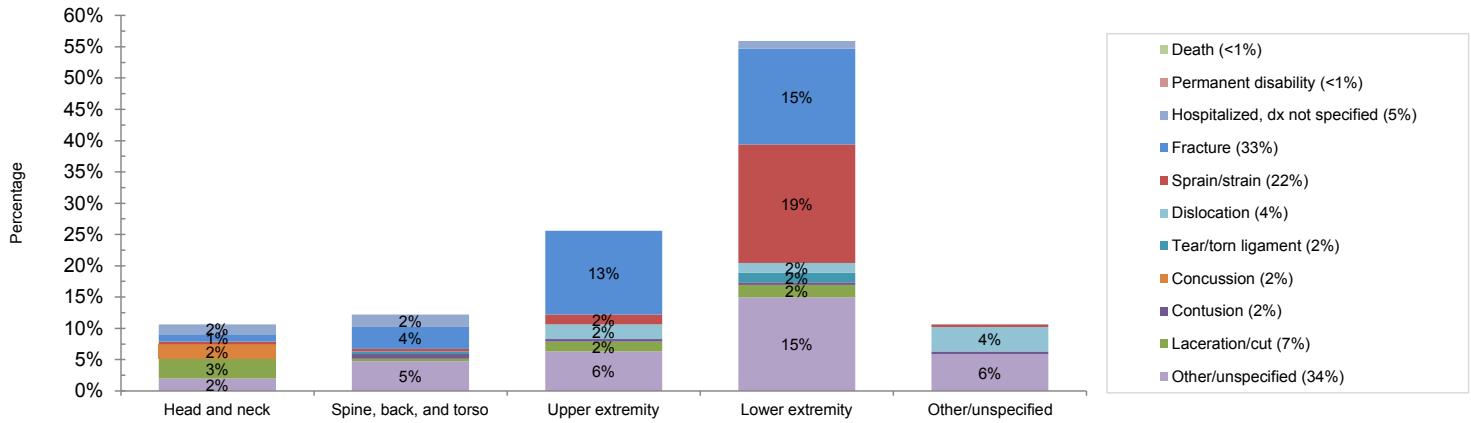
[a]Reported incidents in Army safety, air medical evacuation, and casualty data in 2011
[b]Total Army population in 2011
[c]Rate per 1,000 person-years

FIGURE 1. Distribution of injury types and body regions associated with fall-related injuries in non-deployed settings, active component, U.S. Army, 2011[a]



[a]Because some injury incident reports described injuries of more than one type and/or involving more than one body part, the sums of injuries (1,113) exceed the number of non-deployed fall incidents (n=988) and the calculated percentages add up to more than 100%.

FIGURE 2. Distribution of injury types and body regions associated with fall-related injuries in deployed settings, active component, U.S. Army, 2011[a]



[a]Because some injury incident reports described injuries of more than one type and/or involving more than one body part, the sums of injuries (284) exceed the number of deployed fall incidents (n=254) and the calculated percentages add up to more than 100%.

body region, lower extremity sprains and strains were the most common (21%). The distributions of these leading injury types and body regions were similar among both non-deployed and deployed populations **(Figures 1 and 2)**.

Activities

The leading activities associated with fall-related injuries **(Figure 3)** in non-deployed settings were sports (22%), parachuting (20%), and walking/marching (19%). In deployed settings, the most frequently reported activities associated with fall-related injuries were occupational tasks (53%), walking/marching (24%), and climbing (23%).

Sports resulting in the most frequent fall-related injuries in non-deployed settings were snowboarding (26%), basketball (20%), and football (10%) **(Figure 4)**. Fractures (40%) and strains and sprains (33%) were the most common types of non-deployed sports fall injuries and the lower extremities were the most frequently injured body region (49%), followed by the upper extremities (35%) **(data not shown)**. Obstacles on the ground and surface irregularities were the leading sports-related contributing hazards **(data not shown)**. Fifty-three percent of the non-deployed sports incidents occurred off duty during personal time and not on military property or with any military oversight or endorsement **(data not shown)**.

Sports most frequently associated with fall-related injuries in deployed settings were basketball (49%), football (23%), and volleyball (21%) **(Figure 4)**. The most common sports-related injuries in deployed settings were fractures (33%) and sprains and strains (30%); the lower extremities were

FIGURE 3. Percentages of fall-related injuries associated with specific activities, active component, U.S. Army, 2011

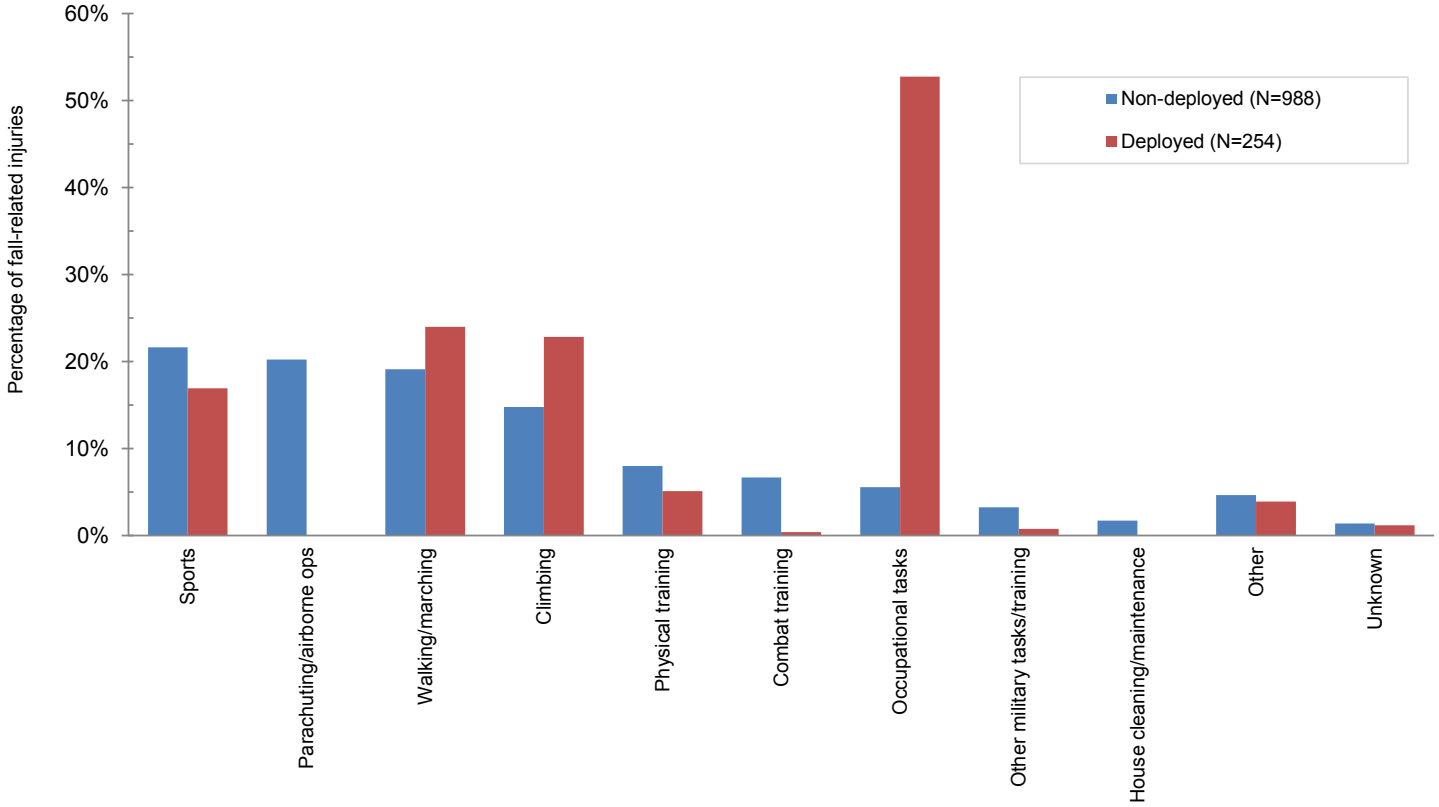
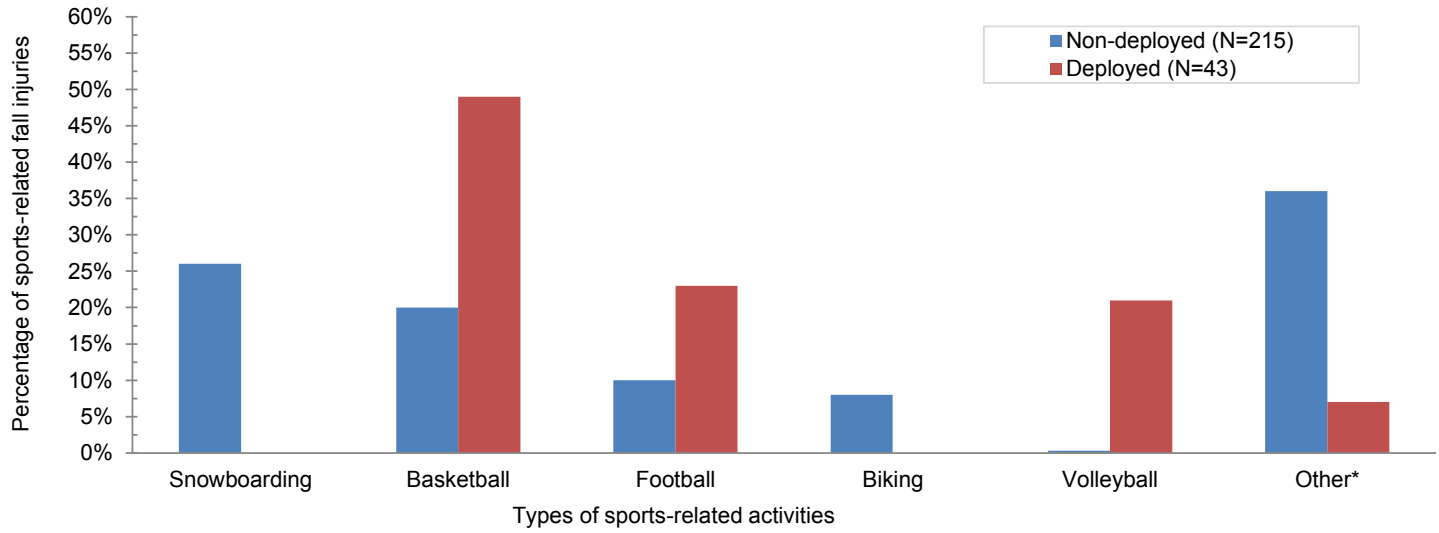


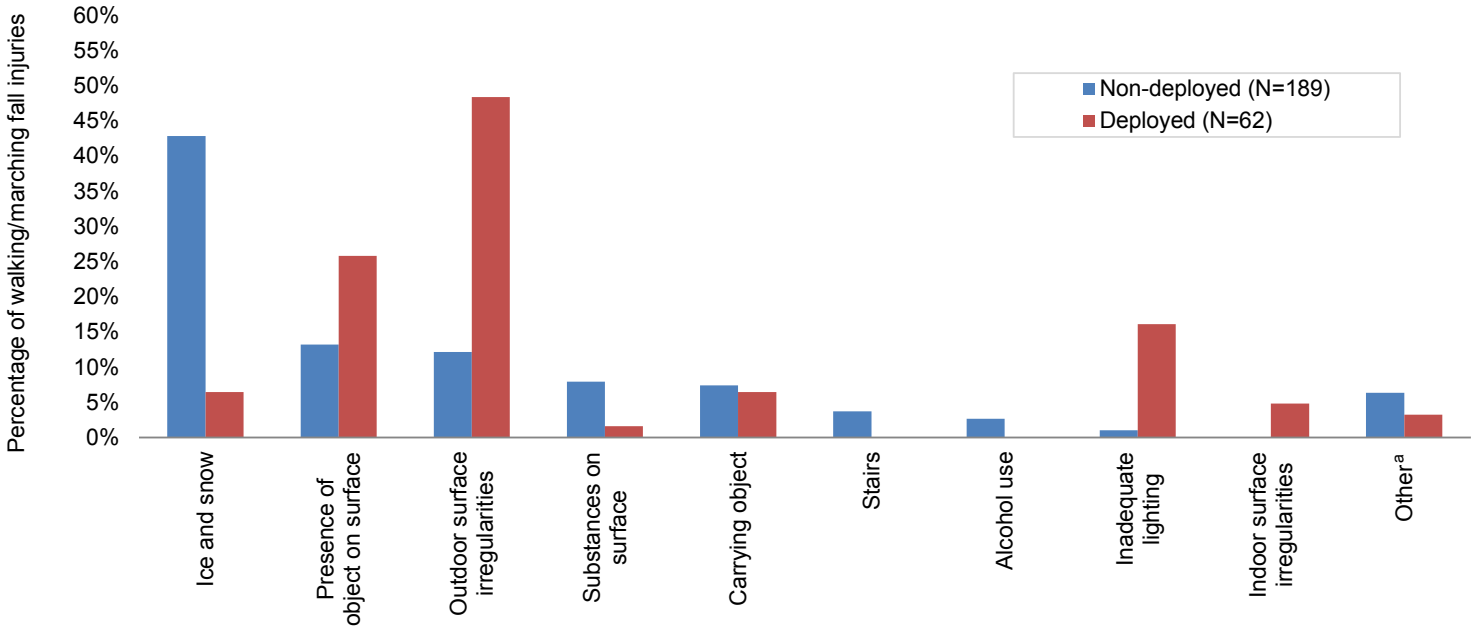
FIGURE 4. Percentages of sports-related fall injuries associated with particular sports, active component, U.S. Army, 2011



the primary injured body region (67%) and most of these were ankle/foot injuries (53%) **(data not shown)**. Hazards most frequently associated with these injuries were obstacles on the ground and surface irregularities **(data not shown)**.

Occupational tasks, walking/marching, and climbing were frequently cited as concurrent activities, so were often difficult to differentiate. For example, patrolling was considered both an occupational task and a walking/marching activity. Falls also occurred when entering or exiting vehicles during occupational tasks (31% non-deployed, 35% deployed) **(data not shown)**. Mine-resistant ambush protected (MRAP)vehicles were the most common type of vehicle associated with fall-related

FIGURE 5. Percentages of walking/marching fall injuries associated with specific hazards, active component, U.S. Army, 2011



[a]"Other" represents factors with <2% of walking/marching fall injuries: jumping (not parachuting), transport vehicle, ladders/scaffolds/stools, fatigue, fainting, and lack of situational awareness.

injuries in deployed settings, whereas light-medium military multipurpose vehicles were more commonly associated with non-deployment injuries.

The leading hazards associated with walking incidents in non-deployed settings were ice and snow (43%) **(Figure 5)**. Some narratives explained a lack of situational awareness regarding ice and snow, whereas a few mentioned that the soldier had failed to follow local policies requiring the use of anti-slip devices. The next most commonly reported walking hazards included objects on the walking surface (e.g., dogs, boxes, beds/furniture, 13%), and outdoor surface irregularities including rocks, curbs, and holes in the ground (12%). The types of objects and irregularities were highly varied with no discernible pattern.

The most common hazards associated with walking/marching fall-related injuries in deployed settings were outdoor surface irregularities (48%), objects on the walking surface (26%), and inadequate lighting (16%) **(Figure 5)**. These hazard categories were not mutually exclusive; 70% of the records of injuries attributed to inadequate lighting also noted outdoor surface irregularities and/or objects on the walking surface. Unlike non-deployed settings, the records of deployed walking/marching incidents also often referred to heavy loads being carried. For instance, a typical fall scenario described a soldier carrying a rucksack while on patrol, at night with limited lighting, who fell due to the presence of a surface irregularity/object. Although evidence indicates that personnel usually wear armor and carry heavy loads during patrols,[20] this factor could not be quantified because it was not consistently documented.

Climbing-related fall incidents in non-deployed settings were most commonly associated with ascending or descending stairs, followed by falls occurring when entering or exiting stationary vehicles. Narratives frequently described a lack of situational awareness and/or a combination of other factors such as ice and snow or carrying an object. Although a majority of the incidents occurred on military property, no consistent problems with engineering controls were noted. In the deployed settings, falls were most commonly associated with entering or exiting stationary vehicles.

Fall heights and severity

The deaths and permanent disabilities identified were associated with falls from heights **(Table 2)**. Fractures, on the other hand, occurred with approximately equal frequency from falls on the same level and falls from heights in both non-deployed and deployed settings. Sprains and strains occurred more frequently during falls from the same level compared to falls from heights.

EDITORIAL COMMENT

Fall-related injuries among active component Army soldiers continue to be serious in nature, regardless of deployment status **(Table 3)**.[3,5,10] The vast majority of these injuries result in temporary restricted or limited lost duty time. It is difficult to assess the full cost and days of lost duty (DLD) because of substantial underreporting, as prior estimates have shown that safety incident reports matched with less than 15% of inpatient hospital data and less than 1% of outpatient data.[2] However,

TABLE 2. Fall-related injury type relative to height of fall, active component, U.S. Army, 2011

Injury type	Non-deployed (N=985)[a]		Deployed (N=254)	
	Falls from height (n=494)	Falls from same level (n=491)	Falls from height (n=109)	Falls from same level (n=145)
Death	4 (1%)	-	-	-
Permanent disability (not otherwise specified)	4 (1%)	1 (<1%)	-	1 (<1%)
Fracture	181 (36%)	175 (36%)	34 (31%)	50 (34%)
Sprain/strain	145 (29%)	172 (35%)	16 (15%)	40 (28%)
Laceration/cut	25 (5%)	46 (9%)	5 (5%)	12 (8%)
Concussion	41 (8%)	20 (4%)	3 (3%)	3 (2%)
Contusion	26 (5%)	21 (4%)	6 (6%)	-
Tear/torn ligament	16 (3%)	20 (4%)	3 (3%)	4 (3%)
Dislocation	11 (2%)	20 (4%)	4 (4%)	6 (4%)
Hospitalized, not otherwise specified	13 (3%)	7 (1%)	6 (6%)	5 (3%)
Other/unspecified injury type	110 (21%)	59 (12%)	46 (42%)	40 (28%)
Total injuries [b]	576 (115%)[b]	541 (110%)[b]	123 (113%)[b]	161 (110%)[b]

[a]For three non-deployed incidents, fall height could not be determined from the narrative description.

[b]Some falls resulted in more than one injury type and/or involved more than one body part.

the DLD for the most frequent type of fall-related injury (fractures) identified in this study can be calculated from current Army data obtained from the Defense Medical Surveillance System (DMSS).[21] Fractures have been estimated as resulting in an average of 100 DLD.[2] The DMSS Army data for 2014 show falls as the cause of 17% of 963 hospitalizations and 16% of 144,956 outpatient cases.[21] Assuming that 35% of fall-related injuries result in fractures as was observed in this investigation, it can be estimated that 8,175 fall-related fractures resulted in over 800,000 DLD in 2014. Although fractures are the most predominant fall-related injury, sprains and strains are also very common.

Demographic and fall height data have not provided adequate information from which to direct Army fall-related injury prevention efforts. Instead, the activities and hazards identified in this investigation provide the needed basis from which to develop actionable interventions to reduce these injuries.[20] Army medical providers should place greater emphasis on the use of the ICD-10 codes for these activities (Y codes) and hazards (V and W codes) to improve future monitoring and assessment of prevention strategies. Interventions that may help reduce fall-related injuries include the following:

Sports activities. Snowboarding (suggested ICD-10: Y93.23) is a particularly high risk sport for soldiers in non-deployed settings. Because evidence supports the use of helmets and wrist guards to reduce injuries,[22,23] protective gear should be recommended. As supported by previous studies, basketball (ICD-10: Y93.67) is a leading fall-related injury activity in both non-deployed and deployed military settings.[7,24] Ankle injuries are also common, a portion of which may be reduced by use of rigid ankle braces.[25–27]

Military parachuting (suggested ICD-10: V97.22XA). There is substantial evidence for the effectiveness of outside-of-the-boot ankle braces to reduce both the frequency and severity of ankle-related injuries.[27–29] Anecdotal concerns regarding comfort and logistics appear to have been obstacles to implementation of this intervention.[27,28] More recently, studies have also suggested that injuries may be reduced by using a new type of military parachute (T-11) in place of the older parachute type (T-10).[30]

Ice and snow hazards (suggested ICD-10: W00.***). Although there are few proven interventions for fall-related injuries attributed to ice and snow, various low-cost approaches to increase awareness are worthy of consideration.[31] Examples include regulation and policy change, media alerts, signage in areas of icy conditions, mechanisms to report icy areas, and provision of basic supplies such as sand/salt and floor mats. Because persons may be at greater risk in areas less prone to icy conditions due to a lack of awareness and/or engineering controls, ice and snow fall hazards should be emphasized in all locations.

Stationary vehicles (suggested ICD-10: V87.8XXA). A lack of familiarity or training on entering and exiting vehicles such as the very tall MRAP may have played a role in deployment injuries. Future evaluation may also consider engineering controls or procedures associated with vehicle structure, night vision, load carriage, fatigue, and/or individuals' balance skills.

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Conflicts of interest: None.

Disclaimer: The views expressed are those of the authors and do not necessarily reflect the official policy of the Department of Defense, Department of the Army, U.S. Army Medical Department, or the U.S. Government. Use of trademarked names does not imply endorsement.

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TABLE 3. Comparison of findings of U.S. Army active component fall-related injury studies

Characteristic	Prior studies			Current study
Population	Non-deployed 1980–1998[3]	Non-deployed 1994–2002[10]	Deployed 2001–2012[5]	Non-deployed and deployed 2011
Data source	Hospitalization records	Safety reports	Air evacuation, casualty reports	Safety, air evacuation, casualty reports
Incident rate[a]	0.13–0.37 per 1000 p-yrs Found steady decline in rates[b]	0.59 per 1,000 p-yrs Used "falls" code used in the Army Safety Management Information System	3.5–4.7 per 1,000 p-yrs Number of air evacuated fall injuries per 1,000 deployed p-yrs[c]	2.20 per 1,000 non-deployed p-yrs 2.21 per 1,000 deployed p-yrs Used narratives to standardize and correct for inconsistencies and gaps in coding
Demographics of highest risk groups	Aged 20–26 yrs, enlisted male, white, single	Aged 20–24 yrs; enlisted white, single Infantry, military police, armor tank crewman	Aged 20–29 yrs, enlisted, male	Aged 20–24 yrs, male, enlisted (E1–E4) had highest rates and most frequent injuries (Highest subgroup rate = aged 20–24 yrs = 2.67) No substantial subgroup differences
Types of Injuries	Fracture (41%) Intercranial (15%) Sprains and strains (12%) Fatalities (<1%)	Fracture (53%) Sprain/strain (21.3 %)	Fracture (39%) Dislocation (19%) Fatalities (<1%)	Fracture (36%, 33%) Sprain/strain (30%, 22%) Dislocations, lacerations, concussions, other (each <8%) Fatalities (<1%)
Key body regions (non-fatal)	Lower extremity (44%) Head (23%) Upper extremity (19%)	Lower extremity (> 38%) Spine /back torso (>20%) Upper extremity (>18%)	Lower extremity (>47%) Knee (29%), Ankle/foot (18%) Wrist/hand (13%)	Lower extremity (47%, 56%) Ankle/foot (31%; 39%) Knee (17%, 17%) Wrist/hand (14%; 13%)
Fall height	42% falls on same level 43% fall from height 15% falls on stairs or ladders Found almost half of falls (49%) occurred off duty; least common were from stairs/ ladders	49% falls from same level 51% fall from elevation Found higher elevation equals more severe injury (>hospital/ lost work time)	39% falls on same level 30% fall one to other level 30% near falls* (*Did not result in actual fall/ contact with surface)	50%, 57% falls from same level 50%, 43% fall from height - Very few incidents >3- to 4-ft height - Height contributed to four fatalities, but no trends in fractures/sprains/sprains
Activities	On duty (64%), approximately one-half in military training Off duty (36%)	Most in military training (32%) Housing areas (18%) Routine activities (35%) (i.e., walking, entering/exiting a vehicle); Sports (12%) Physical training (12%)	Entering/exiting a vehicle (>33%)	Duty-related/military property: majority during activity with some Army oversight[e] Sports: Snowboarding (non-deployed); basketball (non-deployed, deployed); parachuting (non-deployed); walking/marching (non-deployed, deployed) Climbing includes stairs and entering/exiting a vehicle Occupational tasks (deployment)
Hazards	Barracks window/balcony (climbing in/out); substance abuse/alcohol; epilepsy/sleep disorder [d]			Ice/snow most common (non-deployment); Next: substances on surfaces, surface irregularities; lack of familiarity with vehicles; fatigue; poor lighting; carried loads

[a]Rates are numbers of fall-related injuries/1,000 active duty soldier person-years (p-yrs). Denominators are overall active duty population. Current study adjusted for deployment with deployment rates using denominator of deployed population for given time period; Kersellius et al., 2014 injuries are those that were medically evacuated from Afghanistan/Iraq. Current study defined deployment settings as deployments associated with Operation Iraqi Freedom, Operation Enduring Freedom, and Operation New Dawn.
[b]Decline considered likely due to a number of policy and procedural changes, including fall injury safety training, engineering controls (anti-slip devices, ice removal), increased reliance on outpatient care, and changes in policy for soldiers in barracks. Study notes that reliance on medical codes was for inpatient treatments and likely missed many fall injuries and thus is an underestimate.
[c]Study found falls to be second leading cause of medical air evacuations; falls found to be cause of 23% of all non-battle injuries.
[d]Based on a limited review of some narratives.
[e]Percent depends on specific activity; for example, 53% sports and 66% walking/marching in non-deployed settings, all activities in deployed settings.

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Incidence and Recent Trends in Functional Gastrointestinal Disorders, Active Component, U.S. Armed Forces, 2005–2014

Amelia G. Johnson, MPH; Zheng Hu, MS; Angelia A. Cost, ScM, PhD

Functional gastrointestinal disorders (FGIDs) are common chronic conditions with an unknown pathophysiology and etiology. FGIDs elevate healthcare costs and cause substantial burden to public health and the military, including diminished readiness, productivity, and quality of life. This retrospective cohort study of active component U.S. military personnel covered a 10-year surveillance period, 2005–2014. The Defense Medical Surveillance System (DMSS) was the data source. Incident cases were identified and rates were calculated and stratified by important covariates. Trends were described over the surveillance period. Incidence rates among deployed personnel were compared to rates in non-deployed personnel, stratified by age and sex. An increasing trend in functional constipation was observed during 2005–2012. Being female, black, in the Army or Air Force, and younger than 20 years of age or 40 years of age or older was associated with higher incidence rates. Deployment-exposed personnel had incidence rates that were 53% higher than those of non-deployed personnel. Elevated rates in personnel younger than 20 years of age and deployed personnel evoke interest concerning readiness and cost implications for the Military Health System. These subgroups should be examined in future studies.

The term "functional gastrointestinal disorders" (FGIDs) refers to a group of chronic conditions affecting the digestive tract. These disorders occur frequently, yet their pathophysiology and exact causes are unclear. Because structural or etiological criteria currently are not available, cases are typically diagnosed on the basis of symptoms using guidelines such as the Rome Criteria.[1] Gastrointestinal dysmotility and hypersensitivity are terms that generally characterize typical FGID symptoms.[2] Symptoms for a given FGID can overlap between different FGIDs and patients can suffer from multiple FGIDs simultaneously. [2–4] For the purposes of this study, four common FGIDs were investigated: irritable bowel syndrome (IBS), functional diarrhea (FD), functional constipation (FC), and dyspepsia (D).

FGIDs are common in the U.S., both in the general population and in the military.[4] Prevalence estimates suggest that up to 27% of the population has FC, with a predominance in the elderly and in females.[5] One study estimated the 12-year cumulative incidence of FC to be 17.4%.[5] The prevalence of IBS in the general population is estimated at 10%–20%, with about 200 incident cases per 100,000 persons per year.[6,7] Generally, IBS patients are disproportionately female, and younger in age compared to FC patients.[7] Prevalence of D is estimated to be 20%–30% and FD prevalence ranges from 2%–8% in the general population.[4,8] A previous case-control study of FGIDs (IBS, FD, FC, and D) in the U.S. military from 1999–2007 found an overall incidence of 231 per 100,000 person-years, with higher rates in females compared to males.[9] FGID prevalence is thought to be underestimated because only a fraction of those suffering seek medical care.

Despite some ambiguity concerning FGIDs, it is apparent the disorders have significant detrimental impact on productivity and quality of life.[10] There are no cures or treatments beyond symptom management.[4] Furthermore, simply managing a case of FGID presents a challenge as the disorders are enigmatic and effective treatments remain elusive.[11] Persons suffering from FGIDs frequently score lower on quality of life scores compared to both healthy populations and persons with chronic diseases.[4,12] FGIDs impose a considerable burden on the healthcare system because they are linked to increased utilization of inpatient and outpatient services as well as non-gastrointestinal-related physician visits and elevated healthcare costs.[10,13,14]

The currently established FGID risk profile is multifactorial, with genetic, physiological, environmental, social, and behavioral factors believed to be related to condition development.[11,15,16] Of note, acute gastroenteritis (AGE) is associated with increased risk of developing FGID in both the general population and the U.S. military.[9,17] A wealth of evidence supports this association and post-infectious IBS is a well-established sequelae of AGE.[18] Military personnel are often deployed to locations around the world with high rates of traveler's diarrhea; as a result, traveler's diarrhea is common in this population.[17] Thus, FGIDs related to AGE are of particular interest to the military, considering the implications for readiness and costs to the Military Health System (MHS).[17]

Other deployment exposures may also affect FGID risk. Deployed personnel may be more likely to experience increased stress; however, the relationship between deployment-related stress and FGIDs is not clearly established. A recent case-control

study found that neither combat nor non-combat related deployment stressors were associated with increased risk of FGID in U.S. active duty personnel.[17] However, there is evidence of a relationship between FGIDs and Gulf War service; IBS is included in the working definition of Gulf War illness [4,19,20] In 2011, the Veterans Health Administration added FGIDs to the working definition of chronic multisymptom illness (CMI), designating the disorders as presumptive service-related conditions.[19] Moreover, a recent study of veteran's health records found an increased prevalence of FGIDs in recently returned Iraq and Afghanistan veterans, among whom rates were highest in those with mental illness.[21] Therefore, deployment remains a variable of interest and studies involving deployed populations are necessary to assess what impact deployment-related exposures may have on FGID risk.[9]

Much of the natural history of FGIDs remains uncertain and comprehensive epidemiological studies are needed to elucidate the causal pathways for these common disorders.[22–24] This study examines incident FGID trends, deployment-related effects, and important covariates, and thereby provides a basis for further research into the complex causal pathway for FGIDs while informing providers and policy makers.

METHODS

This study used a retrospective cohort design and a surveillance population that included all active component service members of the Army, Navy, Air Force, and Marine Corps. The surveillance period was 1 January 2005 through 31 December 2014. Data on the population were ascertained from records routinely maintained in the Defense Medical Surveillance System (DMSS) by the Armed Forces Health Surveillance Branch (AFHSB). Specific sections of DMSS used included demographics and military service data that originated from the Defense Manpower Data Center (DMDC), the Defense Health Services System (DHSS) data to obtain inpatient and outpatient medical encounter data, and the Theater Medical Data Store (TMDS) for data on shipboard medical encounters and encounters during deployment.

Cases of irritable bowel syndrome (IBS) (ICD-9: 564.1), functional diarrhea (FD) (ICD-9: 564.5), functional constipation (FC) (ICD-9: 564.0), and dyspepsia (D) (ICD-9: 536.8) were defined as having at least two medical encounters (inpatient or outpatient) for the specific condition within one year of one another. The diagnosis had to be in the first diagnostic position for at least one of the encounters and the incident diagnosis had to occur during the study period. Individuals who qualified for more than one case condition were excluded from the individual condition case counts but were included in the total count.[15]

Deployment exposure was defined as concurrent deployment or deployment up to 2 years before the initial FGID medical encounter, loss to follow-up, or end of the study period. Incident cases were considered deployment exposed if they occurred between 6 and 24 months following deployment start. This 6-month diagnostic delay from deployment start ensured an adequate exposure timeframe.[7] An exposure window of up to 18 months accounts for potential delays in diagnosis resulting from diagnostic processes and patient care-seeking behaviors.[8] The dataset covered the surveillance period through the end of 2014. Therefore, deployment exposure was assessed only for cases occurring among service members who had deployed through 2013 to allow for at least a portion of the 24-month follow-up needed to assess cases following deployment. For service members whose deployments began during 2005–2013, rates for each deployment year were calculated based on cases diagnosed during the 24-month follow-up period and person-time accumulated from the dates of deployment. Many personnel with deployment exposure were deployed to multiple countries in a given deployment; therefore, the country with the longest deployed time during deployment was used for analysis purposes. Although all deployment countries were investigated, only Iraq and Afghanistan were included in the analysis, as these were the primary countries of interest for military deployments. Covariates investigated include age, sex, race, education, military branch, and military rank.

Incident cases of FGID were quantified by year and descriptive statistics and incidence rates were calculated, with stratification by important covariates. Incidence rates were compared over the surveillance period to identify trends. Additionally, incidence rates and rate ratios were calculated for FGIDs in deployed versus non-deployed active component personnel, stratified by age and sex. Quantitative analyses were performed using R version 3.2.3[25] and Microsoft Excel.

RESULTS

During the 10-year surveillance period, a total of 53,438 service members had incident diagnoses of one or more FGIDs. Approximately 60% were FC, 19% IBS, 15% D, and 1% FD. About 5% of the cases met the definition for more than one FGID (overlapping category). The overall incidence was 376 FGID cases per 100,000 person-years. Of the individual FGID groups, FC had the highest incidence rate with 226 cases per 100,000 person-years followed by IBS at 71 cases per 100,000 person-years, D at 14 cases per 100,000 person-years, and FD at about four cases per 100,000 person-years. The **Table** provides incidence rates and incidence rate ratios (IRRs) by demographic and service variables. Females displayed an elevated incidence rate compared to males (IRR=4.73), and this relationship remained throughout the study period. Higher incidence rates were observed among black service members compared to their white counterparts (IRR=1.47). The highest rates were observed in personnel younger than 20 years of age followed by those aged 40 years or older. Compared to the Navy, both Army and Air Force displayed elevated incidence rates of FGIDs, whereas rates were reduced in the Marine Corps. Personnel with deployment exposure had an overall incidence rate that was 53% higher than those without such exposure.

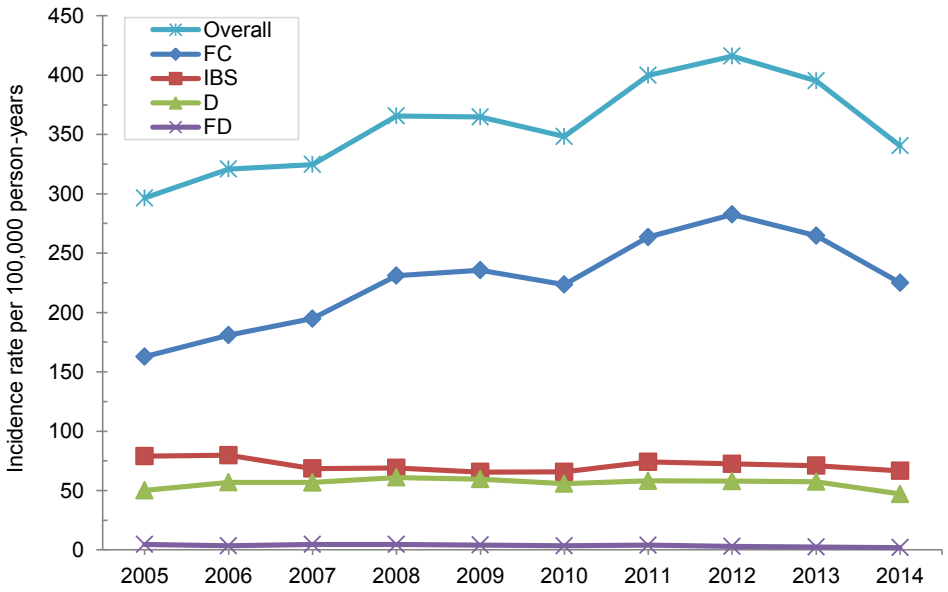
Yearly incidence rates increased overall compared to the beginning of the study but declined from 2012 to 2014. This trend

TABLE. Demographic and military characteristics in incident cases of functional gastrointestinal disorder, active component, U.S. Armed Forces, 2005–2014

	No.	%	Rate[a]	Incidence rate ratio
Total	53,438	100.0	375.7	-
Sex				
Female	23,817	44.6	1186.2	4.73
Male	29,621	55.4	250.9	Ref
Age group				
<20	6,379	11.9	712.0	1.86
20–24	17,287	32.4	383.3	Ref
25–29	11,371	21.3	350.1	0.91
30–34	6,592	12.3	318.7	0.83
35–39	5,591	10.5	344.4	0.90
≥40	6,218	11.6	423.7	1.11
Race/ethnicity				
Black	12,145	23.2	513.5	1.47
White	33,546	64.0	350.2	Ref
Other	3,822	7.3	204.3	0.58
Service				
Army	22,285	41.7	422.1	1.20
Air Force	12,863	24.1	387.2	1.10
Navy	11,553	21.6	351.1	Ref
Marine Corps	5,062	9.5	263.5	0.75
Military rank				
Enlisted (E1–E4)	28,513	53.4	473.8	1.43
Enlisted (E5–E9)	18,158	34.0	330.9	Ref
Officer (O1–O5)	6,351	11.9	451.0	1.36
Officer (O6–O10)	416	0.8	46.2	0.14
Deployment exposure				
Yes	8,237	15.4	545.6	1.53
No	45,201	84.6	355.5	Ref

[a]Rate per 100,000 person-years

FIGURE 1. Annual incidence rates of functional constipation (FC), irritable bowel syndrome (IBS), dyspepsia (D), and functional diarrhea (FD), active component, U.S. Armed Forces, 2005–2014



appeared largely driven by FC incidence rates **(Figure 1)**. Rates in personnel younger than 20 years of age increased over time and remained higher than all other ages throughout the study period **(Figure 2)**. An increasing trend in incidence rates was true in females over the entire period and in males after 2007 **(data not shown)**.

Incidence rates of FGID among personnel who deployed in the 2 years prior to diagnosis were consistently higher throughout the study period than rates among personnel without a deployment **(Figure 3)**. This was observed overall and for each individual FGID category **(data not shown)**. The trend also remained after stratification by sex **(data not shown)**. Age stratification revealed that rates in personnel aged 20 years or younger were lower in those with deployment exposure compared to those without **(Figure 4)**. For 20- to 24-year-olds, there was little difference in annual incidence rates by deployment status until 2010 when rates rose in the deployment exposed. For the remaining age groups, rates were higher in deployment-exposed personnel for the entire study period compared to personnel without the exposure. FGID incidence rates for those who had deployed to Afghanistan increased slightly throughout the study period **(Figure 5)**. The rates among those who had deployed to Iraq showed a pattern similar to Afghanistan from 2005–2011, but then rose sharply in 2012, and fell to zero cases in 2013 (Operation Iraqi Freedom ended in 2011, with drastic reduction in forces deployed to Iraq in the years after).

EDITORIAL COMMENT

This analysis provided estimates of the trends in FGID incidence among the U.S. active component service members during 2005–2014 and examined the association between deployment exposure and incident FGID during 2005–2013. Trends in incidence followed those identified in the general population as far as type distribution, with the highest rates observed for FC, followed by IBS, D, and FD. Also similar to the general population, females had higher incidence rates compared to

FIGURE 2. Annual incidence rates of functional gastrointestinal disorders, by age category, active component, U.S. Armed Forces, 2005–2014.

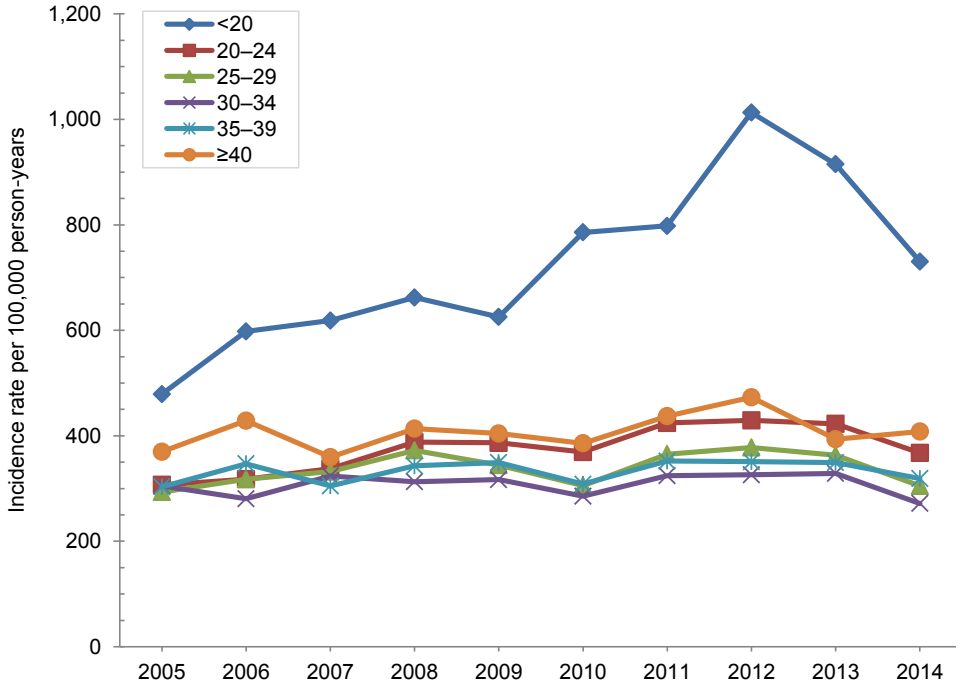
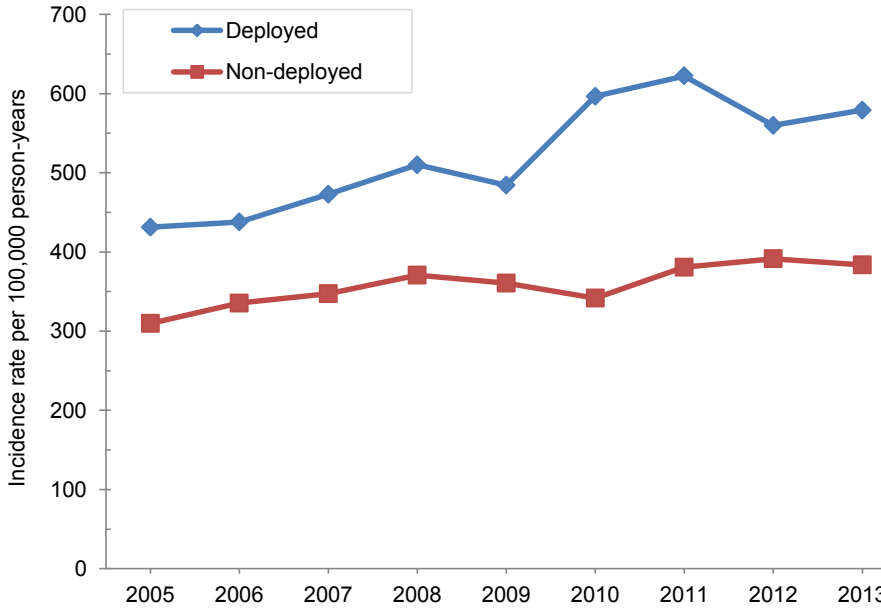


FIGURE 3. Annual incidence rates of functional gastrointestinal disorders, by deployment status, active component, U.S. Armed Forces, 2005–2013[a]



[a]Calculated based on year of deployment rather than year of incident FGID diagnosis. Deployment exposure was assessed until only 2013, permitting follow-up through 2014 to identify cases of FGID and deployers' person time for the calculation of rates.

males. However, overall incidence rates in the military were somewhat lower than those estimated for the general population; this observation was similar to that seen in a past study on incident FGIDs in active component personnel during 1999–2007.[9] Reasons for this difference may include differences in case inclusion criteria, study design, and a healthy population effect seen in the military—a largely young, healthy, male population. A major difference observed between trends in the general population and this study's findings are the elevated incidence rates observed in personnel younger than 20 years of age. This is a unique population in the military as it includes new recruits undergoing basic training and advanced training programs. Living environments for the recruit population may involve high amounts of stress, crowded barracks arrangements, and increased risk for communicable diseases including AGE. It is possible that these important environmental risk factors are driving the high rates seen in the military in this otherwise low-risk age group. Personnel with deployment exposure in this study also consistently displayed higher incidence rates throughout the study. This finding mirrors the current literature and supports the inclusion of FGIDs as presumptive deployment-related conditions.[9,17,19,20]

A number of limitations affect the interpretation and generalizability of these results. By using administrative data with ICD-9-coded diagnoses, this study was unable to confirm that FGID diagnoses were made using the Rome criteria. Also, because of the subjective nature of FGID symptom presentation and provider diagnosis, some cases may have been misclassified (although false positives are less likely due to the strict case definition criteria). As a retrospective study, temporality (cause precedes effect) of the exposure-outcome relationship cannot be fully guaranteed. Additionally, there are many potential confounders that were not available for consideration. Some of these variables include body mass index at time of diagnosis, AGE exposure, stressors during deployment or training, medications, and diet.[26,27] Future studies concerning FGID natural history should attempt to account for the multifactorial risk profile of FGIDs and incorporate suspected risk factors and confounders in their analyses.

Despite the limitations of this study, there are notable strengths, including the near-complete ascertainment of the population of interest and a large sample size, which allowed for a comprehensive estimate

FIGURE 4. Incidence rate ratios for deployed cases compared to non-deployed cases, by age category, active component, U.S. Armed Forces, 2005–2013

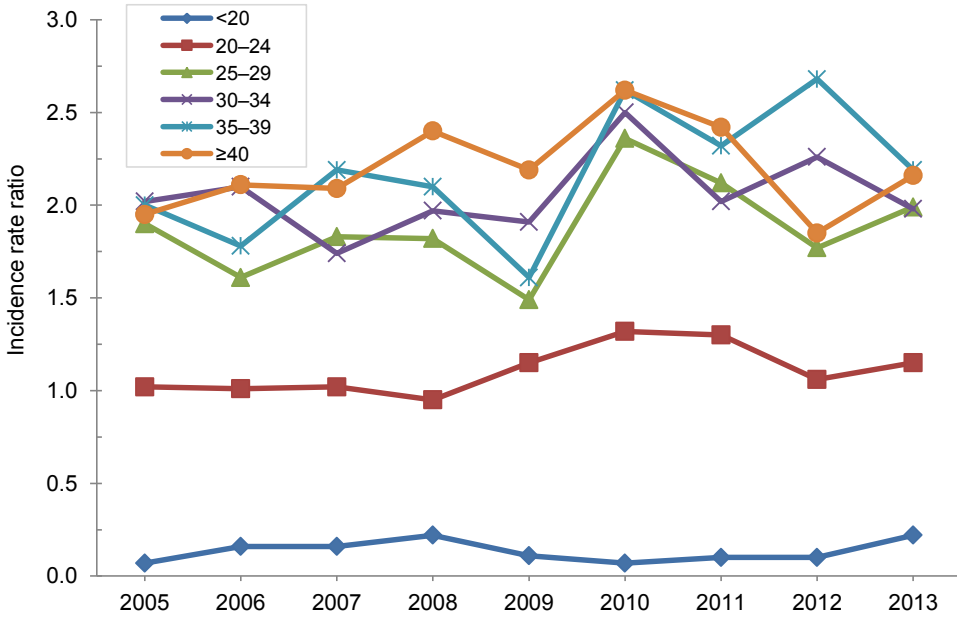
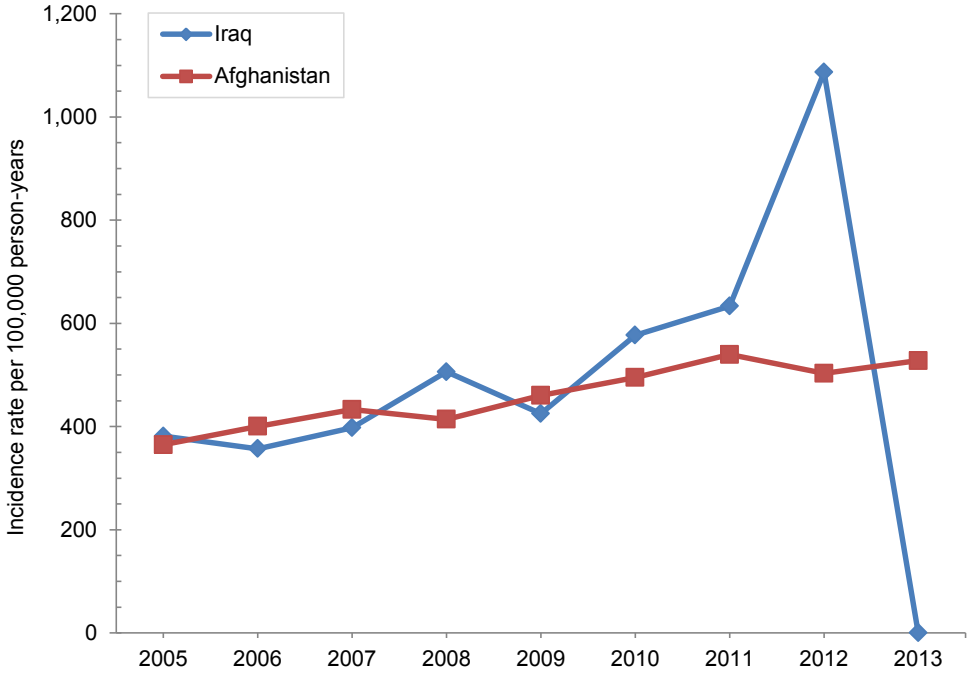


FIGURE 5. Annual incidence rates for country of deployment exposure, Iraq and Afghanistan, active component, U.S. Armed Forces, 2005–2013



of incidence rates and trends in this population. Use of strict case criteria, including the requirement of two diagnoses in 1 year with at least one in the first diagnostic position, likely provided higher positive predictive value for cases. Additionally, the diagnostic delay from the start of deployment likely reduced misclassification of disease attributable to deployment. Ultimately, this study was hypothesis generating, providing a wealth of results that will serve to stimulate investigation into the trends observed for incident FGIDs among the active component forces. The results provide a starting point for future research into the relationship between the youngest segment of the military population (younger than 20 years of age) and incident FGID as well as deployment-related exposures and FGID. The implications and long-term effects of increased rates in these subpopulations of the active component U.S. military should be investigated to determine the true impact of these chronic disorders on military readiness, quality of life, and costs to the MHS.

Disclaimer: The views expressed are those of the authors and do not necessarily reflect the official views of the Uniformed Services University of the Health Sciences or the Department of Defense.

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Medical Surveillance Monthly Report (MSMR) invites readers to submit topics for consideration as the basis for future *MSMR* reports. The *MSMR* editorial staff will review suggested topics for feasibility and compatibility with the journal's health surveillance goals. As is the case with most of the analyses and reports produced by Armed Forces Health Surveillance Branch staff, studies that would take advantage of the healthcare and personnel data contained in the Defense Medical Surveillance System (DMSS) would be the most plausible types. For each promising topic, Armed Forces Health Surveillance Branch staff members will design and carry out the data analysis, interpret the results, and write a manuscript to report on the study. This invitation represents a willingness to consider good ideas from anyone who shares the *MSMR*'s objective to publish evidence-based reports on subjects relevant to the health, safety, and well-being of military service members and other beneficiaries of the Military Health System (MHS).

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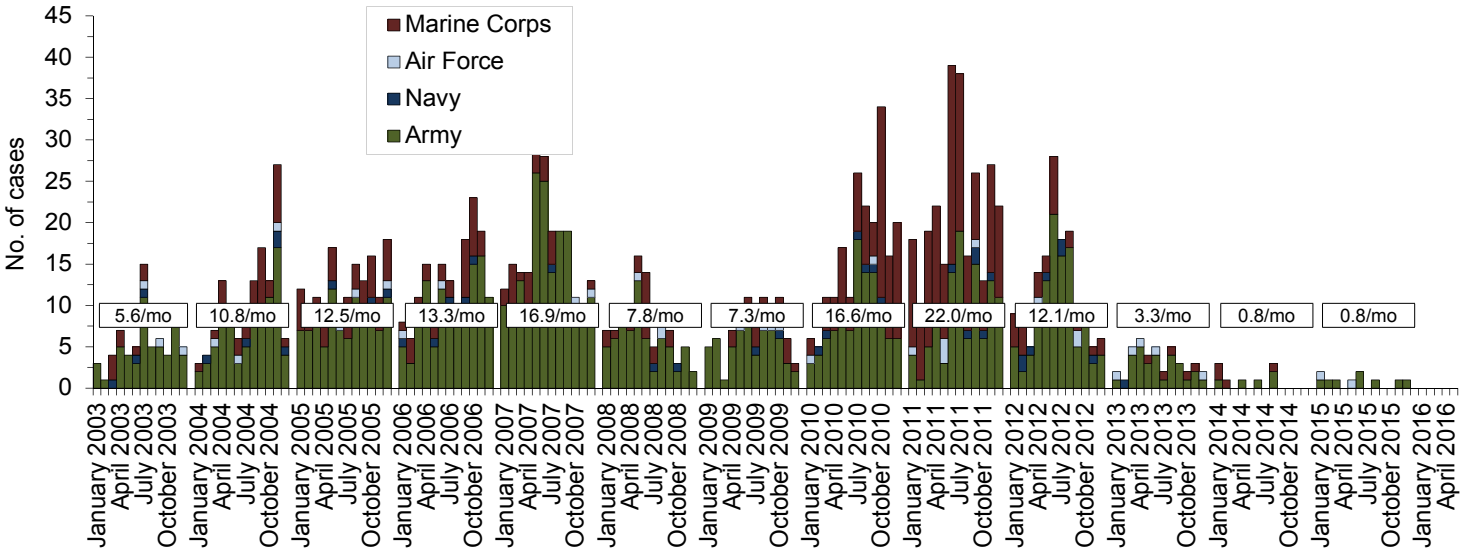
Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003–May 2016 (data as of 22 June 2016)

Amputations[a,b]

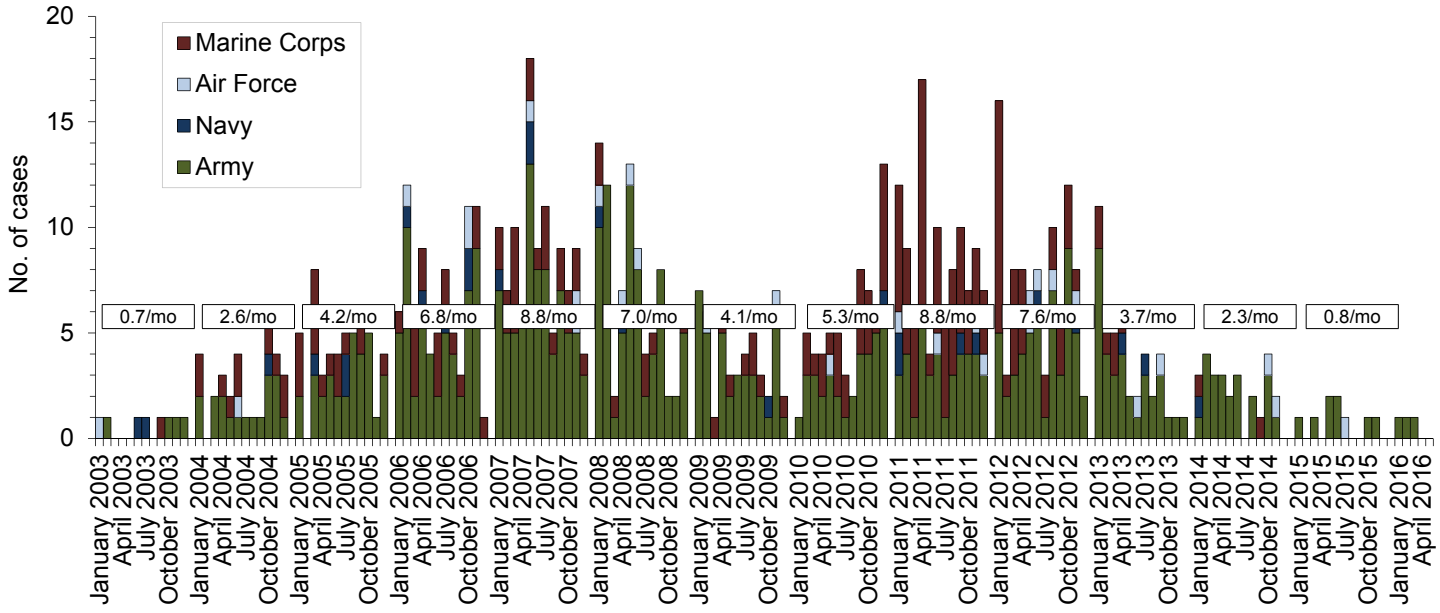


Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: amputations. Amputations of lower and upper extremities, U.S. Armed Forces, 1990–2004. *MSMR*. 2005;11(1):2–6.

[a]Amputations (ICD-10: S48, S58, S684, S687, S78, S88, S980, S983, S989, Z440, Z441, Z4781, Z891, Z892, Z8943, Z8944, Z895, Z896, Z899)

[b]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 365 days of returning from deployment.

Heterotopic ossification[a,b]



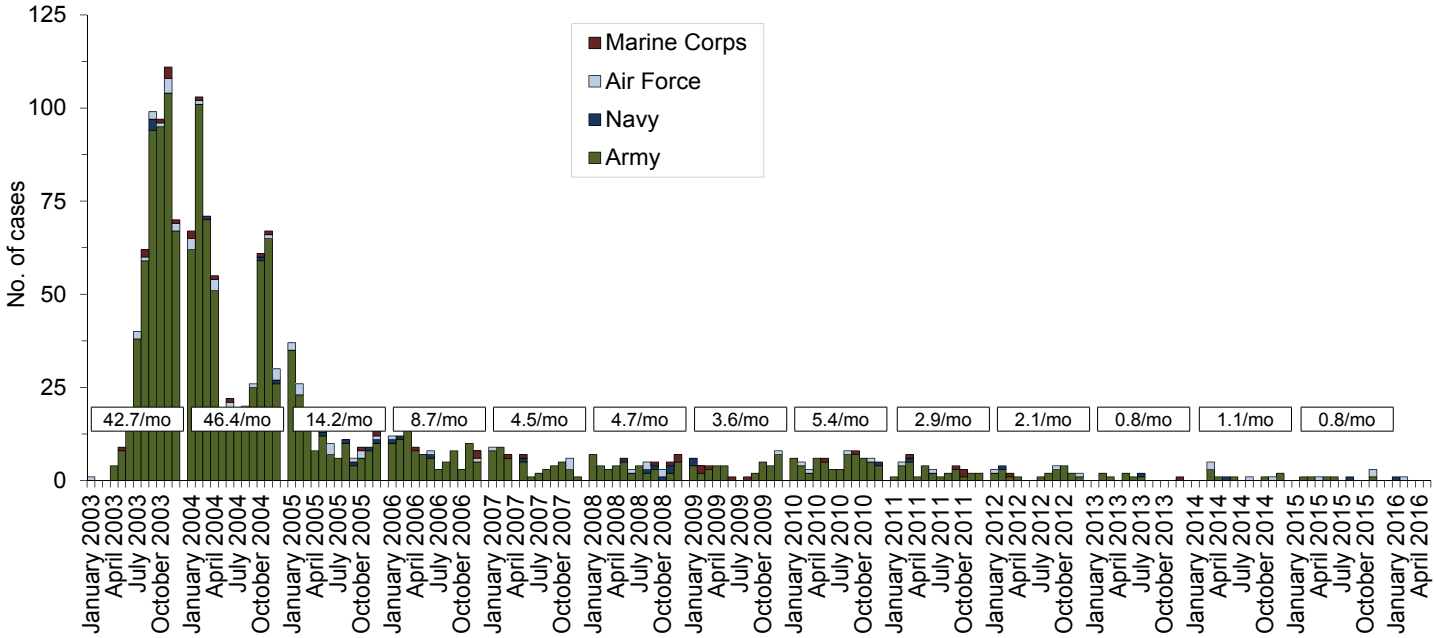
Reference: Army Medical Surveillance Activity. Heterotopic ossification, active components, U.S. Armed Forces, 2002–2007. *MSMR*. 2007;14(5):7–9.

[a]Heterotopic ossification (ICD-10: M610, M614, M615)

[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 365 days of returning from deployment.

Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003–May 2016 (data as of 22 June 2016)

Leishmaniasis[a,b]

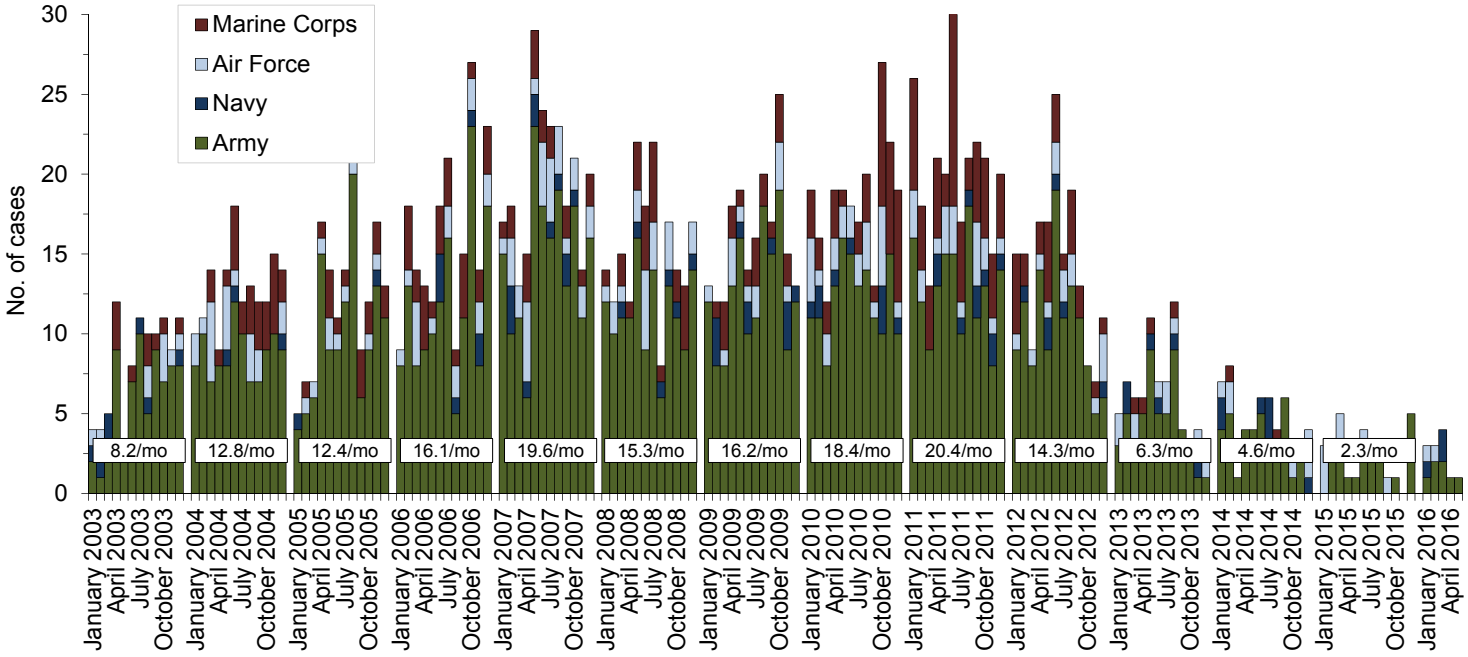


Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: leishmaniasis. Leishmaniasis among U.S. Armed Forces, January 2003–November 2004. *MSMR*. 2004;10(6):2–4.

[a]Leishmaniasis (ICD-10: B55, B550, B551, B552, B559

[b]Indicator diagnosis (one per individual) during a hospitalization, ambulatory visit, and/or from a notifiable medical event during or after service in OEF/OIF/OND.

Deep vein thrombophlebitis/pulmonary embolus[a,b]



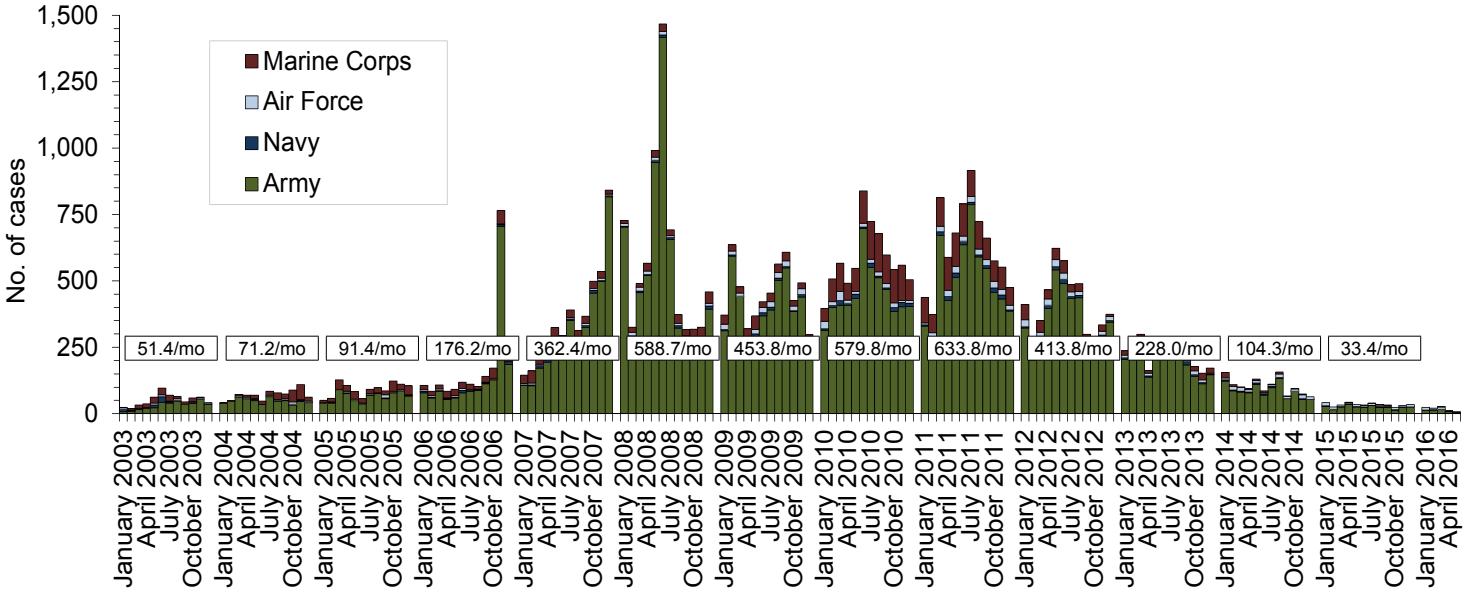
Reference: Isenbarger DW, Atwood JE, Scott PT, et al. Venous thromboembolism among United States soldiers deployed to Southwest Asia. *Thromb Res*. 2006;117(4):379–383.

[a]Deep vein thrombophlebitis/pulmonary embolus (ICD-10: I2601, I2609, I2690, I2699, I801–I803, I808, I809, I822–I824, I826, I82A1, I82B1, I82C1, I8281, I82890, I8290)

[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 90 days of returning from deployment.

Deployment-Related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003–May 2016 (data as of 22 June 2016)

Traumatic brain injury (TBI)[a,b]



Reference: Armed Forces Health Surveillance Center. Deriving case counts from medical encounter data: considerations when interpreting health surveillance reports. *MSMR*. 2009;16(12):2–8.

[a]For the complete list of ICD-10 codes used here for TBI, see p. 23 of the May 2016 issue of the *MSMR*.

[b]Indicator diagnosis (one per individual) during a hospitalization or ambulatory visit while deployed to/within 30 days of returning from deployment (includes in-theater medical encounters from the Theater Medical Data Store [TMDS] and excludes 4,690 deployers who had at least one TBI-related medical encounter any time prior to deployment).

Erratum: Armed Forces Health Surveillance Branch. Absolute and relative morbidity burdens attributable to various illnesses and injuries, active component, U.S. Armed Forces, 2015. *MSMR*. 2016;23(4):2–7.

The annual *MSMR* morbidity burden summaries for active component service members and for the non-service member beneficiaries of the Military Health System state that the ICD-9 and ICD-10 codes (2015) for single live birth (V27.0 and Z37.0, respectively) were used in the analyses. However, it has come to our attention that those codes were not included in the data analyses and thus were not represented in the results. In response to this finding, the full sets of nine V27 and 19 Z37 codes for outcomes of delivery have been added to the burden data dictionary to be used for the analyses in future *MSMR* burden summaries.
—The MSMR Editors

Work/Rest Times and Fluid Replacement Guide

Heat Category	WBGT Index (°F)	Easy Work Walking on hard surface, 2.5 mph, <30 lb. load; weapon maintenance, marksmanship training.		Moderate Work Patrolling, walking in sand, 2.5 mph, no load; calisthenics.		Hard Work Walking in sand, 2.5 mph, with load; field assaults.	
		Work/Rest (minutes)	*Fluid Intake (quarts/hour)*	*Work/Rest (minutes)*	*Fluid Intake (quarts/hour)*	*Work/Rest (minutes)*	*Fluid Intake (quarts/hour)*
1	78° - 81.9°	NL	½	NL	¾	40/20 (70)*	¾ (1)*
2 (GREEN)	82° - 84.9°	NL	½	50/10 (150)*	¾ (1)*	30/30 (65)*	1 (1¼)*
3 (YELLOW)	85° - 87.9°	NL	¾	40/20 (100)*	¾ (1)*	30/30 (55)*	1 (1¼)*
4 (RED)	88° - 89.9°	NL	¾	30/30 (80)*	¾ (1¼)*	20/40 (50)*	1 (1¼)*
5 (BLACK)	> 90°	50/10 (180)*	1	20/40 (70)*	1 (1¼)*	10/50 (45)*	1 (1½)*

NL = No limit to work time per hour.

*Use the amounts in parentheses for continuous work when rest breaks are not possible. Leaders should ensure several hours of rest and rehydration time after continuous work.

This guidance will sustain performance and hydration for at least 4 hours of work in the specified heat category. Fluid needs can vary based on individual differences (± ¼ qt/hr) and exposure to full sun or full shade (± ¼ qt/hr).

Rest means minimal physical activity (sitting or standing) in the shade if possible.

Body Armor - Add 5°F to WBGT index in humid climates.

NBC (MOPP 4) - Add 10°F (Easy Work) or 20°F (Moderate or Hard Work) to WBGT Index.

CAUTION: Hourly fluid intake should not exceed 1½ qts. Daily fluid intake should not exceed 12 qts.

USAPHC

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Armed Forces Health Surveillance Branch
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MEDICAL SURVEILLANCE MONTHLY REPORT (MSMR), in continuous publication since 1995, is produced by the Armed Forces Health Surveillance Branch (AFHSB). The *MSMR* provides evidence-based estimates of the incidence, distribution, impact and trends of illness and injuries among United States military members and associated populations. Most reports in the *MSMR* are based on summaries of medical administrative data that are routinely provided to the AFHSB and integrated into the Defense Medical Surveillance System for health surveillance purposes.

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