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

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

Deployment-related conditions of special surveillance interest
Identification of Specific Activities Associated with Fall-related Injuries, Active Component, U.S. Army, 2011

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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.

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. 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, 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 and exported to Microsoft Excel 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.

S

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veronique D. Hauschild</td>
<td>MPH; Anna Schuh, PhD; Bonnie J. Taylor, PhD; Michelle Canham-Chervak, PhD, MPH; Bruce H. Jones, MD, MPH (COL, USA, Ret)</td>
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</tr>
</tbody>
</table>
• **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 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*

<table>
<thead>
<tr>
<th></th>
<th>Non-deployed fall-related incidents</th>
<th>Deployed fall-related incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ratea</td>
<td>Ratea</td>
</tr>
<tr>
<td></td>
<td>Percentage</td>
<td>Demographic composition</td>
</tr>
<tr>
<td></td>
<td>distribution of incidents</td>
<td>of Army populationb</td>
</tr>
<tr>
<td>Total</td>
<td>2.20</td>
<td>100%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>85%</td>
<td>86%</td>
</tr>
<tr>
<td>Female</td>
<td>15%</td>
<td>14%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>20–24</td>
<td>35%</td>
<td>29%</td>
</tr>
<tr>
<td>25–29</td>
<td>23%</td>
<td>25%</td>
</tr>
<tr>
<td>30–34</td>
<td>12%</td>
<td>16%</td>
</tr>
<tr>
<td>35–39</td>
<td>9%</td>
<td>12%</td>
</tr>
<tr>
<td>≥40</td>
<td>9%</td>
<td>12%</td>
</tr>
<tr>
<td>Unknown</td>
<td>6%</td>
<td>---</td>
</tr>
<tr>
<td>Rank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enlisted (E1–E4)</td>
<td>57%</td>
<td>46%</td>
</tr>
<tr>
<td>Enlisted (E5–E9)</td>
<td>30%</td>
<td>37%</td>
</tr>
<tr>
<td>Officer</td>
<td>10%</td>
<td>18%</td>
</tr>
<tr>
<td>Other/unknown</td>
<td>3%</td>
<td>---</td>
</tr>
</tbody>
</table>

*Reported incidents in Army safety, air medical evacuation, and casualty data in 2011

Total Army population in 2011

Rate per 1,000 person-years
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
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
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, this factor could not be quantified because it was not consistently documented.

Climbing-related fall incidents in non-deployed settings were most common 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). 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. However,
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). Fractures have been estimated as resulting in an average of 100 DLD. The DMSS Army data for 2014 show falls as the cause of 17% of 963 hospitalizations and 16% of 144,956 outpatient cases. 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. 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, 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.

Ankle injuries are also common, a portion of which may be reduced by use of rigid ankle braces.

### Military parachuting
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. Anecdotal concerns regarding comfort and logistics appear to have been obstacles to implementation of this intervention. 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).

### 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. 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.

### REFERENCES


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

<table>
<thead>
<tr>
<th>Injury type</th>
<th>Non-deployed (N=985)</th>
<th>Deployed (N=254)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Falls from height</td>
<td>Falls from same</td>
</tr>
<tr>
<td></td>
<td>(n=494)</td>
<td>level (n=491)</td>
</tr>
<tr>
<td>Death</td>
<td>4 (1%)</td>
<td>-</td>
</tr>
<tr>
<td>Permanent disability (not otherwise specified)</td>
<td>4 (1%)</td>
<td>1 (&lt;1%)</td>
</tr>
<tr>
<td>Fracture</td>
<td>181 (36%)</td>
<td>175 (36%)</td>
</tr>
<tr>
<td>Sprain/strain</td>
<td>145 (29%)</td>
<td>172 (35%)</td>
</tr>
<tr>
<td>Laceration/cut</td>
<td>25 (5%)</td>
<td>46 (9%)</td>
</tr>
<tr>
<td>Concussion</td>
<td>41 (8%)</td>
<td>20 (4%)</td>
</tr>
<tr>
<td>Contusion</td>
<td>26 (5%)</td>
<td>21 (4%)</td>
</tr>
<tr>
<td>Tear/torn ligament</td>
<td>16 (3%)</td>
<td>20 (4%)</td>
</tr>
<tr>
<td>Dislocation</td>
<td>11 (2%)</td>
<td>20 (4%)</td>
</tr>
<tr>
<td>Hospitalized, not otherwise specified</td>
<td>13 (3%)</td>
<td>7 (1%)</td>
</tr>
<tr>
<td>Other/unspecified injury type</td>
<td>110 (21%)</td>
<td>59 (12%)</td>
</tr>
<tr>
<td>Total injuries b</td>
<td>576 (115%)</td>
<td>541 (110%)</td>
</tr>
</tbody>
</table>

bFor three non-deployed incidents, fall height could not be determined from the narrative description.

cSome falls resulted in more than one injury type and/or involved more than one body part.
TABLE 3. Comparison of findings of U.S. Army active component fall-related injury studies

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Prior studies</th>
<th>Current study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data source</strong></td>
<td>Hospitalization records</td>
<td>Safety reports</td>
</tr>
<tr>
<td><strong>Incident rate</strong></td>
<td>Found steady decline in rates&lt;sup&gt;3&lt;/sup&gt;</td>
<td>0.59 per 1,000 p-yrs</td>
</tr>
<tr>
<td><strong>Demographics of highest risk groups</strong></td>
<td>Aged 20–26 yrs, enlisted male, white, single</td>
<td>Aged 20–24 yrs; enlisted white, single Infantry, military police, armor tank crewman</td>
</tr>
<tr>
<td><strong>Types of Injuries</strong></td>
<td>Fracture (41%)</td>
<td>Fracture (53%)</td>
</tr>
<tr>
<td><strong>Key body regions (non-fatal)</strong></td>
<td>Lower extremity (44%)</td>
<td>Lower extremity (&gt; 38%)</td>
</tr>
<tr>
<td><strong>Fall height</strong></td>
<td>42% falls on same level</td>
<td>49% falls from same level</td>
</tr>
<tr>
<td><strong>Activities</strong></td>
<td>On duty (64%), approximately one-half in military training</td>
<td>Most in military training (32%)</td>
</tr>
<tr>
<td><strong>Hazards</strong></td>
<td>Barracks window/balcony (climbing in/out); substance abuse/alcohol; epilepsy/sleep disorder &lt;sup&gt;4&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup>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.

<sup>2</sup>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.

<sup>3</sup>Study found falls to be second leading cause of medical air evacuations; falls found to be cause of 23% of all non-battle injuries.

<sup>4</sup>Based on a limited review of some narratives.
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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. Gastrointestinal dysmotility and hypersensitivity are terms that generally characterize typical FGID symptoms. Symptoms for a given FGID can overlap between different FGIDs and patients can suffer from multiple FGIDs simultaneously. 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. Prevalence estimates suggest that up to 27% of the population has FC, with a predominance in the elderly and in females. One study estimated the 12-year cumulative incidence of FC to be 17.4%. The prevalence of IBS in the general population is estimated at 10%–20%, with about 200 incident cases per 100,000 persons per year. Generally, IBS patients are disproportionately female, and younger in age compared to FC patients. Prevalence of D is estimated to be 20%–30% and FD prevalence ranges from 2%–8% in the general population. 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. 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. There are no cures or treatments beyond symptom management. Furthermore, simply managing a case of FGID presents a challenge as the disorders are enigmatic and effective treatments remain elusive. Persons suffering from FGIDs frequently score lower on quality of life scores compared to both healthy populations and persons with chronic diseases. 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.

The currently established FGID risk profile is multifactorial, with genetic, physiological, environmental, social, and behavioral factors believed to be related to condition development. Of note, acute gastroenteritis (AGE) is associated with increased risk of developing FGID in both the general population and the U.S. military. A wealth of evidence supports this association and post-infectious IBS is a well-established sequelae of AGE. 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. 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).

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. However, there is
evidence of a relationship between FGIDs and
Gulf War service; IBS is included in the
working definition of Gulf War illness 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. 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. Therefore,
deployment remains a variable of interest
and studies involving deployed populations
are necessary to assess what impact deploy-
ment-related exposures may have on FGID
risk.

Much of the natural history of FGIDs
remains uncertain and comprehensive epi-
demiological studies are needed to elucidate
the causal pathways for these common
disorders. This study examines incident
FGID trends, deployment-related effects,
and important covariates, and thereby pro-
vides 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 ascer-
tained from records routinely maintained
in the Defense Medical Surveillance Sys-
tem (DMSS) by the Armed Forces Health
Surveillance Branch (AFHSB). Specific sec-
tions of DMSS used included demographics
and military service data that originated
from the Defense Manpower Data Center
(DMDC), the Defense Health Services Sys-
tem (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 constipa-
tion (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 diag-
nosis had to be in the first diagnostic posi-
tion 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.

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 consid-
ered deployment exposed if they occurred
between 6 and 24 months following
deployment start. This 6-month diagnos-
tic delay from deployment start ensured an
adequate exposure timeframe. An expo-
sure window of up to 18 months accounts
for potential delays in diagnosis result-
ing from diagnostic processes and patient
care-seeking behaviors. The dataset cov-
ered the surveillance period through the
end of 2014. Therefore, deployment expo-
sure was assessed only for cases occurring
among service members who had deployed
through 2013 to allow for at least a por-
tion of the 24-month follow-up needed to
assess cases following deployment. For ser-
vices members whose deployments began
during 2005–2013, rates for each deploy-
ment 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 deploy-
ment; therefore, the country with the lon-
gest 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 deploy-
ments. 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 strati-
fication by important covariates. Incidence
rates were compared over the surveillance
period to identify trends. Additionally,
incidence rates and rate ratios were calcu-
lated for FGIDs in deployed versus non-
deployed active component personnel,
stratified by age and sex. Quantitative anal-
yses were performed using R version 3.2.3
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
(IRR) by demographic and service vari-
ables. Females displayed an elevated in-
cidence rate compared to males (IRR=4.73),
and this relationship remained through-
out the study period. Higher incidence
rates were observed among black service
members compared to their white coun-
terparts (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 inci-
dence rate that was 53% higher than those
without such exposure.

Yearly incidence rates increased over-
all compared to the beginning of the study
but declined from 2012 to 2014. This trend
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).

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

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

*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

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
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. 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.

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. 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.
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.

Author affiliations: Department of Preventive Medicine and Biostatistics, Uniformed Services University of the Health Sciences, Bethesda, MD (Ms. Johnson); Armed Forces Health Surveillance Branch, Silver Spring, MD (Dr. Cost, Ms. Hu).

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REFERENCES

5. Choung RS, Locke GR 3rd, Schleck CD,


**MSMR’s Invitation to Readers**

*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).

In addition, MSMR encourages the submission for publication of reports on evidence-based estimates of the incidence, distribution, impact, or trends of illness and injuries among members of the U.S. Armed Forces and other beneficiaries of the MHS. Information about manuscript submissions is available at [www.health.mil/Military-Health-Topics/Health-Readiness/Armed-Forces-Health-Surveillance-Branch/Reports-and-Publications/Medical-Surveillance-Monthly-Report/Instructions-for-Authors](http://www.health.mil/Military-Health-Topics/Health-Readiness/Armed-Forces-Health-Surveillance-Branch/Reports-and-Publications/Medical-Surveillance-Monthly-Report/Instructions-for-Authors).

Please email your article ideas and suggestions to the MSMR editorial staff at: dha.ncr.health-surv.mbx.afhs-msmr@mail.mil.
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\(^a,b\)


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

Heterotopic ossification\(^a,b\)


\(^a\)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\(^{a,b}\)

<table>
<thead>
<tr>
<th>Month</th>
<th>Marine Corps</th>
<th>Air Force</th>
<th>Navy</th>
<th>Army</th>
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</thead>
<tbody>
<tr>
<td>January 2003</td>
<td>42.7/mo</td>
<td>46.4/mo</td>
<td>14.2/mo</td>
<td>8.7/mo</td>
</tr>
<tr>
<td>April 2003</td>
<td>8.7/mo</td>
<td>4.5/mo</td>
<td>3.6/mo</td>
<td>5.4/mo</td>
</tr>
<tr>
<td>July 2003</td>
<td>2.9/mo</td>
<td>2.1/mo</td>
<td>0.8/mo</td>
<td>1.1/mo</td>
</tr>
</tbody>
</table>


\(^{a}\)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\(^{a,b}\)

<table>
<thead>
<tr>
<th>Month</th>
<th>Marine Corps</th>
<th>Air Force</th>
<th>Navy</th>
<th>Army</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 2003</td>
<td>8.2/mo</td>
<td>12.8/mo</td>
<td>12.4/mo</td>
<td>16.1/mo</td>
</tr>
<tr>
<td>April 2003</td>
<td>19.6/mo</td>
<td>15.3/mo</td>
<td>16.2/mo</td>
<td>18.4/mo</td>
</tr>
<tr>
<td>July 2003</td>
<td>20.4/mo</td>
<td>14.3/mo</td>
<td>6.3/mo</td>
<td>4.6/mo</td>
</tr>
</tbody>
</table>


\(^{b}\)One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed or 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)\textsuperscript{a,b}


\textsuperscript{a}For the complete list of ICD-10 codes used here for TBI, see p. 23 of the May 2016 issue of the MSMR.

\textsuperscript{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).


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

<table>
<thead>
<tr>
<th>Heat Category</th>
<th>WBGT Index (°F)</th>
<th>Easy Work</th>
<th>Moderate Work</th>
<th>Hard Work</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Walking on hard surface, 2.5 mph, &lt;30 lb. load; weapon maintenance, marksmanship training.</td>
<td>Patrolling, walking in sand, 2.5 mph, no load; calisthenics.</td>
<td>Walking in sand, 2.5 mph, with load; field assaults.</td>
</tr>
<tr>
<td>1</td>
<td>78° - 81.9°</td>
<td>NL</td>
<td>½</td>
<td>¾</td>
</tr>
<tr>
<td>2 (GREEN)</td>
<td>82° - 84.9°</td>
<td>NL</td>
<td>½</td>
<td>⁴⁄₉ (1)*</td>
</tr>
<tr>
<td>3 (YELLOW)</td>
<td>85° - 87.9°</td>
<td>NL</td>
<td>¾</td>
<td>¾ (1)*</td>
</tr>
<tr>
<td>4 (RED)</td>
<td>88° - 89.9°</td>
<td>NL</td>
<td>¾</td>
<td>¾ (1¼)*</td>
</tr>
<tr>
<td>5 (BLACK)</td>
<td>&gt; 90°</td>
<td>50/10 (180)*</td>
<td>1</td>
<td>1 (1¼)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fluid Intake (quarts/hour)**
- **Work/Rest (minutes)**
- **Work/Rest (minutes)**
- **Work/Rest (minutes)**
- **Work/Rest (minutes)**

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.
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