A Comparison of Injuries, Limited-Duty Days, and Injury Risk Factors in Infantry, Artillery, Construction Engineers, and Special Forces Soldiers

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Abstract

Objectives: We compared injuries/risk factors in infantry soldiers (I), construction engineers (CE), combat artillery (CA), and Special Forces (SF) during their operational and fitness activities. Methods: Anthropometrics, ethnicity, and fitness data were collected before review of medical records. Results: Injury rates for I, CE, and CA were 4.0, 7.2, and 5.5 injuries/100 soldier-months, respectively; 70% of them resulted from overuse. SF soldiers had an injury rate of 3.5 injuries/100 soldier-months, 50% of them reported as traumatic. Average limited-duty days (LDDs) were threefold higher in SF. Smoking, BMI $>25$, and APFT run time for 3.2 km $>14$ minutes were risk factors in I. Caucasian ethnicity, height $<170.2$ cm, weight $>90$ kg, and BMI $>25$ were risk factors in CE and CA. Age $>27$ years old was a risk factor in SF. Conclusions: Greater emphasis should be placed on risk factor identification and testing strategies to reduce injuries among SF and other troops.

Introduction

Operational and physical fitness training activities are important to maintain combat readiness. Troops must be physically capable of deploying at any time. However, musculoskeletal injuries resulting from training and fitness activities are a major cause of lost training time, disabilities, and health care costs in the U.S. Army. In 1985, the Office of the Surgeon General mandated that the impact of physical training injuries on combat readiness of the Army be studied and countermeasures be designed to reduce injuries. Although disability-related total medical care costs for Army soldiers are unknown, estimates of the compensation costs to the injured soldier are as high as 2 billion dollars. Therefore, injuries not only impact combat readiness but also generate large financial burdens on the U.S. Armed Forces.

Epidemiologists have studied and quantified training injuries in basic trainees, combat, and combat support units. However, comparative injury data between combat infantry, combat support, and Special Operations Forces (SOF) that include the SF are limited. The occupational tasks and physical training activities and hazardous exposures tend to differ between these military specialties, so injury patterns may also vary between these units. Another important step in the process of injury prevention is the identification of risk factors for injury, which have been determined in basic trainees and in combat infantry and infantry support units. However, there is little risk factor data on the SF soldiers. Such information permits the evaluation and testing of interventional strategies that may reduce musculoskeletal injuries that are a major cause of morbidity in trained units during peacetime and combat.

The purposes of this field study were (1) to determine and compare the incidence of injuries and types of injuries in trained units with diverse mission requirements and varying degrees of hazardous exposure, and (2) to examine the relationship between soldier characteristics such as age, tobacco use, body stature, and fitness.

Methods

Volunteers and Study Design

This 2-year prospective study of training-related injuries obtained from medical records was conducted in two types of combat battalions: infantry (I), and combat artillery (CA), and a support battalion: construction engineers (CE) in the 10th Mountain Division, Fort Drum, New York. Prospective medical records data were collected on SF soldiers who trained within an operational detachment group at Fort Carson, Colorado.

All battalions were briefed about the objectives, design, risks, and benefits of the study and gave their written informed consent. The Scientific and Human Use Review Committees at the U.S. Army Research Institute of Environmental Medicine and the U.S. Army Medical Research and Material Command approved this study. The study populations included both injured and noninjured individuals who had complete demographic, anthropometric, Army Physical Fitness Test (APFT), and medical data.

The study was composed of an initial site visit followed by a periodic review of medical records to determine injury
incidence. The researchers obtained demographic, anthropometric, and physical fitness data at the beginning of the study.

**Job Tasks and Physical Activities**

Typically during combat/training missions, I soldiers carry heavy equipment and supplies on long-range patrols. They undergo winter training exercises such as carrying heavy equipment cross-country on skis. They participate in a fitness training program that includes strength training, running, and calisthenics.³

During combat/training missions, CE soldiers operate heavy machinery to breach minefields and obstacles, and build fortifications such as bridges. They also repair heavy machinery and equipment that requires pushing, pulling, and lifting more than 59 kg.¹³ Like other units, they also engage in fitness training such as running, calisthenics, strength training, and road marches.¹⁵

Typically in combat and training missions, combat artillery soldiers participate in field artillery activities such as lifting and carrying ammunitions averaging 44 kg each and firing over 200 rounds per day. They also participate in a formal physical training program that includes running, strength training, and loaded road marches.¹⁵

To carry out antiterrorist and other behind-enemy-line missions, the SF is composed of small 12-man units called “A” teams (Green Berets), short for Operational Detachment α, and support groups. These “A” small infiltration teams must physically move their ammunition and equipment behind enemy lines with little additional support. These teams engage in climbing and participating in mountainous endurance road and cross-country marches with backpacks. The SF soldiers in the present study maintained airborne infiltration skills and completed a series of jumps every 4 months that included high altitude low opening (HALO) jumps. They also engage in running, strength training, and calisthenics to maintain fitness.¹⁷

**Risk Factor Data**

Data on age, ethnicity, cigarette smoking history, and past running injuries were obtained from questionnaires given at the beginning of the study. Study participants were asked if they had smoked cigarettes within the past year, number of cigarettes per day, and length of time. They also were asked if they had experienced running-related musculoskeletal injuries during the past 2 years. Height, weight, and physical fitness data including run time were obtained from the most recent Army Physical Fitness Test (APFT).

**Injury Data**

The injury data were obtained using a passive surveillance technique (medical records check). The medical record of each study participant was reviewed on a quarterly basis by the same physician and technician. For each visit, information extracted from medical records included date of each clinic visit, the verbatim diagnosis, body part involved, and the amount of limited-duty days (LDDs). Study staff reviewed all radiographic reports to confirm all traumatic fractures.

An injury was defined as any injury-related clinic visit resulting from operational or physical fitness training. Injuries were categorized as either overuse or traumatic. Overuse injuries were defined as musculoskeletal complaints of an insidious onset caused by cumulative trauma. Traumatic injuries were specified as injuries resulting from a single acute event. Because strains, sprains, tendonitis, and bursitis injuries primarily involved ligaments and tendons, they were classified as soft tissue inflammatory injuries. Traumatic injury types were categorized as tears/ruptures, fractures, blisters, dislocations/subluxations, and lacerations. Body part categories were head/face, neck/upper back, shoulder/arm, abdomen/chest, lower back, and lower extremity (hip to toe).

Injury-related LDDs were also reported. A limited-duty day was prescribed by a credentialed health care provider and involved at least a 24-hour period of restriction of physical activity or regular duty.

**Statistics**

Descriptive data included mean, median, and standard deviations. All data were double-entered and cross-checked for error control with Epi-Info 3.32 (Centers for Disease Control and Prevention, Atlanta, Georgia) and then uploaded for analyses. The analyses were conducted with SPSS version 15.0 (SPSS, Chicago, Illinois).

Independent categorical variables (e.g., smoking) were expressed as frequency and percentages. Continuous independent variables were displayed by estimates of the mean and standard deviation. These variables were age, cigarette smoking, height, body mass, BMI, and APFT raw scores.

Dependent variables were tears/ruptures, fractures, blisters, dislocations/subluxations, lacerations, and soft tissue inflammatory injuries and associated limited-duty days. Also, all body part categories were included as dependent variables. χ² tests were used to determine if there were significant differences in the numbers of injuries for each injury type between I, CE, CA, and SF soldiers. ORs and 95% CI were then calculated. A χ² analysis was also conducted to evaluate statistically significant differences between numbers of LDDs between the battalions.

Risk factor analyses of independent continuous variables in individuals in each study population were divided into equal-sized groups from low to high, slow to fast, etc. The percentage of musculoskeletal injuries occurring in each group was calculated. The group with the lowest risk of injury was selected as the reference group.¹⁰ The remaining group levels were compared to the referent group. Significance of differences in incidence of injury between the equal-sized groups was tested using partitioned χ² analyses. Estimates of ORs were computed.

χ² tests were used to compare risk groups and test for significance of differences in injury occurrences. ORs and 95% CI were
also computed. A logistic regression analysis was performed to examine the inter-relationship among the risk factors.

RESULTS

Descriptive Data

Table I represents the summary data of age, height, weight, BMI, and physical fitness collected on the battalion of I (n = 125), CE (n = 188), CA (n = 188), and SF soldiers (n = 162). For other characteristics, 72.0% I soldiers were Caucasian, 15% were African American, 8.2% Hispanic, and 4.8% were of other races. Of the CE soldiers, 70.0% were Caucasian, 18.2% African American, 13% Hispanic, and 4.5% of other races. Of the 188 CA soldiers, 54.1% were Caucasian, 33.9% were African American, 5.5% Hispanic, and 7.1% of other races. Of the 162 SF soldiers, 79.7% were Caucasian, 5.5% were African American, 7.3% Hispanic, and 9.3% of other races. Twenty-nine percent of I soldiers, 37.2% of CE soldiers, 35.9% of CA, and 33.3% of SF soldiers reported smoking histories.

Rates of Injuries and Overall Time Lost

Table II shows the overall number and rates of injured soldiers and clinic visits and total LDDs for each battalion. The average number of LDDs of a soldier for each battalion. For other characteristics, 72.0% I soldiers were Caucasian, 15% were African American, 8.2% Hispanic, and 4.8% were of other races. Of the CE soldiers, 70.0% were Caucasian, 18.2% African American, 13% Hispanic, and 4.5% of other races. Of the 188 CA soldiers, 54.1% were Caucasian, 33.9% were African American, 5.5% Hispanic, and 7.1% of other races. Of the 162 SF soldiers, 79.7% were Caucasian, 5.5% were African American, 7.3% Hispanic, and 9.3% of other races. Twenty-nine percent of I soldiers, 37.2% of CE soldiers, 35.9% of CA, and 33.3% of SF soldiers reported smoking histories.

Table II represents the frequencies and percentages of injury visit types (overuse and traumatic) in I, CE and CA, and SF. Overuse injuries were predominantly strains, sprains, tendinitis, and bursitis. Different severities existed between the battalions. In general, a majority of the injuries were overuse in the I and CA, and the SF soldiers incurred a slightly higher percentage of traumatic injuries than overuse injuries. The odds of incurring traumatic tears/ruptures (primarily shoulders, knees, and legs) were over 5 (OR = 5.7, 95% CI = 2.8–11.9) times higher than in the CE, and over 30 (OR = 37.2, 95% CI = 10.9–152.6) times higher than in the CA soldiers. The odds of blistering was over 4 (OR = 4.52, 95% CI = 1.4–16.5) times higher in the SF than in the I soldiers and over 19 (OR = 19.1, 95% CI = 2.6–391.8) times higher than the CA soldiers. The odds of incurring dislocations/subluxations (primarily shoulders and knees) were over 2 (OR = 2.5, 95% CI = 1.1–5.4) times higher in the SF soldiers than in the I soldiers. The odds of incurring a laceration (primarily hands) were over 12 (OR = 12.5, 95% CI = 3.6–52.2) times higher than in SF soldiers.

LDDs because of specific injuries in I, CE, CA, and SF soldiers is shown in Table IV. Overuse soft tissue inflammatory injuries accounted for the highest number of LDDs in I, CE, and CA soldiers. Traumatic fracture injuries resulted in the second highest number of LDDs in I and CE soldiers.

Table III represents the frequencies and percentages of injury visit types (overuse and traumatic) in I, CE and CA, and SF. Overuse injuries were predominantly strains, sprains, tendinitis, and bursitis. Different severities existed between the battalions. In general, a majority of the injuries were overuse in the I and CE and CA, and the SF soldiers incurred a slightly higher percentage of traumatic injuries than overuse injuries. The odds of incurring traumatic tears/ruptures (primarily shoulders, knees, and legs) were over 5 (OR = 5.7, 95% CI = 2.8–11.9) times higher than in the CE, and over 30 (OR = 37.2, 95% CI = 10.9–152.6) times higher than in the CA soldiers. The odds of blistering was over 4 (OR = 4.52, 95% CI = 1.4–16.5) times higher in the SF than in the I soldiers and over 19 (OR = 19.1, 95% CI = 2.6–391.8) times higher than the CA soldiers. The odds of incurring dislocations/subluxations (primarily shoulders and knees) were over 2 (OR = 2.5, 95% CI = 1.1–5.4) times higher in the SF soldiers than in the I soldiers. The odds of incurring a laceration (primarily hands) were over 12 (OR = 12.5, 95% CI = 3.6–52.2) times higher than in SF soldiers.

LDDs because of specific injuries in I, CE, CA, and SF soldiers is shown in Table IV. Overuse soft tissue inflammatory injuries accounted for the highest number of LDDs in I, CE, and CA soldiers. Traumatic fracture injuries resulted in the second highest number of LDDs in I and CE soldiers.

Types of Injuries and Injury-Specific Time Lost

Table III represents the frequencies and percentages of injury visit types (overuse and traumatic) in I, CE and CA, and SF. Overuse injuries were predominantly strains, sprains, tendinitis, and bursitis. Different severities existed between the battalions. In general, a majority of the injuries were overuse in the I and CE and CA, and the SF soldiers incurred a slightly higher percentage of traumatic injuries than overuse injuries. The odds of incurring traumatic tears/ruptures (primarily shoulders, knees, and legs) were over 5 (OR = 5.7, 95% CI = 2.8–11.9) times higher than in the CE, and over 30 (OR = 37.2, 95% CI = 10.9–152.6) times higher than in the CA soldiers. The odds of blistering was over 4 (OR = 4.52, 95% CI = 1.4–16.5) times higher in the SF than in the I soldiers and over 19 (OR = 19.1, 95% CI = 2.6–391.8) times higher than in SF soldiers.

LDDs because of specific injuries in I, CE, CA, and SF soldiers is shown in Table IV. Overuse soft tissue inflammatory injuries accounted for the highest number of LDDs in I, CE, and CA soldiers. Traumatic fracture injuries resulted in the second highest number of LDDs in I and CE soldiers.
A Four-Group Comparison of Injuries, Limited-Duty Days, and Injury Risk Factors

Laceration injuries accounted for the second highest number of LDDs in the CA soldiers. For SF soldiers, traumatic fracture injuries resulted in the highest number of LDDs, followed by overuse soft tissue inflammatory injuries.

A majority of the injuries resulted in 24 hours or more of limited duty in all of the battalions: I (54.0%), CE (64.0%), CA (56.4%), and SF soldiers (66.0%).

**Causes of Injuries**

For causes of injury, 88.0% of the injuries in the I battalion were attributed to duty-related physical fitness and marching with packs. Over half of the injuries in the CE and CA were associated with duty-related physical training such as running and marching with packs. Another 30.0% of the injuries were related to occupational activities such as repairing heavy vehicle equipment or constructing bridges (CE), or carrying shells during field artillery activities or firing ammunitions (CA). Over 80% of the injuries in the SF soldiers were related to physical training and sports.

**Risk Factors for Injuries**

Table V shows OR and 95% CI for significant risk factors in injured I, CE, CA, and SF soldiers. For the I soldiers, risk factors for low back and lower extremity musculoskeletal injuries were history of cigarette smoking (>10 cigarettes per day), higher BMI (≥25), and slower run times (>14 minutes) for 3.2 km. For the CE and CA soldiers, risk factors for low back and lower extremity musculoskeletal injuries were Caucasian ethnicity, shorter stature (<170.2 cm), greater body mass (≥290.0 kg), and higher body mass index (≥25.0 kg). For

**TABLE III.** Frequencies and Percentages of Injury Visit Types in Infantry (I), Construction Engineers (CE), Combat Artillery (CA), and Special Forces (SF) Injury Visits

<table>
<thead>
<tr>
<th>Unit Category</th>
<th>Tear/Rupture</th>
<th>Fracture</th>
<th>Disloc/Sublux</th>
<th>Laceration</th>
<th>All Traumatic*</th>
<th>Overuse Injuries&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Total Injuries&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (N = 181)</td>
<td>16 (5.5)</td>
<td>27 (9.30)</td>
<td>4 (1.40)</td>
<td>2 (0.7)</td>
<td>0 (0.0)</td>
<td>49 (16.27)</td>
<td>240 (83.10)</td>
</tr>
<tr>
<td>CE (N = 125)</td>
<td>0 (0.0)</td>
<td>12 (0.20)</td>
<td>0 (0.0)</td>
<td>11 (8.50)</td>
<td>23 (17.70)</td>
<td>95 (80.51)</td>
<td>118 (100.00)</td>
</tr>
<tr>
<td>CA (N = 188)</td>
<td>0 (0.0)</td>
<td>3 (1.70)</td>
<td>1 (0.50)</td>
<td>36 (20.00)</td>
<td>40 (22.20)</td>
<td>140 (77.80)</td>
<td>180 (100.00)</td>
</tr>
<tr>
<td>SF (N = 162)</td>
<td>65 (21.90)</td>
<td>61 (20.50)</td>
<td>15 (5.10)</td>
<td>3 (1.00)</td>
<td>150 (50.50)</td>
<td>147 (49.50)</td>
<td>297 (100.00)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Soldiers may have more than one injury type. <sup>b</sup>All traumatic, total traumatic visits tabulated for each population. <sup>c</sup>Soft tissue includes tendonitis, fasciitis, strains, sprains.

**TABLE IV.** Injury Visits Resulting in Limited-Duty Days in Infantry (I), Construction Engineers (CE), Combat Artillery (CA), and Special Forces (SF)

<table>
<thead>
<tr>
<th>Unit Category</th>
<th>Tear/Rupture</th>
<th>Bilater</th>
<th>Fracture</th>
<th>Disloc/Sublux</th>
<th>Laceration*</th>
<th>All Traumatic&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Ovveruse Injuries&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Soft Tissue/Inflammatory&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Total Injuries&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (N = 181)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>49 (432) x</td>
<td>240 (671)</td>
<td>289 (1103)</td>
<td>3.8</td>
</tr>
<tr>
<td>Mean LDD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.3</td>
<td>1.5</td>
<td>11.2</td>
<td>3.5</td>
<td>0.0</td>
<td>8.8</td>
<td>2.8</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>CE (N = 125)</td>
<td>0 (0)</td>
<td>12 (138)</td>
<td>0 (0)</td>
<td>23 (165)</td>
<td>95 (578)</td>
<td>61</td>
<td>6.9</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>Mean LDD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.0</td>
<td>0.0</td>
<td>11.5</td>
<td>2.5</td>
<td>7.2</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>CA (N = 188)</td>
<td>0 (0)</td>
<td>1 (0)</td>
<td>3 (27)</td>
<td>36 (82)</td>
<td>40 (109)</td>
<td>140 (969)</td>
<td>180 (1078)</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>Mean LDD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.0</td>
<td>0.0</td>
<td>3.0</td>
<td>2.3</td>
<td>2.7</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>SF (N = 162)</td>
<td>65 (751)</td>
<td>15 (39)</td>
<td>61 (1241)</td>
<td>6 (57)</td>
<td>3 (0)</td>
<td>150 (2088)</td>
<td>147 (1091)</td>
<td>297 (3179)</td>
<td></td>
</tr>
<tr>
<td>Mean LDD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.5</td>
<td>12.6</td>
<td>20.3</td>
<td>9.5</td>
<td>0.0</td>
<td>13.9</td>
<td>7.4</td>
<td>10.7</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>All traumatic, total traumatic visits tabulated for each population. <sup>b</sup>Soft tissue includes tendonitis, fasciitis, strains, sprains. <sup>c</sup>Mean LDD, number of limited-duty days per injury.
SF soldiers, older age (>27 years old) was a risk factor for musculoskeletal injuries.

### DISCUSSION

The present investigation is one of the first to document and compare noncombat injury rates in SF, I, C3, and CA troops during their physical training and operational activities. Several differences were observed for injuries between these units. The injury rates for musculoskeletal injuries were higher in the CE and CA than the I and SF units. However, the average LDD was higher in the SF than the I, CA, and CE. Perhaps this difference is attributable to the finding that a higher percentage of fractures and tears/ruptures/dislocations were reported in the SF than the other units. These were the most severe injuries in terms of restricted and lost duty time and required prolonged rehabilitation.

Overuse soft tissue inflammatory injuries accounted for a majority of clinic visits and limited-duty days in I, CE, and CA, which is consistent with reports on other infantry units.5·12·14·18·22 The low back and lower extremities were the most common area injured in the I population, as is expected for a physical training program that consisted of primarily weight-bearing activities. In the CE and CA populations, the shoulders/arms and low back/lower extremities were the most common areas of involvement, which are anticipated for occupational tasks that involve lifting heavy loads, repetitive stooping and twisting, such as shoveling and repairing heavy equipment (CE) and prolonged kneeling when firing ammunition (CA). The SF soldiers had a slightly higher percentage of traumatic injuries than overuse injuries, which is probably because of exposure to activities associated with a higher risk of trauma such as parachuting, running, and climbing with packs.

In terms of injury severity, traumatic fractures accounted for the highest average number of LDDs per case in the current SF study. Potter et al.23 reported similar findings in a study conducted with the 82nd Airborne at Fort Bragg, North Carolina, except stress fractures also contributed to many of the limited-duty days in the airborne unit. Stress injuries were not reported in the present SF study. Perhaps the SF group had a higher level of physical fitness and followed a more consistent running and marching program than the airborne population in Potter’s study.23 Also, Potter et al.23 reported a higher incidence of parachute-related fracture cases (30.0%) than the SF population (8.0%). Perhaps some of the differences in incidence of parachute-related fractures could be attributed to type of parachute used. In contrast to the airborne soldiers in Potter’s study,23 the SF primarily conduct HALO jumps, which in experienced soldiers tend to be associated with lower injury risk than the “conventional” military static line parachuting using a round parachute.17 Also, SF soldiers frequently conduct their jumps on drop zones in fields. Typically, airborne soldiers will use many types of drop zones including landing strips and airports, which tend to be associated with greater injury risks.17·24 Perhaps other factors contributing to differences reported in these two populations are the inclusion of combat support soldiers and females in the airborne database in Potter’s study.23

A higher percentage of lacerations were reported in the CA than the other troops. Direct contact with the firing of ammunition could result in traumatic injuries such as lacerations.6·15 A higher percentage of foot blisters were reported in the SF than the other battalions. Marching long distances over mountainous routes with heavy loads can place additional stress on the feet, resulting in these types of traumatic injuries. The present study identified several potential contributing factors for training-related injuries in the I, CE, CA, and SF soldiers. Significant risk factors for injuries were as follows: cigarette smoking history (>10 cigarettes per day) and lower maximal effort run times in I; BMI ≥25 kg/m² in I, CE and, CA; body mass ≥90.0 kg, shorter stature, and Caucasian ethnicity in CE and CA; and older age in SF.

Other military studies3·9·10·13 and civilian studies24·25 show that tobacco use increases risk for injury. Studies suggest that smoking may result in physiological changes, which may reduce physical stamina13·26 and increase tissue propensity to injury.27·28 As far as lower maximal effort run times and risk for injury, several military studies6·9·10 and trained populations13·14 have reported similar associations. Maximal effort run time has been shown to be a measure of aerobic capacity.5 It is plausible that a soldier with lower aerobic capacity could be vulnerable to the physiologic stresses of physical training such as a fast run with the unit, or a long grueling road march with a pack.22 Excessive BMI has been implicated as a risk factor for injuries in other studies.26·30 Reports on normative

### TABLE V. Odds Ratios and 95% CI for Risk Factors in Injured Infantry (I), Construction Engineers (CE), Combat Artillery (CA), and Special Forces (SF)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Infantry N = 181</th>
<th>Engineer/Artillery N = 313*</th>
<th>Special Forces N = 162</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 27 yr</td>
<td>NS</td>
<td>NS</td>
<td>2.3 (0.9–5.8)</td>
</tr>
<tr>
<td>Cigarette Smoking &gt; 10 per day</td>
<td>1.6 (1.1–2.3)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>BMI ≥ 25 kg/m²</td>
<td>2.2 (1.3–4.0)</td>
<td>2.1 (1.2–3.4)</td>
<td>NS</td>
</tr>
<tr>
<td>Caucasian Ethnicity</td>
<td>NS</td>
<td>1.9 (1.2–3.0)</td>
<td>NS</td>
</tr>
<tr>
<td>Height &lt; 170.2 cm</td>
<td>NS</td>
<td>2.9 (1.2–6.7)</td>
<td>NS</td>
</tr>
<tr>
<td>Body Mass ≥ 90.0 kg</td>
<td>NS</td>
<td>2.5 (1.2–5.5)</td>
<td>NS</td>
</tr>
<tr>
<td>3.2 km run &gt; 14 min</td>
<td>2.8 (1.4–5.6)</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

*OR (95% CI) = odds ratios (95% confidence intervals), †NS, nonsignificant values.
Army data\textsuperscript{31} show that men in the age range of 22 to 31 years weigh, on the average, 77.5 kg and have a BMI of 24.9 kg/m\textsuperscript{2}. Civilian reports show that BMI $\geq$ 25 mg/kg\textsuperscript{2} is a cut point for overweight status.\textsuperscript{32} Therefore, it makes sense that soldiers with high BMI would have excessive stresses on their musculoskeletal system because of extra weight carried at fit.\textsuperscript{13}

Shorter stature was a risk factor for musculoskeletal injuries in CE and CA soldiers. Other military studies have reported similar associations.\textsuperscript{9,10,33} Perhaps taller height might be important in CE and CA job tasks such as lifting and carrying large and heavy equipment, where maneuvering and maintaining a center of gravity are important in preventing excessive stresses on the shoulder, low back, and other parts of the musculoskeletal system.\textsuperscript{15,34}

Other military studies have reported Caucasian ethnicity as an injury risk factor. A higher incidence of blisters and stress fractures were reported in Caucasian soldiers when compared with African American soldiers.\textsuperscript{3-5} Racial differences in skin physiology,\textsuperscript{17} bone density,\textsuperscript{28} and bone mass\textsuperscript{38} are potential factors contributing to these findings.

Risk factor data on age is contradictory. In Army basic trainees, older soldiers (\geq 24 years) are more likely to incur injuries than younger soldiers.\textsuperscript{9} In contrast, data on infantry soldiers and other operational units show lower injury incidence with increasing age.\textsuperscript{45} These discrepancies between trainees and trained units could be the result of differences in exposure to hazardous physical activities. In trainees, all ages participate in the same types of basic training. In the operational units, older soldiers tend to be higher in rank and can choose the type of physical training (PT) they engage in. These soldiers are more likely to be in supervisory positions with less exposure to occupational hazards than younger troops.\textsuperscript{6} However, in our study older SF soldiers were more likely to sustain an injury than were younger ones. Unlike other operational units, the SF soldier, regardless of rank and age, trains in small teams and participate in fitness and operational training activities as determined by their team specialty and mission requirements. Therefore, the older SF soldier may not have the same physical capability as the younger team member has to withstand the stresses of running with packs, conducting long marches over mountainous routes, and participating in multiple parachute jumps.\textsuperscript{17}

The present study had several limitations. The descriptive and medical data were obtained on a small sample from each battalion of I, CE, CA, and SF soldiers, which probably contributed to the large CIs in some of our findings. We would prefer to have been able to attain larger sample sizes; however, the nature of these populations made it difficult. All battalions had multiple deployments and missions, which made it hard for researchers to track medical data on all soldiers in the battalions. During deployments, medical data were often not consistently recorded, and each soldier's medical record usually remained in the garrison troop medical clinics. The research staff attempted to distinguish garrison-related training injuries from injuries occurring during deployment by interviewing medical staff and unit leaders.

Limited-duty data were not always reported (e.g., dislocations and tears) in the medical records, so time lost from duties was, in some cases, underestimated. Finally, the research staff found it difficult to identify accurately the frequency of injury-related disability from the data sources Physical Exam Board (PEB) and Medical Exam Board (MEB) reports available at the battalions. Reports did not provide good injury diagnosis and causes for the disability. Therefore, we might have underestimated time lost related to convalescent leave and PEB/MEB reviews. Data were not always recorded in the medical records on the cause of injury.

CONCLUSIONS

For all units in this present study, a majority of injuries were related to physical fitness training such as running and marching. There is a clear need to balance the benefits of intense physical training with the intrinsic risks for injury and training days lost. Despite the study limitations, this study is one of the few field injury investigations that compare injury occurrence and patterns. Further, this study associated time lost between a special operational unit and combat support infantry units with diverse missions and occupational tasks. These injuries are also costly in terms of thousands of dollars per injured soldier for lost salaries and medical costs.\textsuperscript{3,7,9} Detailed cost analyses for lost training time, medical care, and rehabilitation costs are needed. Also, training-related disability risk is on the rise in these units and accurate data on economic losses for injury-related disabling conditions is lacking.\textsuperscript{39}

We were able to identify factors that may predispose a soldier to injury. This is an important step in devising and testing interventions that may prevent future injury in these operational units. Prevention of injuries during physical fitness and mission-related training is key to reducing the loss of operational effectiveness. Interventions need to be developed to assure the greatest fitness gains for readiness for deployment.

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REFERENCES

A Four-Group Comparison of Injuries, Limited-Duty Days, and Injury Risk Factors


