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RESEARCH ARTICLE

The Role of Gender and Physical Performance on Injuries: An Army Study

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Introduction: In basic combat training, women experience twice as many injuries as men; however, evidence at the operational Army level is limited. This study aims to investigate the association between gender and injury likelihood while controlling for certain confounding factors in the operational Army.

Methods: Data were analyzed in 2015 from a cross-sectional study utilizing data from a 2010–2011 survey of light infantry Army Soldiers. Gender, age, body fat, tobacco use, Army Physical Fitness Test (2-mile run, push-ups, and sit-ups), occupational physical demand, and injury data were obtained via paper survey. ORs and 95% CIs from a multivariable analysis were calculated.

Results: Surveys were completed by 4,384 male and 363 female Soldiers. Injury incidence was 42% for men and 53% for women. After adjusting for the aforementioned variables, injury likelihood was higher in Soldiers aged ≥27 years (OR [age 27–29/22–26 years]=1.26, 95% CI=1.07, 1.48; OR [age ≥30/22–26 years]=1.28, 95% CI=1.08, 1.51), Soldiers with body fat ≥23.38% (OR [body fat ≥23.38%/≤19.28%]=1.30, 95% CI=1.08, 1.57), and Soldiers with the slowest 2-mile run times (OR [≥15.68/≤14.13 minutes]=1.53, 95% CI=1.26, 1.85). Women were no more likely than men to sustain an injury.

Conclusions: When accounting for age, body fat, physical performance, and occupational physical demand, there was no gender difference in the likelihood of injury among Soldiers. Although women, on average, have lower aerobic and muscular performance than men, results suggest men and women of similar physical performance experience similar injury likelihood.

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INTRODUCTION

With the U.S. Army's proposed plan to reduce its population by 40,000 Soldiers by 2018, it is critically important to ensure an optimal level of military readiness.[1] This can be accomplished by addressing several factors, including fitness and injury. Even though women make up a small portion of the army population (14%), their involvement and contributions are mission essential.[2,3] A recent example recognizing women's importance in the military is the opening of combat arms occupations to women. Therefore, it is more important than ever to assess the physical performance and the likelihood of injury among men and women.[4]

Several physical differences exist between men and women related to cardiovascular endurance, muscular strength, and body composition.[5–8] When comparing maximal oxygen consumption levels, a measure of cardiovascular endurance, aerobically untrained and trained women achieve values approximately 15%–30% lower than men of similar age.[5–7] Absolute muscular strength has also been shown to be lower, on average, in women compared with men, 50% lower in upper body strength and 30% lower in leg strength.[8] When analyses are adjusted for body mass, differences in strength decreased, but still persisted.[8] Additionally, essential

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body fat requirements differ between men and women, with the lowest acceptable limit for healthy men at 3% body fat versus 12% for healthy women.[8]

Associations of physical performance, gender, and likelihood of injury have been well documented within basic combat training (BCT) settings. These studies have shown female trainees experience almost twice as many injuries compared with male trainees and that low levels of aerobic performance (measured by 2-mile run time) are associated with injuries in both men and women.[9–11] However, several studies have shown that women and men of the same physical performance level have similar odds of injury during Army BCT.[12–14] The BCT population on average differs from the operational population at the physical performance level as measured by the Army Physical Fitness Test (APFT). Women's and men's average aerobic and muscular performance scores, as measured by the APFT, are approximately 23%–63% and 17%–47% lower, respectively, at the BCT level compared with the operational population.[10,15,16] Based on these differences, there may also be differing results in odds of injury and gender at the operational level. The association of gender and odds of injury has not been investigated among Soldiers in operational units. This analysis explores the association between gender and odds of injury in an operational Army infantry brigade while controlling for confounding factors such as age, body fat, tobacco use, physical performance as measured by the APFT, and occupational physical demand.

METHODS

This retrospective cross-sectional investigation included enlisted Active Duty Soldiers from two Army light infantry brigades located on the same U.S. military installation from 2010 to 2011. Each brigade consisted of armor, special troops, field artillery, infantry, cavalry, and brigade support units. Participating Soldiers completed paper surveys as part of an ongoing physical training program evaluation required by their leadership. Army Public Health Center staff distributed and collected the surveys at the military installation. The surveys were shipped through a tracked package service to the Army Public Health Center Injury Prevention Program and scanned into an electronic format for quality control and analyses. The survey obtained self-reported data on gender, date of birth, height and weight, Military occupations, cigarette smoking, physical performance (APFT), and injuries occurring within the last 12 months. Injury was defined as "either accidental or on purpose and occurring when strong sudden forces are applied to the body (traumatic) or smaller forces are applied to the body over and over again (overuse)." Overall injuries (traumatic and overuse) were included in the injury analysis. Age was calculated by subtracting the self-reported date of birth from the date the survey was completed and was categorized using APFT-designated age categories.[17] BMI (kg/m^2) was calculated from self-reported height and weight. Body fat percentage was indirectly calculated using a body fat prediction equation established by Gallagher et al.,[18] as seen below, where sex=1 for male and 0 for female. Body fat percentage results were divided into tertiles (thirds). The prediction error of this equation was low (4.98%).[18]

$$Body\,fat\,percentage = 64.5 - 848 \times (1/BMI) + 0.079 \times age - 16.4 \times sex + 0.05 \times sex \times age + 39.0 \times sex \times (1/BMI)$$

Cigarette smokers were identified as those who had smoked ≥100 cigarettes in their lifetime and smoked at least one cigarette in the 30 days prior to the survey administration date. This definition of cigarette smokers was established by the Centers for Disease Control and Prevention's (CDC's) Behavioral Risk Factor Surveillance System. Physical performance was measured by self-reported results on the most recent APFT. The APFT consists of a 2-minute maximal effort push-up event, a 2-minute maximal effort sit-up event, and a 2-mile run performed for time.[17] All three events were completed in accordance with Field Manual 7-22.[17] APFT results were divided into tertiles (33%) of highest, moderate, and lowest physical performance. Every entry-level enlisted Military Occupational Specialty is assigned a physical demand level necessary to complete occupationally assigned tasks. Occupational physical demand levels are categorized as Very Heavy, Heavy, Moderately Heavy, Medium, and Light as listed in the Department of the Army Pamphlet (DA Pam) 611-21.[19] Anderson and colleagues [16] identify the Military Occupational Specialties and physical demand requirements necessary to be categorized in each of the levels listed above.

Statistical Analysis

Data were analyzed in 2015 using SPSS, version 19.0. Unadjusted risk ratios and 95% CIs were calculated to assess the association of personal characteristics and physical performance with injury risk for men and women separately. When calculating regression analysis, a reference parameter was selected for each variable that was expected to have the lowest injury risk (e.g., non-smokers, low body fat percentage, younger age), or if none was expected, the lowest injury percentage category was selected. Potential risk factors significant at the $p \leq 0.10$ level in the univariate logistic regression results were entered into a multiple logistic regression model. ORs and 95% CIs from multivariate analyses were calculated to assess independent factors associated with injury.

RESULTS

Surveys were voluntarily completed by 4,747 enlisted Soldiers in two brigades (4,384 men and 363 women), accounting for 43% of the population. Soldiers had a mean age of 30.4 (SD=6.0) years (men, 30.5 [SD=6.0] years; women, 29.9 [SD=6.1] years). The average estimated body fat percentage for men was 20.4% (SD=4.6%) and for women was 31.7% (SD=5.3%). Forty-three percent of Soldiers reported an injury in the past 12 months (42% men and 53% women).

Figure 1 displays the percentage of enlisted men and women injured by APFT age groups (oldest, moderate, and youngest) and estimated body fat percentage (highest, moderate, and lowest). Men in the oldest age category experienced 8% more injuries than women, but women