

# Incidence of Anterior Cruciate Ligament Injury among Active Duty U.S. Military Servicemen and Servicewomen

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Although some studies have reported an increased incidence of anterior cruciate ligament (ACL) injuries in women athletes, little is known about the gender differences in injury patterns in the U.S. military. Using the Defense Medical Epidemiology Database, a search was performed for International Classification of Diseases, 9th Revision (ICD-9) codes 717.83 (old disruption of ACL) and 844.2 (sprain, strain cruciate ligament of the knee) among all servicemen and servicewomen between 1997 and 2003. Multivariate Poisson regression analysis was used to estimate the rate of ACL injuries per 1,000 person-years, controlling for age and race, for each ICD-9 code. We computed rate ratios and 95% confidence intervals (CIs) by using male as the reference category. The injury rates for code 717.83 were 3.09 cases per 1,000 person-years for men and 2.29 cases per 1,000 person-years for women, controlling for age and race (relative risk, 0.74; 95% CI, 0.71–0.76). The injury rates for ICD-9 code 844.2 were 3.79 cases per 1,000 person-years for men and 2.95 cases per 1,000 person-years for women, controlling for age and race (relative risk, 0.78; 95% CI, 0.76–0.80). There was not an observed increase in the incidence of ACL injuries among female soldiers in the U.S. military between 1997 and 2003.

## Introduction

Some studies suggested an increased incidence of anterior cruciate ligament (ACL) injuries among women involved in similar sporting activities, compared with male athletes.<sup>1–4</sup> Those reports have led to an increased interest in ACL injuries in female athletes.

The U.S. Armed Forces represents an active population of male and female service members who sustain many athletic and soft-tissue injuries.<sup>5</sup> The military maintains large injury databases and is thus an excellent population in which to study athletic injuries, such as ACL disruption. One such database is the Defense Medical Epidemiology Database (DMED), which compiles International Classification of Diseases, 9th Revision (ICD-9) coding information for every patient encounter occurring in a military treatment facility. This database also maintains the total number of soldiers on active duty each year and contains patient demographic and military-specific data. This database is managed by the Army Medical Surveillance Activity and provides eligible military and civilian researchers with timely and efficient access to data collected in the Defense Medical Surveillance System. DMED provides four types of data, namely, demographic features, inpatient hospitalizations, ambulatory visits, and reportable events. Using this database, we sought to determine the incidence of ACL injuries in the U.S. military, among male and female soldiers in all services.

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## Methods

The outpatient data in the DMED are a combination of the standard ambulatory data records extracted from the Ambulatory Data System and the Composite Health Care System used in military treatment facilities worldwide and outsourced (nonmilitary) outpatient health care facilities providing care to active duty service members. Only completed records are processed into DMED. The ambulatory data from 1997 to 2003 used this consistent method and were considered the most accurate for analysis.

DMED was queried for the years 1997 to 2003 to determine the total number of reported ICD-9-CM codes 717.83 (old disruption of ACL) and 844.2 (sprain, strain cruciate ligament of the knee), according to gender, age, and race. The age categories used were <20, 20 to 24, 25 to 29, 30 to 34, 35 to 39, and >40 years. The race categories were Caucasian, African American, and other. Inpatient data were excluded, to capture only ambulatory encounters. Events were limited to first occurrences to exclude repeat coding of the same initial injury for all services during the study period. To determine the total person-time at risk during the study period, we also queried DMED to determine the total number of service members on active duty during the study time period, according to gender, age, and race.

We used multivariate Poisson regression to estimate the rate of ACL injury per 1,000 person-years, controlling for age and race for each ICD-9 code. We computed adjusted rate ratios and 95% confidence intervals (CIs), using male as the reference category. Statistical analysis was performed by using SAS software version 8.2 (Cary, North Carolina).

## Results

During this 7-year study period, a total of 28,631 male injuries and 3,540 female injuries were coded with ICD-9 code 717.83. A total of 33,881 male injuries and 4,480 female injuries were coded with ICD-9 code 844.2. During this time period, the total male population at risk was 8,298,264 person-years, whereas the female population at risk was 1,398,552 person-years. The injury rates for code 717.83 were 3.09 cases per 1,000 person-years for men and 2.29 cases per 1,000 person-years for women, controlling for age and race; the adjusted rate ratio was 0.74 (95% CI, 0.71–0.76). The injury rates for ICD-9 code 844.2 were 3.79 cases per 1,000 person-years for men and 2.95 cases per 1,000 person-years for women, controlling for age and race; the adjusted rate ratio was 0.78 (95% CI, 0.76–0.80).

Overall population rates were calculated for both genders, controlling for race and age. For code 717.83, the overall rate was 2.96 cases per 1,000 person-years. For code 844.2, the overall rate was 3.65 cases per 1,000 person-years.

## Discussion

There has been much study of ACL injuries in female athletes, because of a reported increased incidence in multiple studies comparing male and female athletes.<sup>1-4</sup> Gwinn et al.<sup>4</sup> showed an increased risk for female midshipmen at the U.S. Naval Academy. However, this highly active, young cohort is not representative of the military as a whole. In addition, the absence of the exposure data that Gwinn et al.<sup>4</sup> used makes comparison with our results difficult. Using a large military database, we did not observe an increased incidence of ACL injuries in female soldiers across all services for the years 1997 through 2003.

The overall rates observed (2.96 cases per 1,000 person-years for code 717.83 and 3.65 cases per 1,000 person-years for code 844.2) were greater than the commonly accepted rates for the general population. The San Diego Kaiser group reported the incidence of ACL injuries in the middle 1980s to be 0.38 cases per 1,000 persons per year.<sup>6</sup> This number is consistent with a population study from Denmark that reported an ACL injury incidence rate of 0.31 cases per 1,000 persons per year.<sup>7</sup> Of note, both population studies reported a greater incidence of male ACL injuries, compared with female injuries. However, these large population studies take into account all persons in the community, not primarily athletes, and do not account for exposure to activity. There have been no previous studies assessing the ACL injury rate in the military population. The few studies on the epidemiological features of ACL injury in this population have focused on either outcomes of the injured soldier<sup>8</sup> or specific populations.<sup>4,9,10</sup>

This increased incidence of ACL injuries in the military population is not surprising. The U.S. Armed Forces constitute an extremely active cohort that cannot be directly compared with the U.S. population. The increased activity level, both in extracurricular athletics and in military training exercises, places these individuals at extremely high risk for knee ligament injury. The injury incidence rate in this study (controlling for age and race) for code 717.83 was 2.96 cases per 1,000 person-years and that for code 844.2 was 3.65 cases per 1,000 person-years. These rates are 10 times the rates of 0.38 and 0.31 cases per 1,000 person-years reported in the studies from the San Diego Kaiser group<sup>6</sup> and Denmark,<sup>7</sup> respectively.

This study has several limitations. The quality of the data presented here is only as good as the data obtained by the individual military or civilian providers and clinic staff members. The diagnoses were determined by multiple providers of various skill levels. No imaging data or confirmatory diagnoses from a specialist were provided. In addition, Current Procedural Terminology codes were not available to yield the number of ACL injuries that required surgical intervention. By using the option of capturing the first occurrence only, we eliminated multiple visits for the same injury. However, we also lost the ability to capture bilateral injuries. The accuracy of the ICD-9 data is also limited by the inadequacies of this coding system. For example, ICD-9 code 844.2 can be used to code for either an acute ACL or posterior cruciate ligament injury. However, posterior cruciate ligament injuries represent only 10% of all cruciate ligament

injuries.<sup>6</sup> Because it is possible that a case coded as 844.2 in the acute period could later be coded as 717.83 for the same injury, we chose not to combine these codes for our analysis but instead evaluated them separately. However, because these two codes are commonly used for the diagnosis of ACL injuries, it was important to evaluate both codes.

Another limitation was the absence of exposure data or injury mechanism data. Although capturing these data would be desirable, our current data collection capabilities do not provide this information. The collection of exposure data would be cost-prohibitive in a population of this size. The results of this study do not contradict the previous reports that showed an increased risk for specific populations of female athletes engaging in high-level athletics.<sup>1,4</sup> The higher rates of ACL injury in this military cohort may represent a higher activity level of the male service members. In the previous large population sample reported by Hirshman et al.,<sup>6</sup> men accounted for 68% of ACL injuries.

Our study included a large population from which to draw inferences. Because of the large size of our database, we were able to assess injury incidence in a large active population. However, the applicability of these data to other populations may be limited.

## Conclusion

There was not an increased incidence of ACL injuries among women in the U.S. military between 1997 and 2003. The incidence of ACL injuries among U.S. service members was 10 times the reported rate for the U.S. population as a whole.

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