# Clavicle Fractures in the United States Military: Incidence and Characteristics

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**ABSTRACT** Background: Although it is generally known that clavicle fractures represent a common injury of the shoulder girdle in the general population, the true incidence in the active duty military population is unknown. Given the implications for such injuries on the ability to perform occupation-specific tasks, determining the incidence in the U.S. military population is worthwhile. The purpose of this study was to determine the incidence of clavicle fractures in the U.S. military and to identify any demographic risk factors for injury. Methods: We performed a query of the Defense Medical Epidemiology Database with the code from the International Classification of Diseases, Ninth Revision, for clavicle fractures for the years 1999 through 2008. An overall injury incidence was calculated, in addition to multivariate analysis, to determine independent risk factors among the following demographic considerations: sex, race, branch of military service, rank, and age. Results: During the study period, a total of 12,514 clavicle fractures were documented among an at-risk population of 13,770,767 person-years for an incidence rate (IR) of 0.91 per 1,000 person-years in the U.S. Military. Males, when compared with females, were more than twice as likely to sustain a clavicle fracture (IR ratios [IRR], 2.30; 95% confidence intervals [CI], 2.12–2.49). The peak incidence of clavicle fractures occurred in the age groups of <20 and 20 to 24. Compared to black service members, the white service members were associated with significantly higher rate of clavicle fractures (IRR, 2.45; 95% CI, 2.28–2.63). The service members serving in the Marine Corps were associated with a higher IR of clavicle fractures when compared to those in the Navy (IRR, 1.44; 95% CI, 1.35–1.53). Junior enlisted service members were 34% as likely to sustain a clavicle fracture when compared to senior officers (IRR, 1.46; 95% CI, 1.34–1.60 and IRR, 1.12; 95% CI, 0.99–1.28, respectively). Conclusions: The incidence of clavicle fractures among U.S. military personnel (0.908 per 1,000 person-years) is higher than previous epidemiological reports.

## INTRODUCTION

Fractures of the clavicle have been reported to account for 2.6% to 10% of all adult fractures,[1–5] increasing to 10% to 15% of pediatric fractures,[4,6,7] and 35% to 44% of injuries to the shoulder girdle.[4,5] The annual incidence rate (IR) of clavicle fractures reported in adults ranges from 0.29 to 0.64 per 1,000 population per year.[3,4,8,9] In pediatric populations, the IR has been estimated to be slightly higher at 0.80 per 1,000 population per year.[7] The mechanism of clavicle fracture has been well described in the literature.[3,10–13] The majority of these injuries, approximately 94%, typically involve a direct blow on the shoulder with the remaining 6% of injuries resulting from a fall onto an outstretched hand.[10]

Several studies have investigated the IRs and epidemiology of clavicle fractures in the general European population. However, little is known about the epidemiology of clavicular fractures within young and physically active populations. Similarly, little is known about the risk of clavicle fracture in occupational groups that have substantial upper extremity demands. The active duty military population is a young and physically active group with significant upper extremity occupational demands. As a result, we hypothesize that the IR of clavicular fracture in this population would be significantly higher than previous reports. Furthermore, we hypothesized that the IR for clavicle fracture would be associated with various demographic and occupational factors such as sex, race, age, branch of military service, and military rank of the patient.

## MATERIALS AND METHODS

We conducted a retrospective cohort study to examine the IR for clavicle fractures within active duty military personnel between 1999 and 2008 using injury data extracted from The Defense Medical Epidemiological Database (DMED). A secondary objective was to examine the association between demographic (e.g., sex, age, race) and occupational (e.g., branch of military service, rank) risk factors associated with the incidence of clavicular fracture during the study period. The DMED compiles International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) coding information for every patient encounter occurring in a U.S. military treatment facility (as well as civilian contracted care). This database also contains patient demographic and military-specific data, which can be used

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for epidemiological purposes. In addition, the DMED also maintains the total numbers of U.S. military personnel on active duty each year (obtained from the Defense Manpower Data Center). The structure, capabilities, and utility of this military database for public health surveillance and epidemiological research have been previously described in the literature[14,15], as well as used to evaluate the epidemiology of shoulder conditions and fractures.[16–23]

We queried the DMED by sex, age, race, branch of military service, and military rank and age for the years 1999 through 2008 using ICD-9-CM code 810.0 to determine the number of incident cases of clavicle fracture. The age categories were <20, 20 to 24, 25 to 29, 30 to 34, 35 to 39, and ≥40 years. The race categories were white, black, and others. The service categories were U.S. Army, U.S. Marine Corps, U.S. Navy, and U.S. Air Force. The rank categories included junior enlisted (E1–E4), senior enlisted (E5–E9), junior officer (O1–O4), and senior officer (O5–O9). Inpatient data were excluded to capture only ambulatory encounters with a primary diagnosis of clavicle fracture. In addition to primary diagnosis, incident events were limited to a "first occurrence" to exclude repeat coding of the same initial injury for all service members during the study period.[14]

The primary outcome of interest was the IR of clavicle fractures per 1,000 person-years at risk of injury during the study period. The IR for an injury or illness is defined as the number of new cases occurring during a specific period of time in a population at risk for experiencing the injury.[24] IRs are calculated by dividing the total number of injuries observed in a population by a measure of exposure or person-time at risk to injury.[24] Accurate population denominator data for IR calculations are available through DMED and are validated against Department of Defense personnel data obtained from the Defense Manpower Data Center.[14] Exposure time during the current study period was calculated from the day each individual entered military service until he or she either sustained an incident clavicle fracture injury or left military service. All IRs are reported per 1,000 person-years at risk to injury in the present study.

The overall incidence of clavicle fractures in the study population, along with the 95% confidence interval (CI), was calculated by dividing the total number of injuries by the total person-years at risk and multiplying by 1,000. Using the injury and personnel data extracted from DMED, we used a multivariable Poisson regression model to estimate the IR of clavicle fractures per 1,000 person-years by strata (e.g., sex) while controlling for the influence of the other variables in the model (age, race, service, and rank). We calculated unadjusted and adjusted IRs, IR ratios (IRRs), and 95% CI for each demographic category using the subset with the lowest IR as the referent category.

## RESULTS

Between 1999 and 2008, a total of 12,514 incident clavicle fractures were documented in the DMED among a population at risk of 13,770,767 person-years. There was an average of 1,254 clavicle fractures diagnosed per year during the study period. The overall IR for clavicle fractures during the study period was 0.91 (95% CI, 0.90–0.91) per 1,000 person-years. The IR for injury varied significantly by gender, age, race, military service, and rank. All demographic and occupational variables were associated with the incidence of clavicle fractures ($p < 0.001$), indicating that sex, age, race, service, and rank are important risk factors related to clavicle fractures.

### Sex

Men experienced clavicle fractures at a significantly higher rate than women, when controlling for the influence of the other risk factors in the model. Among all service members, men were more than twice as likely (IRR, 2.20; 95% CI, 2.12–2.49) to sustain a clavicle fracture when compared to women. The adjusted IR for men was 0.67 per 1,000 person-years at risk to injury compared with 0.29 for women. IRs, IRRs, and 95% CIs by gender are presented in Table I.

### Race

The IR of clavicle fractures was significantly higher for white service members than for those in the "other" category and black service members. The adjusted IR observed for white service members was 0.66 per 1,000 person-years at risk to injury, 0.49 for service members in the "other" category for race, and 0.27 for black service members. White service members were twice as likely (IRR, 2.45; 95% CI, 2.28–2.63) to sustain a clavicle fracture when compared with black service members. IRs, IRRs, and 95% CIs for each racial group are presented in Table II.

### Age

The IR for clavicle fracture was significantly higher in the age groups of <20, 20 to 24, and 25 to 29 years when compared with the age group of ≥40 years, and rates generally declined with increasing age (Table III). Service members in the age groups of <20, 20 to 24, and 25 to 29 years experienced IRs for

**TABLE I.** Gender

| | | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| Gender | Injuries | Person-Years | Rate | RR (95% CI) | Rate | RR (95% CI) |
| Male | 11,736 | 11,762,120 | 1.0 | 2.57 (2.40–2.77) | 0.67 | 2.30 (2.12–2.49) |
| Female | 778 | 2,008,647 | 0.39 | N/A | 0.29 | N/A |

Rate per 1,000 person-years; male referent category; adjusted for race, age, service, and rank.

**TABLE II.** Race

| | | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| Race | Injuries | Person-Years | Rate | RR (95% CI) | Rate | RR (95% CI) |
| White | 10,115 | 9,443,676 | 1.07 | 2.65 (2.49–2.83) | 0.66 | 2.45 (2.28–2.63) |
| Other | 1,345 | 1,717,070 | 0.78 | 1.94 (1.79–2.11) | 0.49 | 1.81 (1.66–1.99) |
| Black | 1,054 | 2,610,021 | 0.40 | N/A | 0.27 | N/A |

Rate per 1,000 person-years; male referent category; adjusted for gender, age, service, and rank.

**TABLE III.** Age

| | | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| Age | Injuries | Person-Years | Rate | RR (95% CI) | Rate | RR (95% CI) |
| <20 | 1,267 | 1,106,254 | 1.15 | 1.72 (1.58–1.80) | 0.52 | 1.38 (1.22–1.55) |
| 20–24 | 5,170 | 4,562,946 | 1.13 | 1.70 (1.58–1.82) | 0.54 | 1.42 (1.28–1.57) |
| 25–29 | 2,413 | 2,868,417 | 0.84 | 1.26 (1.17–1.36) | 0.45 | 1.18 (1.07–1.30) |
| 30–34 | 1,475 | 2,014,212 | 0.73 | 1.10 (1.01–1.19) | 0.41 | 1.08 (0.98–1.19) |
| 35–39 | 1,247 | 1,808,575 | 0.69 | 1.03 (0.95–1.13) | 0.39 | 1.01 (0.92–1.12) |
| >40 | 942 | 1,410,363 | 0.67 | N/A | 0.38 | N/A |

Rate per 1,000 person-years; male referent category; adjusted for gender, race, service, and rank.

**TABLE IV.** Service

| | | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| Service | Injuries | Person-Years | Rate | RR (95% CI) | Rate | RR (95% CI) |
| Marines | 2,406 | 1,771,855 | 1.36 | 1.73 (1.63–1.82) | 0.55 | 1.44 (1.35–1.53) |
| Army | 4,429 | 4,896,215 | 0.91 | 1.15 (1.10–1.21) | 0.45 | 1.16 (1.10–1.23) |
| AF | 2,855 | 3,516,060 | 0.81 | 1.03 (0.98–1.09) | 0.41 | 1.06 (1.00–1.13) |
| Navy | 2,824 | 3,586,637 | 0.79 | N/A | 0.39 | N/A |

Rate per 1,000 person-years; male referent category; adjusted for gender, race, age, and rank.

**TABLE V.** Rank

| | | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| Rank | Injuries | Person-Years | Rate | RR (95% CI) | Rate | RR (95% CI) |
| E1-E4 | 6,698 | 6,069,491 | 1.10 | 1.69 (1.58–1.82) | 0.53 | 1.46 (1.34–1.60) |
| E5-E9 | 4,349 | 5,478,762 | 0.79 | 1.22 (1.13–1.31) | 0.49 | 1.35 (1.24–1.47) |
| O4-O9 | 586 | 870,056 | 0.67 | 1.03 (0.93–1.15) | 0.41 | 1.12 (0.99–1.28) |
| O1-O3 | 881 | 1,352,458 | 0.65 | N/A | 0.36 | N/A |

Rate per 1,000 person-years; male referent category; adjusted for gender, race, age, service.

clavicle fracture that were 38%, 42%, and 18% higher, respectively, than those in the oldest age group.

### *Branch of Military Service and Military Rank*

Branch of military service was an occupational risk factor associated with the IR for clavicle fractures. The highest IR of injury was experienced by those serving in the Marine Corps, followed by those in the Army, Air Force, and Navy. Examining the IRs by service suggests that those serving in the Marine Corps, Army, and Air Force experienced IRs for clavicle fracture that were 44%, 16%, and 6% higher, respectively, when compared with those serving in the Navy (Table IV). Military rank was also associated with the incidence of clavicle fracture after controlling for the influence of age and other variables in the statistical model. The highest adjusted IR for clavicle fracture was observed in junior enlisted service members, followed by senior enlisted service members, junior officers, and senior officers. All groups experienced significantly higher IRs of injury when compared with senior officers. The IR for clavicle fracture was 46% higher among junior enlisted, 35% higher among senior enlisted, and 12% higher among junior officers when compared to senior officers (Table V).

## DISCUSSION

Although clavicle fractures are common injuries, we are aware of no other population-based studies about the epidemiology of clavicle fractures in the U.S. or in the Active Duty U.S.

Military Population, despite several studies reporting IRs within the general European population.[3–5,8] In a 2-year study between 1989 and 1990 in Uppsala, Sweden, Nowak et al[8] reported an annual IR of 0.50 per 1,000 person-years. In a Scottish study, Robinson et al[3] reported IRs of 0.29 per 1,000 person-years. In one of the earliest studies with the longest surveillance from Malmö, Sweden, Nordqvist et al[4] calculated the age- and gender-specific incidences in 2,035 cases of fracture of the clavicle between 1952 and 1987. They reported an annual IR of 0.06 per 1,000 person-years. In a study from Rome, Italy, Postacchini et al,[5] we were unable to determine the annual IR of clavicle fractures, however, the study did characterized 535 isolated clavicle fractures of 20,501 fractures treated in a hospital of a large metropolis during an 11-year study period from 1990 to 2001. A review of prior population-based studies that have reported IRs for clavicle fractures is presented in Table VI.

The IR for clavicle fracture injuries observed within the active duty U.S. military population in the current study was 0.91 per 1,000 person-years. The cohort studied represents a relatively young and active group that has unique upper extremity demands required by the nature of their jobs. Although some of these upper extremity demands may be similar to those individuals who perform manual labor or participate in athletics, military service members participate in some unique training exercises and deployments that are upper extremity intensive activities.[18] Therefore, it may elucidate a higher IR than other previous reports.

When sex was evaluated as an independent risk factor for clavicle fractures in the current study, we found that men experienced significantly higher IRs of injury. Men experienced 93.8% of all clavicle fractures during the study period while women only accounted for 6.3% of all injuries. This is consistent with previous reports[3–5,8] suggesting a male preponderance to sustain clavicle fractures (Table VI). However, this increased incidence among male service members may be a reflection of various occupational and recreational activity levels between genders. Future studies with more precise athletic, occupational, and recreational exposure data may provide a more accurate depiction.

The association between race and the incidence of clavicle fracture has not been evaluated previously, to our knowledge. We found a significantly increased incidence among white service members when compared with black service members. Similarly, Jones et al[25] also reported race as a potential risk factor for stress fractures and documented that the incidence of stress fractures was higher in white male Army trainee (1.1%) than for Black (0.6%) or other nonwhite (0.1%) trainees.[25,26] As a result, race may play a role in the increased IRs, could suggest a certain amount of genetic predisposition, and may deserve further study.

Younger service members in the <20, 20 to 24, and 25 to 29 age groups sustained more clavicle fractures during the current study, and this age effect was found to be significant. This finding is also consistent with previous reports,[3–5,8] and it may be associated with increased activity levels in these individuals and other risk factors associated with the younger population.

Service in the Marines and Army as well as being in the enlisted ranks were significant risk factors in our cohort. The impact of the service branches and rank may also be a reflection of differing activity levels in these groups. The fact that the Army and Marines had the higher injury rates is not surprising given the increased levels of physical activity requirements involved in these services; however, some caution is warranted in interpreting differences by military service due to some variability in injury surveillance methods.[25] Further examination of the specific modifiable and nonmodifiable occupational risk factors associated with the incidence of clavicle fracture is also warranted.

Some limitations should be noted in the present study and these have been described in previous studies.[16–23] The overall quality of medical surveillance data depends on the completeness, validity, consistency, timeliness, and accuracy of the data overall.[14] Despite the comprehensive nature of the injury data collected and stored in this military database, data quality issues are commonly associated with large administrative health care databases and cannot be overlooked. Errors such as miscoding of data at the health care provider or coding department level and/or failure to complete data records may impact the overall data quality within this military database. Another limitation is that inclusion of only the first occurrence of injury in our data may have altered our results. This filter is intended to remove multiple coding of distinct injuries for the same individual so that only incident cases are included in our analysis; however, this may also limit our ability to document reinjury or contralateral injuries sustained by the same service member. Another limitation of our data is the lack of more precise athletic or occupational exposure information. We were able to incorporate branch of military service and rank data into our analysis, which may provide some insight into activity

**TABLE VI.** Comparison of Previous Population-Based Studies Calculating IRs for Clavicle Fractures

| Study (Duration) | Population | Injuries | Population (Person-Years) | Age (Yrs) | Gender | IR (Per 1,000 Person-Years) |
|---|---|---|---|---|---|---|
| Nowak[8] (2 years) | Civilian, Urban, Sweden | 187 | 400,000 | >15 | 0.71 Men, 0.30 Women | 0.50 |
| Postacchini[5] (11 years) | Civilian, Urban, Italy | 535 | N/A | 29.3 ± 22 | 2.1:1 Ratio | N/A |
| Robinson[3] (6.2 years) | Civilian, Urban, Scotland | 1,000 | 556,469 | >13 | 2.6:1 Ratio | 0.29 |
| Nordqvist[4] (13 years) | Civilian, Urban, Sweden | 2,035 | 3,110,000 | 27 (Avg.) | 0.082 Men, 0.041 Women | 0.06 |
| Current 2010 (10 years) | Military, United States | 12,514 | 13,770,767 | 17–40+ | 0.67 Men, 0.29 Women | 0.91 |

levels. This analysis could have been strengthened by also including an evaluation of job-specific occupational and athletic requirements. These data were not available, but including it in future studies may help overcome some limitations of the current study.

Despite the limitations noted earlier, the ambulatory care data contained within the DMED provide many advantages over similar civilian systems. First of all, data are collected for all visits for the population of interest (e.g., U.S. service members on active duty) with use of standardized inpatient and ambulatory care data records. The Armed Forces Health Surveillance Center makes a concerted effort to ensure a standardized and consistent approach to data processing and validation.[14] Furthermore, accurate demographic and person-time at risk for injury data are included in this database through the Defense Manpower Data Center. The person-time at risk information provides excellent denominator data for calculating IRs for the entire active duty military population.[27]

A further strength of this investigation is the large and physically active cohort that was studied. Previous studies have shown that active duty military personnel sustain a large number of injuries related to sports, exercise, and physical training.[28] Although this population may not be comparable with the general population in the United States, it may in fact be representative of the large segment of the population that engages in activities with high upper extremity athletic and occupational demands on a regular basis. By studying the epidemiology of clavicle fractures in a cohort in which it is endemic, we are able to discern more clearly the demographic and occupational risk factors that may not be apparent in an evaluation of the general population. Also, the study of the military population may provide more accurate results because of the closed health care system, greater patient observance, and more accurate records.

In summary, the IR of clavicle fractures in the U.S. military population is higher than that in previous reports. Male sex, white race, and an age of >30 years were associated with the highest rates of clavicle fracture in the study population. All demographic (sex, age, race) and occupational (service, rank) factors studied were associated with the IR for clavicle fracture. Future studies should focus on further delineating the modifiable risk factors associated with the incidence of clavicle fractures.

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