Introduction

Lower extremity major tendon ruptures are a significant problem in sports. The incidence of Achilles tendon ruptures has been documented at 2.66 per 1000 person-years over a four-year period of study in Malmo, Sweden, with the peak incidence in the third and fourth decades of life [15]. Approximately two-thirds of Achilles tendon ruptures occur during sporting activity [8,15]. In addition to sports injuries, major tendon ruptures in the lower extremity occur as a result of non-traumatic mechanisms. These injuries are rarer and seem to occur in older patients with comorbidities such as renal disease and autoimmune disorders [5]. The risk factors for tendon ruptures in otherwise healthy patients are less clear. There have been associations with blood groups and certain genetic polymorphisms [7,8,14]. One previous study showed an increased incidence of Achilles tendon ruptures in individuals of black race, compared to nonblacks [1]. We sought to investigate the racial differences in major tendon rupture incidence using a large military database.

Methods

The Defense Medical Epidemiology Database (DMED) compiles International Classification of Diseases, Ninth Revision, and Clinical Modification code 727.65 (rupture of quadriceps tendon), 727.66 (rupture of patellar tendon), and 727.67 (rupture of Achilles tendon) using the U.S. Defense Medical Epidemiology Database (DMED). Multivariate poisson regression was used to estimate the rate of major tendon rupture per 1000 person-years, while controlling for differences in gender, service, rank, and age for each code. We computed rate ratios and 95% confidence intervals using whites as the referent category. The adjusted rate ratio for black service members when compared to white service members was 2.89 (95% CI 2.42, 3.44) for quadriceps tendon tears, 4.52 (95% CI 3.94, 5.19) for patellar tendon tears, and 3.58 (95% CI 3.31, 3.88) for Achilles tendon tears. There appears to be a significant relative predisposition toward lower-extremity major tendon rupture in black U.S. service members when compared to white service members. Investigation of the racial differences in risk factors is warranted.
727.66 (rupture of patellar tendon), and 727.67 (rupture of Achilles tendon). The race categories were white, black, and other. The service categories used were Army, Navy, Air Force, and Marines. The rank categories we used were E1–E4, E5–E9, O1–O3, and O4–O9. The age categories used were < 20, 20–24, 25–29, 30–34, 35–39, and ≥ 40. Inpatient data were excluded to capture only ambulatory encounters. Events were limited to a “first occurrence” to exclude repeat coding of the same initial injury for all services during the study period. The database was also queried for the total number of service members on active duty during the study time period and a total of 6771865 service member-years among black, white, and other service members. The injury rate, adjusted for gender, rank, service, and age differences, for quadriceps tendon was 0.126 tears (per 1000 person-years) for black service members, 0.047 for those categorized as other, and 0.044 for white service members; the adjusted rate ratio was 2.98 (95% CI 2.42, 3.44) for black service members when compared to white service members and 1.09 (95% CI 0.79, 1.49) for service members categorized as other when compared to white service members (Table 1). The adjusted incidence rate for patellar tendon injuries was 0.212 for black service members and 0.050 for race category other, and 0.047 for race category white; the adjusted rate ratio was 4.50 (95% CI 3.94, 5.13) for black service members when compared to white service members and 1.10 (95% CI 0.76, 1.44) for service members categorized as other when compared to white service members (Table 1).

### Results

There were a total of 4451 major tendon ruptures in the lower extremity during the study time period and a total of 6771865 service member-years among black, white, and other service members. The injury rate, adjusted for gender, rank, service, and age differences, for quadriceps tendon was 0.126 tears (per 1000 person-years) for black service members, 0.047 for those categorized as other, and 0.044 for white service members; the adjusted rate ratio was 2.98 (95% CI 2.42, 3.44) for black service members when compared to white service members and 1.09 (95% CI 0.79, 1.49) for service members categorized as other when compared to white service members (Table 1). The adjusted incidence rate for patellar tendon injuries was 0.212 for black service members and 0.050 for race category other, and 0.047 for race category white; the adjusted rate ratio was 4.50 (95% CI 3.94, 5.13) for black service members when compared to white service members and 1.10 (95% CI 0.76, 1.44) for service members categorized as other when compared to white service members (Table 1).
Males had a higher rate of injury when compared to females after adjusting for race, age, rank, and service (Table 2). Increased age also appeared to be associated with higher rates of tendon injury when compared to those < 20 years of age (Table 3).

Discussion

We found a significantly higher incidence of major tendon rupture among black soldiers when compared to white soldiers over a four-year time period using a large military database. This supports the findings of Davis et al. who found an increase incidence of Achilles tendon injuries undergoing surgical repair in black U.S. soldiers [1]. While their study is limited to a 3 year review of Achilles tendon injuries treated operatively in military hospitals, the findings of the current study using a large database encompassing all lower extremity tendon ruptures further strengthens the argument that there does appear to be a relative increased incidence of lower extremity tendon injuries in black U.S. soldiers compared to white U.S. soldiers.

There are many potential reasons for the racial differences in tendon injuries. A recent biomechanical study of the viscoelastic properties of Achilles tendon-gastrosoleus complex showed a higher stiffness in black athletes [2]. The authors proposed this to be an explanation of the superior sprinting/jumping performance seen in black athletes. These differences could also result in tissue that is more likely to undergo catastrophic failure if subjected to sufficient trauma.

There has also been a reported link between ABO blood group O and an increased risk for tendon rupture [7–9]. However, other reports, also from Europe, have not shown this association [10,13]. A recent report took this potential risk factor of blood type O and analyzed its association with the gene for the tenascin-c protein, which is closely linked to the ABO gene. These authors found an increased risk for Achilles tendon injury among individuals who possessed a certain repeat polymorphism within the tenascin-c gene [14].

There are no published reports evaluating the link of ABO blood grouping and tendon injuries with the population in North America. However, we do know that there are ABO differences among different races in the United States, with blacks having a higher percentage of individuals with type O blood than whites (50.2% versus 45.2%) [3]. Future studies should explore this phenomenon in a large database such as the DMED.

Racial differences in body weight have been reported. Obesity has been reported to be more prevalent in black adults than Caucasian adults in the United States [17]. This trend has also been noted in an active duty U.S. military cohort [12]. However, physical activity was not found to be independently linked to being overweight. Increased body weight has been linked to an increase in overuse injuries in military recruits [4]. Body weight data was not available in our current study, therefore we are unable to determine the effect of this parameter on tendon ruptures in our population. Activity level data was also not available in our current study, therefore we cannot comment on its potential effect on our results. The availability of occupation data could assist in the inference of activity level. However, in the study by Davis et al. [1], a majority of Achilles ruptures occurred during play of basketball, an off-duty activity.

We also found males had a higher tendon rupture rate when compared to females. There are previous reports detailing the clear male predominance in these injuries [6,7,16]. While these results support male gender as a risk factor for lower extremity tendon rupture, it is unclear whether activity patterns or body weight may have influenced these results. Athletic exposure data, not just number of person-years in the Armed Forces, would be needed to completely eliminate this potential bias.

We also found that increased aged was an independent risk factor for major lower extremity tendon rupture. This is consistent with other reports that show a peak in Achilles tendon ruptures...
in the third decade of life [7,15]. It is unclear whether body weight or activity level may have affected these results. This study has both strengths and weaknesses. The greatest strength of this study is the large number of young, active individuals whose injuries are annotated in the DMED database. This allows for comparison of demographic groups. However, the quality of the data in any large database is only as good as the data entry. This database uses data generated from the coding of ambulatory and inpatient visits. We chose to evaluate only the ambulatory data, as the inpatient numbers were significantly lower. The data entered into the database from an ambulatory report relies on the accurate ICD-9 coding of injuries, which is suspect to occasional errors. The addition of athletic exposure and mechanism of injury information would allow better comparison of relative risk and this concern with the DMED system has been noted by other authors [11]. However, this information would be difficult to obtain on such a large population and currently is not available. The addition of ABO blood type information would also be beneficial to analyze, however, this information is currently not available with the DMED database.

Conclusion

There appears to be a predisposition among black U.S. service members toward lower extremity major tendon rupture. Currently, it is not possible to determine if race itself is a risk factor or is a proxy for as associated intrinsic or behavioral factor. Continued study of risk factors for tendon rupture is needed.

References

1 Davis JJ, Mason KT, Clark DA. Achilles tendon rupture stratified by age race and cause of injury among active duty US military members. Mil Med 1999; 164: 872 – 873
3 Garratty G, Glynn SA, McEntire R. ABO and Rh(D) phenotype frequencies of different racial/ethnic groups in the United States. Transfusion 2004; 44: 703 – 706