# The Demographics of Fractures and Dislocations Across the Entire United States due to Common Sports and Recreational Activities

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**Background:** There exists little nationwide data regarding fracture and dislocation patterns across a wide variety of sporting activities for all ages and sexes.

**Hypothesis:** Participant demographics (age and sex) will vary with regard to fracture and joint dislocation sustained during sport-related activities.

**Study Design:** Descriptive epidemiology study.

**Level of Evidence:** Level 3.

**Methods:** The National Electronic Injury Surveillance System All Injury Program data 2005 through 2013 were accessed; 18 common sports and recreational activities in the United States were selected. Statistical software was used to calculate the numbers of fractures and dislocations, and incidence was calculated using US Census Bureau data. Multivariate logistic regression analysis determined the odds ratios (ORs) for the occurrence of a fracture or dislocation.

**Results:** A fracture occurred in 20.6% and a joint dislocation in 3.6% of the emergency department visits for sports-related injuries; annual emergency department visit incidence was 1.51 for fractures and 0.27 for dislocations (per 1000 people). Most of the fractures occurred in football (22.5%). The OR for fracture was highest for inline skating (OR, 6.03), males (OR, 1.21), Asians, whites, and Amerindians compared with blacks (OR, 1.46, 1.25, and 1.18, respectively), and those older than 84 years (OR, 4.77). Most of the dislocations occurred in basketball (25.7%). The OR for dislocation was highest in gymnastics (OR, 4.08), males (OR, 1.50), Asians (OR, 1.75), and in those aged 20 to 24 years (OR, 9.04). The most common fracture involved the finger, and the most common dislocation involved the shoulder.

**Conclusion:** Inline skating had the greatest risk for fracture, and gymnastics had the greatest risk for joint dislocation.

**Clinical Relevance:** This comprehensive study of the risks of sustaining a fracture or dislocation from common sports activities across all age groups can aid sports health providers in a better understanding of those sports at high risk and be proactive in prevention mechanisms (protective gear, body training).

**Keywords:** fracture; dislocation; sport; recreation; demographic; NEISS

Sporting activities not only promote healthy mental and physical development but also carry a risk of injury. There are 30 to 45 million athletes participating at the youth, high school, and collegiate levels.[6,19,38,39,58,68,69] However, sporting injuries are not limited to organized sports or these particular age groups. These injuries result in financial expense as well as other costs to the injured patient (ie, school/work absences, restricted activity/athletic participation, and potential long-term effects of injury) and/or parent/spouse (ie, time missed from work, transportation costs, and other expenses).[6,38,51,68,69]

Studying the demographics of all sports- and recreation-related injuries is essential to develop effective preventive strategies, as injury patterns differ by age and activity.[41,68] Many studies have characterized the epidemiology of sports-related

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injuries for 1 specific sport, while a few have studied multiple sports- and recreation-related injuries over a short duration and in select groups (by either age or school level).[6,36-42,59] However, the results of these studies are not readily comparable because of differences in study design and selected sports. While there has been some research dedicated to fracture rates, much of the published literature focuses on injury rates as a whole, with little data regarding fractures or dislocations. Nationwide data regarding fracture and dislocation patterns across a wide variety of sporting activities for all ages and sexes are sparse. The purpose of the present study was to investigate the demographics of US sports-related fractures and dislocations across a wide range of sporting activities using a national database.

## METHODS

This study was considered exempt by our local institutional review board. The data used for this study are from the National Electronic Injury Surveillance System (NEISS) All Injury Program (AIP). The NEISS is a database managed by the US Consumer Product Safety Commission (USCPSC) that collects injury data from 100 hospital having emergency departments (EDs) in the United States and its territories. It was initially created to monitor injuries associated with consumer products. However, not all injuries are associated with consumer products; thus, the USCPSC selected 65 of these hospitals to collect ED data for all injuries, regardless of the association with consumer products. This has been designated as the AIP. These data are in the public domain and housed by the Inter-University Consortium for Political and Social Research. It can be downloaded from their website at https://www.icpsr.umich.edu/icpsrweb/ICPSR/search/studies?q=all+injury+program.

The database includes date of ED visit, sex/race/age of the injured patient, diagnosis, disposition from the ED, geographic location of the injury, body part injured, and hospital strata. There are 5 hospital strata, 4 based on size (total number of ED visits reported by the hospital: small [0-16,830], medium [16,831-21,850], large [28,151-41,130], or very large [>41,130]), and 1 consisting of children's hospitals of all sizes. A national estimate of the number of injuries (N) is calculated using the actual number of injuries (n) seen in these 65 EDs.

The NEISS-AIP data for the years 2005 through 2013 were accessed. These years were chosen because 2013 was the last available year at the time the study was performed, beginning in late 2017, and data before 2005 were coded differently for many variables, making it difficult to combine the years before 2005 with those afterward. Injuries due to sporting activities were identified by the NEISS-AIP code SPORTS; there are 39 mutually exclusive sports and recreational activity codes. We selected 18 of the 39 as being representative of the most common sports and recreational activities in the United States. These 18 were football, baseball, basketball, softball, soccer, volleyball, ice hockey, ice skating, snow skiing, toboggan/sledding, inline skating, skateboarding, gymnastics, racquet sports, swimming, waterski/surfing, track and field, and combative sports. The excluded activities were nonpowder firearm, other skating, trampolines, scooters, bicycles, mopeds, go-carts, all-terrain vehicles, horseback activities, bowling, golf, miscellaneous ball games, exercise, amusement attractions, playground activities, personal watercraft, snowmobiles, fishing, camping activities, billiards, and others. It can be argued that fractures and dislocations can and do occur in these excluded activities; however, it was a calculated decision by the investigators that these activities, many of which are recreational, are not standard sporting activities for the common person in the United States (eg, fishing, billiards, all-terrain vehicles, trampolines, amusement attractions) or the designation was so nebulous as to not be discernable (eg, other skating, playground activities, other activities).

Race was classified according to Eveleth and Tanner[25] as white, black, Amerindian (Hispanic and Native American), Asian, Indo-Mediterranean (Middle Eastern and Indian subcontinent), and Polynesian. Because of the small numbers of Polynesian and Indo-Mediterranean peoples in the data set, race/ethnicity is only reported for the white, black, Amerindian, and Asian groups when racial analyses were performed.

### Statistical Analysis

Because of the stratified and weighted nature of the NEISS data set, statistical analyses were performed using SUDAAN 11.0.01 software (RTI International, 2013). This software accounts for the weighted and stratified nature of the data and calculates an estimated value and 95% confidence limits [lower, upper] across the population encompassed by the data set. Throughout this study, we denote the actual number of NEISS patients as "n" and the estimated number as "N." Analyses between groups of continuous data were performed using the *t* test (2 groups) or analysis of variance (3 or more groups). Differences between groups of discrete data were analyzed by the $\chi^2$ test. A *P* value less than 0.05 was considered statistically significant. The incidence of ED visits per year for fractures and dislocations was calculated using population data from the US Census Bureau for each year, 2005 through 2013 (https://www.census.gov/data/tables/time-series/demo/popest/intercensal-2000-2010-national.html; https://www.census.gov/programs-surveys/popest/technical-documentation/methodology.html). In this study, incidence means the estimated number of ED visits for sports-related injuries per year per 1000 people. Multivariate logistic regression analysis was used to determine the odds ratios (ORs) and 95% CI, with appropriate *P* values, for the occurrence of a fracture or dislocation. The variables entered into the logistic regression analyses were sporting activity, age group, sex, and race. The reference group was the sporting activity having the lowest odds of sustaining a fracture or dislocation.

## RESULTS

There were an actual 367,300 sports- and recreation-related ED visits over the 9-year period, for an estimated 20,241,049 ED visits nationwide, resulting in an annual estimated ED visit

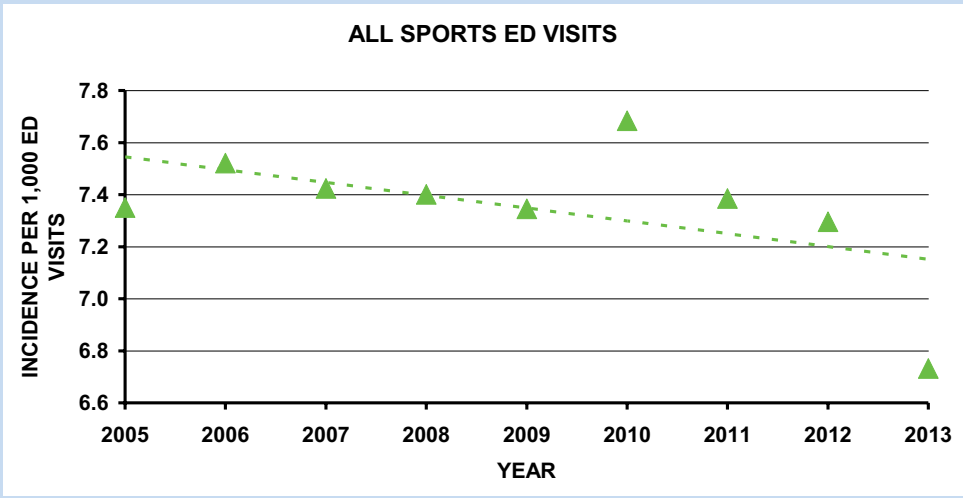


Figure 1. Annual incidence of sports- and recreation-related emergency department (ED) visits. The estimated incidence values are shown as solid triangles, and the best fit by the hatched line. This fit was not significant ($r^2 = 0.27$; $P = 0.15$), indicating no change in incidence over time.

incidence of 7.35 per 1000 people. There was no change in incidence over time (Figure 1). Fractures and dislocations accounted for 78,640 and 12,462 of the actual 367,300 ED visits, respectively, or an estimated 4,159,764 fractures and 731,866 dislocation ED visits (fractures, 20.6%; dislocations, 3.6%). This results in an annual ED visit incidence of 1.51 for fractures and 0.27 for dislocations per 1000 people.

### Fractures

The greatest number of fractures occurred in football (22.5%) and males (Table 1). The majority occurred in the patients' second decade of life and occurred in the autumn and summer (see Appendix 1, available in the online version of this article). The annual incidence decreased from 2005 to 2013 (Figure 2). The majority of fractures occurred in the arm/hand (55.9%; N = 2,326,129). Detailed anatomic fracture locations for all activities are seen in Figure 3 and Appendix 2 (available online). The majority of fractures occurred at school or sporting venues. The odds of sustaining a fracture was higher in males compared with females (OR, 1.21 [95% CI, 1.14-1.27]), with bimodal peaks at 10 to 14 and >84 years. Inline skating had the greatest odds of a fracture (OR, 6.03 [95% CI, 5.1-7.13]), with swimming having the lowest odds of a fracture (reference value) (Table 2).

### Joint Dislocations

The greatest number of dislocations occurred in basketball and males (Table 1). The majority occurred in the patients' second and third decades of life. The majority of dislocations occurred in the autumn and on weekends (Appendix 1). There was no change in annual incidence from 2005 to 2013 (Figure 2). Detailed anatomic dislocations for all activities are seen in Figure 3 and Appendix 3 (available online). The majority of dislocations occurred at school or sporting venues. The odds of sustaining a dislocation was higher in males compared with females (OR, 1.50 [95% CI, 1.38-1.62]), and in the third and fourth decades of life (Table 3). Gymnastics had the greatest odds of a dislocation (OR, 4.08 [95% CI, 2.55-6.54]) with toboggan/sledding having the lowest odds of a dislocation (reference value) (Table 3).

## DISCUSSION

While previous studies have examined injury patterns related to sports, most of the available literature on the epidemiology of sports- and recreation-related injuries generally focuses on the organized sports population (ie, youth, high school, collegiate athletes). This study, by contrast, uses a large data set studying fractures and dislocations in detail for both organized and nonorganized situations across multiple activities, all ages, both sexes, and all racial groups. There were several major findings. A fracture occurred in 20.6% and a joint dislocation in 3.6% of the ED visits for sports-related injuries. The most common fracture involved the finger, and the activities with the 3 highest odds for a fracture were inline skating (OR, 6.03), skateboarding (OR, 3.93), and tobogganing/sledding (OR, 3.19), with swimming the lowest (1.0 Reference). Males had higher odds of a fracture compared with females (OR, 1.21). Although most of the dislocations occurred in basketball (25.7%), the activities with the 3 highest odds for dislocation were gymnastics (OR, 4.08), snow skiing (OR, 3.46), and football (OR, 3.09), with tobogganing/sledding the lowest (1.0 Reference) The most common dislocation involved the shoulder.

### Fractures

The 20.6% fracture rate in sports- and recreation-related injuries using the NEISS AIP data over the 9-year period was higher

Table 1. Fractures and dislocations sustained in 18 sports and recreational activities from the NEISS-AIP database, 2005-2013[a]

| Sports | Fractures | | | Dislocations | | |
|---|---|---|---|---|---|---|
| | n | N | %N | n | N | %N |
| Inline skating | 1306 | 70,430 | 1.7 | 44 | 3285 | 0.4 |
| Ice skating | 1063 | 48,013 | 1.2 | 72 | 3598 | 0.5 |
| Skateboard | 5976 | 367,529 | 8.8 | 240 | 23,231 | 3.2 |
| Toboggan/sled | 1246 | 72,983 | 1.8 | 52 | 2977 | 0.4 |
| Gymnastics | 3558 | 175,341 | 4.2 | 773 | 41,569 | 5.7 |
| Basketball | 16,244 | 799,328 | 19.2 | 3454 | 187,786 | 25.7 |
| Baseball | 4937 | 279,664 | 6.7 | 592 | 39,077 | 5.3 |
| Softball | 2663 | 163,839 | 3.9 | 447 | 27,829 | 3.8 |
| Ice hockey | 1879 | 96,761 | 2.3 | 250 | 14,903 | 2.0 |
| Football | 19,491 | 935,183 | 22.5 | 3061 | 168,191 | 23.0 |
| Soccer | 8811 | 440,426 | 10.6 | 1046 | 55,963 | 7.6 |
| Racquet sports | 620 | 35,343 | 0.8 | 125 | 7653 | 1.0 |
| Volleyball | 1223 | 75,467 | 1.8 | 380 | 25,163 | 3.4 |
| Track/field | 607 | 29,512 | 0.7 | 66 | 4497 | 0.6 |
| Combative | 2956 | 171,927 | 4.1 | 681 | 41,323 | 5.6 |
| Swimming | 1596 | 94,049 | 2.3 | 430 | 29,347 | 4.0 |
| Waterski/surf | 426 | 35,813 | 0.9 | 117 | 11,874 | 1.6 |
| Snow skiing | 4038 | 268,156 | 6.4 | 531 | 43,600 | 6.0 |

NEISS-AIP, National Electronic Injury Surveillance System All Injury Program.
[a]n = actual NEISS number; N = estimated number; %N = percentage for the estimated number.

than that reported in many other studies.[20,36,51,59,68,69] This likely reflects our inclusion of all ages, especially older populations with the comorbidity of age-related osteopenia/osteoporosis. The odds of a fracture was lowest in those aged 0 to 4 years and became 2 times greater or more by age 55 years. This has not been previously described for sporting-related fractures, as most studies only address those of college age or younger. Few studies reported the anatomic location of fracture, with most in the upper extremity.[9,12,16,45,73]

Regarding specific sports, football contributed the greatest number of fractures, similar to previous studies.[6,19,36,68,69,72] Morbidity in many of these activities is likely higher due to greater novice participation, the inability to stop effectively, and no or improper use of protective equipment (ie, outdated equipment that does not fit or function properly).[13,18,21,56] They also share 3 major risk factors for injury: speed, obstacles, and hard surfaces.[13,56] Participants may engage in riskier behavior as they underestimate their susceptibility to and severity of injury and believe the risk of injury affect others more than themselves.[18,47]

Previous studies have calculated fracture rates for high school and collegiate athletes for multiple sports as a function of athletic exposures.[36,63,68,69] We can only report proportions of injuries that were fractures and ED visit incidence from the NEISS data, as exposure data are not available in the NEISS data.

Males were more likely to sustain fractures,[19,36,51,68,69] a potential consequence of biological, behavioral, and regulatory differences between sexes.[19,36] As early as 1 year of age, sex-related behavioral differences begin to show, at least in part, as a result of learned behavior. Actions are first adapted from parents and later reinforced by mass media and popular culture,

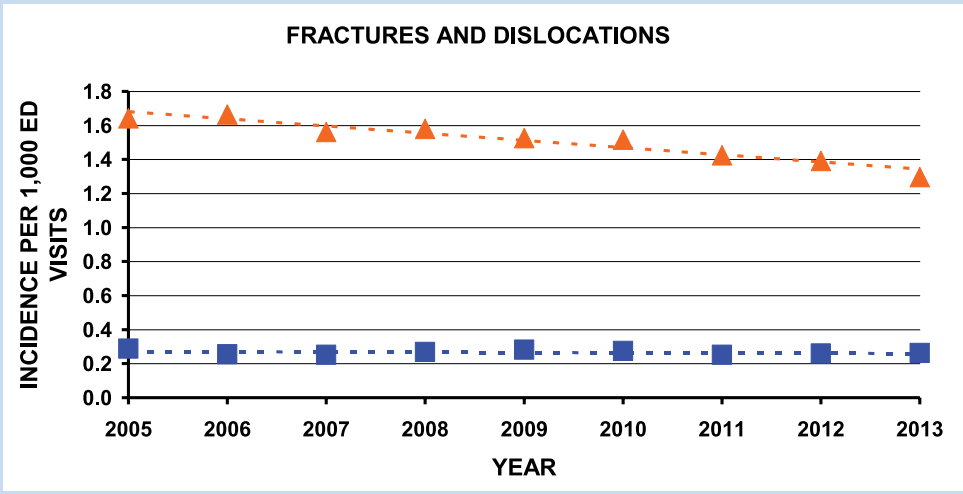


Figure 2. Annual fracture and dislocation emergency department (ED) visit incidence over time. There was a slight decrease in incidence over time for fractures (orange). The estimated incidence values are shown as solid orange triangles, and the best fit by the hatched orange line. This best fit line is represented by the equation: incidence = –86.31 – 0.042(year) ($r^2 = 0.93$; $P = 0.000034$). There was no change in incidence of dislocations (blue) over time. The estimated incidence values are shown as solid blue squares, and the best fit by the hatched blue line. This fit was not significant ($r^2 = 0.079$; $P = 0.47$).

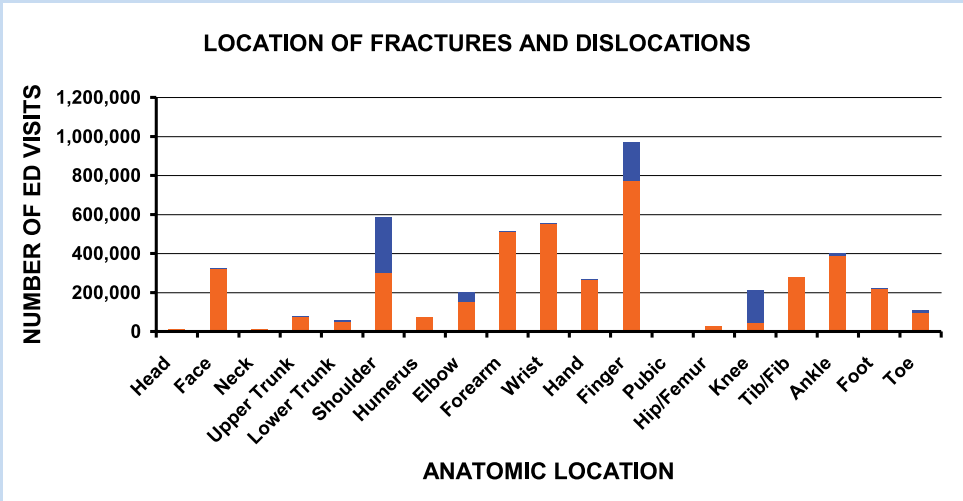


Figure 3. All sports- and recreation-related fractures (orange) and dislocations (blue) by detailed anatomic location. ED, emergency department.

school, and peer groups. Young boys have been observed to engage in more inventive and dangerous play than girls of the same age, who participate in more quiet, passive play. This correlates with the differences in injury type, as the more physically active, aggressive style of males render them more likely to sustain traumatic versus overuse injuries, opposite the injury trends in females.[36,51,60] Larger body masses lead to greater forces absorbed through soft tissues and joints while running, jumping, pivoting, and during contact, which may increase susceptibility to injury in males.[19,36] Sex-comparable sports differ in rules, regulations, and required protective equipment, likely altering injury risk exposure.[36,68]

The increased fracture risk in whites compared with blacks has been previously described in adults sustaining falls[24,55] and may be explained by known racial differences in bone mass and strength.[29] Cortical bone measurements (ie, bone mineral content, bone mineral density, periosteal and endosteal circumferences) are greater in blacks than whites during all stages of childhood and adolescence.[35,46,70] This may be partially mitigated by differences in weight and height between the

Table 2. Odds ratios (ORs) of sustaining a fracture by sport, sex, race, and age group using multivariate logistic regression analysis

| | OR | 95% CI | | *P* |
|---|---|---|---|---|
| | | Lower | Upper | |
| Sport | | | | |
| Inline skating | 6.03 | 5.1 | 7.13 | $<10^{-4}$ |
| Ice skating | 2.82 | 2.31 | 3.44 | $<10^{-4}$ |
| Skateboarding | 3.93 | 3.2 | 4.82 | $<10^{-4}$ |
| Toboggan/sled | 3.19 | 2.65 | 3.82 | $<10^{-4}$ |
| Gymnastics | 2.1 | 1.85 | 2.38 | $<10^{-4}$ |
| Basketball | 1.92 | 1.69 | 2.18 | $<10^{-4}$ |
| Baseball | 1.99 | 1.73 | 2.28 | $<10^{-4}$ |
| Softball | 2.03 | 1.75 | 2.36 | $<10^{-4}$ |
| Ice hockey | 1.67 | 1.41 | 1.98 | $<10^{-4}$ |
| Football | 2.48 | 2.18 | 2.83 | $<10^{-4}$ |
| Soccer | 2.66 | 2.19 | 3.23 | $<10^{-4}$ |
| Racquet sports | 1.42 | 1.21 | 1.67 | $<10^{-4}$ |
| Volleyball | 1.67 | 1.41 | 1.97 | $<10^{-4}$ |
| Track/field | 1.8 | 1.56 | 2.08 | $<10^{-4}$ |
| Combative | 2.54 | 2.18 | 2.96 | $<10^{-4}$ |
| Swimming | 1.0 Reference | — | — | — |
| Waterski/surf | 1.28 | 0.95 | 1.73 | 0.10 |
| Snow skiing | 4.5 | 3.85 | 5.25 | $<10^{-4}$ |
| Sex | | | | |
| Male | 1.21 | 1.14 | 1.27 | $<10^{-4}$ |
| Female | 1.0 Reference | — | — | — |
| Race | | | | |
| White | 1.25 | 1.13 | 1.39 | $<10^{-4}$ |
| Black | 1.0 Reference | — | — | — |
| Amerindian | 1.18 | 1.06 | 1.31 | 0.004 |
| Asian | 1.46 | 1.33 | 1.6 | $<10^{-4}$ |
| Age group, y | | | | |
| 0-4 | 1.0 Reference | — | — | — |
| 5-9 | 1.75 | 1.51 | 2.04 | $<10^{-4}$ |
| 10-14 | 2.13 | 1.83 | 2.47 | $<10^{-4}$ |

*(continued)*

Table 2. (continued)

| | OR | 95% CI | | P |
|---|---|---|---|---|
| | | Lower | Upper | |
| 15-19 | 1.29 | 1.11 | 1.5 | 0.0011 |
| 20-24 | 1.22 | 1.05 | 1.42 | 0.01 |
| 25-34 | 1.35 | 1.17 | 1.56 | 0.0001 |
| 35-44 | 1.51 | 1.3 | 1.75 | $<10^{-4}$ |
| 45-54 | 1.93 | 1.62 | 2.31 | $<10^{-4}$ |
| 55-64 | 2.19 | 1.78 | 2.69 | $<10^{-4}$ |
| 65-74 | 2.79 | 2.2 | 3.54 | $<10^{-4}$ |
| 75-84 | 3.22 | 2.25 | 4.61 | $<10^{-4}$ |
| 85+ | 4.77 | 3.24 | 7.04 | $<10^{-4}$ |

races,[33,35,44] although some data suggest that there are true genetic differences beyond those accounted for by anthropometric differences.[70] There may also be racial differences in bone and mineral metabolism.[23,29,57] Another possible explanation of the higher odds of fracture in whites could be access to care or bone mineralization differences due to socioeconomic status. The studies on fracture quoted prevoiusly[24,55] used hospital admissions to indicate a severe fracture. Such data are not likely due to differences in access to care because of the fact that a person sustaining a fracture necessitating hospitalization would nearly always seek care. It is possible that patients sustaining a minor fracture not needing hospital admission might be influenced by access to care and socioeconomic status, possibly skewing the results. However, bone mineralization in the United States is minimally associated with socioeconomic status compared with physical stature.[44] Thus, we believe that the racial differences seen in this study regarding fractures are valid conclusions.

These findings can guide injury reduction strategies. Using the data from Table 1 and Appendix 2 (available online), football, basketball, soccer, and skateboarding accounted for 61.1% of all fractures. Of these 2,542,466 fractures, 53.4% were in the forearm, wrist, hand, and finger, and prevalence was similar for skateboarding (52.2%), football (56.5%), basketball (54.7%), and soccer (45.3%). Prevention strategies focusing on the distal upper extremity are an important area and involve appropriate protective equipment.[7,11,15,27,28,66,71] These areas will need further research.

Apart from the large burden of fractures in these 4 activities, other areas of focus would be on those activities having the greatest odds of a fracture, such as inline skating (OR, 6.03) and snow skiing (OR, 4.5). Increasing education regarding protective equipment should be considered, which has been shown to be effective with inline skating.[66] Protective equipment minimizing upper extremity mobility for snow skiing would likely not be advantageous due to the quickness and need for motion in the upper extremity, although to our knowledge, no studies have been done on this topic. Protective equipment has been shown to be effective in reducing snowboarding injuries,[30,34,64]especially for the novice participant.[52]

## Dislocations

The majority of dislocations involved the shoulder (38.7%), finger (26.7%), and knee (23.0%) (Figure 3 and Appendix 3 [available online]). The dislocation rate of 3.6% for sports- and recreation-related injuries using the NEISS-AIP was lower than that reported in other studies.[19,20] Regarding specific activities, basketball (N = 187,786) and football (N = 168,191) contributed the greatest number of dislocations, unlike other studies where football was the leading cause followed by wrestling or hockey.[36,38] However, participants involved in gymnastics, volleyball, and snow skiing had the greatest odds of sustaining a dislocation.

Few studies have tracked overall sports- and recreation-related dislocations, as many report only specific joints.[5,22,36-39,43,48,61,62,74] Regarding knee dislocations, those in the NEISS-AIP database were most likely patellofemoral dislocations rather than femoral-tibial (knee) dislocations, which are much rarer than patellofemoral dislocations.[2,4,10,65] Femoral-tibial dislocations are usually associated with high-energy mechanisms (motor vehicle collisions, pedestrian struck, fall from height), although some have been reported in low-energy sports-related activities and spontaneous ambulatory injuries in the morbidly obese.[2,10,65]

Table 3. Odds ratios (ORs) of sustaining a joint dislocation by sport, sex, race, and age using multivariate logistic regression analysis

| | OR | 95% CI | | *P* |
|---|---|---|---|---|
| | | Lower | Upper | |
| Sport | | | | |
| Inline skating | 1.59 | 0.79 | 3.19 | 0.19 |
| Ice skating | 1.72 | 0.96 | 3.09 | 0.07 |
| Skateboarding | 1.39 | 0.82 | 2.35 | 0.21 |
| Toboggan/sled | 1.0 Reference | — | — | — |
| Gymnastics | 4.08 | 2.55 | 6.54 | $<10^{-4}$ |
| Basketball | 2.45 | 1.57 | 3.84 | 0.0002 |
| Baseball | 2.09 | 1.33 | 3.30 | 0.002 |
| Softball | 1.91 | 1.22 | 3.00 | 0.006 |
| Ice hockey | 1.49 | 0.86 | 2.60 | 0.15 |
| Football | 3.09 | 2.03 | 4.68 | $<10^{-4}$ |
| Soccer | 2.16 | 1.37 | 3.41 | 0.001 |
| Racquet sports | 2.11 | 1.30 | 3.45 | 0.003 |
| Volleyball | 3.68 | 2.20 | 6.15 | $<10^{-4}$ |
| Track/field | 2.17 | 1.33 | 3.54 | 0.002 |
| Combative | 2.98 | 1.92 | 4.63 | $<10^{-4}$ |
| Swimming | 2.59 | 1.60 | 4.17 | 0.0002 |
| Waterski/surf | 2.29 | 1.48 | 3.56 | 0.0004 |
| Snow skiing | 3.46 | 2.20 | 5.43 | $<10^{-4}$ |
| Sex | | | | |
| Male | 1.50 | 1.38 | 1.62 | $<10^{-4}$ |
| Female | 1.0 Reference | — | — | — |
| Race | | | | |
| White | 1.01 | 0.86 | 1.20 | 0.88 |
| Black | 1.0 Reference | — | — | — |
| Amerindian | 1.02 | 0.81 | 1.30 | 0.84 |
| Asian | 1.75 | 1.57 | 1.94 | $<10^{-4}$ |
| Age group, y | | | | |
| 0-4 | 4.21 | 3.29 | 5.38 | $<10^{-4}$ |
| 5-9 | 1.0 Reference | — | — | — |
| 10-14 | 2.51 | 2.04 | 3.08 | $<10^{-4}$ |

*(continued)*

Table 3. (continued)

| | OR | 95% CI | | P |
|---|---|---|---|---|
| | | Lower | Upper | |
| 15-19 | 6.26 | 5.24 | 7.48 | $<10^{-4}$ |
| 20-24 | 9.04 | 7.54 | 10.83 | $<10^{-4}$ |
| 25-34 | 9.03 | 7.49 | 10.88 | $<10^{-4}$ |
| 35-44 | 7.63 | 6.26 | 9.30 | $<10^{-4}$ |
| 45-54 | 7.28 | 5.63 | 9.40 | $<10^{-4}$ |
| 55-64 | 8.50 | 6.16 | 11.72 | $<10^{-4}$ |
| 65-74 | 4.55 | 3.13 | 6.62 | $<10^{-4}$ |
| 75-84 | 6.23 | 3.36 | 11.56 | $<10^{-4}$ |
| 85+ | 5.08 | 1.60 | 16.12 | 0.007 |

Patellar instability, however, is a frequent cause of knee complaints, especially in young athletic individuals. Instability represents 2% to 3% of all knee injuries and the second most common cause of traumatic knee hemarthrosis.[53,67] The majority of first-time patellofemoral dislocations occur as a result of sports-related activities (60%-72%)[3] with a recurrence rate of 15% to 71%.[31,49,53] They usually occur secondary to a noncontact twisting mechanism but may also be associated with a direct blow to the knee. They may be transient, with the patient unaware of the event.[26]

Males were more likely to sustain dislocations, similar to many other studies[5,36,38,39,48] yet not all.[20,62,74] Contact with another person has been reported as the most common mechanism of injury, especially for full-contact (ie, football, wrestling) and partial-contact (ie, soccer, basketball) sports.[38] This may be a consequence of the aforementioned biological, behavioral, and regulatory differences between sexes as discussed for fractures.[19,36]

As with fractures, these findings can guide injury reduction strategies. Appropriate sports-specific education can be given regarding falling or other events during sporting/recreational activities,[8] especially those having high likelihood of a dislocation (gymnastics, volleyball, snow skiing) or a high number of dislocations (football, basketball). Appropriate exercise programs for the shoulder and knee should be encouraged in all these high-risk activities.[14,17,50,54] Regarding finger dislocations, as with fractures, reduction in finger dislocations might be possible with a better understanding of how such dislocations occur with ball handling and development of appropriate player education to reduce such injuries. These areas will need further research.

### Limitations

Limitations of the NEISS database are many. Large data sets inherently possess some inaccuracy. NEISS data collection protocols have an 89% to 98% accuracy.[1,32] Another limitation is that the NEISS only captures those who sought care in the ED. The consequences of this are 2-fold: First, the overall number of injuries in this study underrepresent the true number, and second, patients sustaining significant injuries will likely seek immediate care in the ED, skewing the NEISS sample toward more severe injuries. This may explain the slight decrease in the ED fracture incidence over time. Furthermore, these data are descriptive and cannot be used to ascertain the reasons for the various injuries. It does not include information on risk/protective factors or mechanism of injury, limiting our understanding of any changes observed from 2005 to 2013. Finally, the uncommon event of a patient having both a fracture and a dislocation cannot be ascertained, as the NEISS data only contain 1 diagnosis. The NEISS coders are instructed to code the diagnosis by the most severe injury, which would likely be a fracture, but would be up to interpretation by each coder.

## CONCLUSION

The greatest burden of fractures from common sports and recreational activities involved football and basketball, while the activities with the highest odds of a fracture were in inline skating, skateboarding, and tobogganing/sledding, with swimming the lowest. The most common fracture was in the finger followed by the wrist and forearm. Thus, the best opportunity for prevention should be focused on the mechanisms of finger fractures in football/basketball and

appropriate external guards for the wrist and forearm. The greatest burden of dislocations involved basketball and football, while the activities with the highest odds of a dislocation were gymnastics, snow skiing, and football, with tobogganing/sledding the lowest. The most common joint dislocation was the shoulder followed by the finger and knee. The biggest room for prevention should again focus on the mechanisms of finger dislocations in football/basketball and appropriate rehabilitation/exercise programs for the shoulder and knee. Males have greater odds for both fractures and dislocations in these common sporting and recreational activities, but the above strategies should be equally promoted for both sexes and all races.

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