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**Original Article**

# Extremity Injuries during Sporting Activities According to Life Course: Focusing on Fractures

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**Abstract**

**Background:** The increased participation in sports has led to an increased number of sports-related injuries. We aimed to identify the incidence of sports-related injuries by life course and the risk factors for sports-related extremity fractures.

**Methods:** We analyzed data of patients with sports-related extremity injuries from Emergency Department-based national injury surveillance systems, obtained from Jan 2013 to Dec 2016. A multiple logistic regression analysis was performed to identify risk factors of extremity fracture by life course after adjusting for sex, injury season, injury time, injury place, sports type, and mechanism of injury.

**Results:** Overall, 23385 patients met our inclusion criteria. Soccer injuries were most common in the 5–14-year (32.4%), 15–24-year (43.0%), and 25–44-year groups (32.7%), and hiking injuries were most common in the 45–64-year (23.6%) and ≥65-year age groups (38.0%). The upper extremity injury and fracture rates were higher in the younger-age group; nevertheless, the injury and fracture rates of the lower extremities increased with increasing age. Moreover, the rate of hip and thigh injuries and fractures increased significantly in the ≥65-year age group.

**Conclusion:** The incidence and severity of sports injuries are affected by player factors and the sports activity itself. The age of players is a major determinant that affects their medical and physiologic conditions and the sport of choice. The strategy for preventing sports injuries should be structured based on age.

**Keywords:** Athletic injuries; Fractures; Bone; Extremities

## Introduction

Participation in recreational physical activity is widely promoted as part of a healthy lifestyle. Experts have reviewed the evidence on the protective effects of physical activity on rates of obesity, cardiovascular disease, colon cancer, diabetes, and musculoskeletal degeneration. Moreover, sports activity improved well-being, reduced stress, reduced distress, and increased social functioning and vitality (1). The percentage of the population engaging in leisure and sports activities is increasing worldwide (2). However, the increased participation in sports has led to an increased number of sports-related injuries, which are some of the most common injuries in modern Western societies (3). In particular, the occurrence of sports injuries among children and ado-

lescents reportedly accounted for approximately one-fifth of the total number of injured patients visiting Emergency Departments (EDs) (4).

Injuries to the lower and upper extremities are common in sports, accounting for approximately 50% of all injuries (5). Despite the high incidence rates, the significance of these injuries tends to be underestimated because they result in low rates of death or disability (6) compared to head, trunk, and spine injuries. However, extremity injuries limit the range of the performed physical and daily activities. These injuries cause pain in most cases, which negatively affects the physical and mental health of the patient (7), in addition to the burden caused by the resulting medical expenses. When the injury involves fracture or requires surgical operation, the patient may have to stop working temporarily. Ironically, health-promoting activities can result in overall poor health conditions.

Several previous epidemiologic studies related to sports injuries have focused on a specific age, sex, and professional athletes (8, 9). Others have focused on injuries to a specific organ or those caused by a specific sport (10-12), and the comprehensive research was not covered.

Therefore, the objective of this study was to identify the epidemiological characteristics of patients admitted to the ED because of overall sports-related extremity injuries. As sports activity is influenced by an individual's physical development and social activities, this study also examined the characteristics of extremity injuries and fracture risk factors in each age group based on life course (13).

## Materials and Methods

A descriptive epidemiological study was conducted using data of an emergency department (ED)-based national injury surveillance system from Jan 2013 to Dec 2016. This national database investigates and tracks data from 23 sentinel emergency centers and includes information on mechanisms of onset, sources and places of injury, and post-injury activities under the guidance of the Korean Centers for Disease Control and Prevention.

### *Study population*

The final diagnosis was identified according to International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10)-based diagnosis data. We included patients with injuries of the lower or upper extremity that occurred during leisure in this study. In cases of multiple diagnoses (two or more injuries to a single body region or multi-organ injuries), injury severity levels were used to define the main diagnosis. The participants were divided into five age groups according to their life course for analysis as follows: 5–14, 15–24, 25–44, 45–64, and ≥65 years. Children aged <5 yr were also excluded because of their immature physical and social development.

### *Variables*

We investigated the injury time, because the time of performing sports activities could differ according to age. The injury time was divided into four 6-h groups. The place of injury was divided into indoor vs. outdoor occurrences. The sports types were divided into team and individual. As sport activities depend on the season, we conducted an analysis using the seasons as variables. The season, in which the injury occurred was divided into four groups: spring (Mar–May), summer (Jun–Aug), autumn (Sep–Nov), and winter (Dec–Feb). The nature of the injury was divided into seven groups: fracture, dislocation, contusion, sprain or strain, superficial wound, deep wound, and others. Superficial wounds included abrasions and skin layer lacerations without muscle layer involvement. Deep wounds included injuries to the tendons, muscles, nerves, and other deep tissues. Injury mechanisms were classified as fall, overuse, contact with sport materials, contact with other players, and others. Overuse was defined as no contact injury outside the joint range of motion (14,15).

### Outcomes

The primary outcome was fracture of extremities during sporting activities according to life course. Additionally, we identified the demographic characteristics of extremity injuries because of sport activity.

### Statistical methods

Statistical analyses were conducted using SPSS ver. 25.0 (IBM Corp., Armonk, NY, USA). A *P*-value<0.05 was considered statistically significant. A descriptive analysis was performed to describe the characteristics of the injuries in each stage of life course. The Chi-squared or Fisher's exact test was used to evaluate the differences between the fracture and non-fracture groups. A multiple logistic regression analysis was performed to identify risk factors for extremity fracture adjusted by sex, injury season, injury time, injury place, sports type, and injury mechanism.

### Ethical statement

This study was approved by the Institutional Review Board at the Hallym University (Approval number: HDT 2018-07-005).

## Results

In total, 1,065,704 patients with injuries visited the ED over the 4-year period. Among those, 49,075 had sports injuries and 23,285 met the inclusion criteria of the present study, which accounted for 48.80% of the total patients with injury. According to age grouping, 5593, 6207, 7525, 3570, and 663 patients were included in the 5–14-, 15–24-, 25–44-, 45–64-, and ≥65-year groups, respectively (Fig. 1).

Table 1 shows the general characteristics of patients with extremity injuries by life course. The rate of male injury was high at all groups, except for those aged ≥65 years.

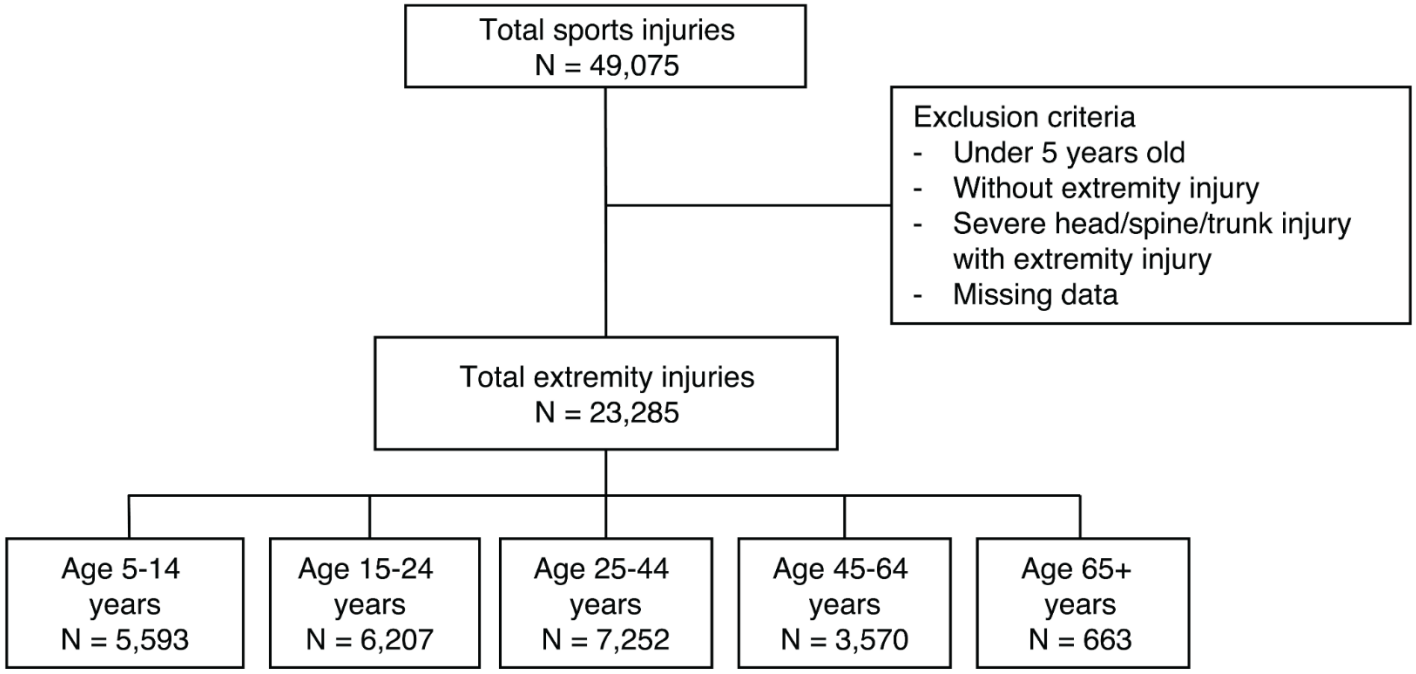


**Fig. 1:** Life course distribution of patients with sports-related extremity injuries.

**Table 1:** General characteristics of patients with extremity injuries by age group

| *Variable* | | *Age group (yr)* | | | | | *Total* |
|---|---|---|---|---|---|---|---|
| | | 5-14 N=5,593 | 15-24 N=6,207 | 25-44 N=7,252 | 45-64 N=3,570 | 65+ N=663 | N=23,285 |
| Sex, n (%) | Male | 4,498 (80.4) | 5,319 (85.7) | 6,223 (85.8) | 2,508 (70.3) | 322 (48.6) | 18,870 (81.0) |
| Injury time, n (%) | 00:00-06:00 | 221 (4.0) | 343 (5.6) | 520 (7.2) | 187 (5.3) | 30 (4.5) | 1,301 (5.6) |
| | 06:00-12:00 | 811 (14.6) | 990 (16.0) | 1,494 (20.7) | 839 (23.6) | 236 (35.8) | 4,370 (18.8) |
| | 12:00-18:00 | 2,793 (50.1) | 2,635 (42.6) | 2,747 (38.0) | 1,733 (48.8) | 313 (47.4) | 10,221 (44.1) |
| | 18:00-24:00 | 1,748 (31.4) | 2,212 (35.8) | 2,470 (34.2) | 792 (22.3) | 81 (12.3) | 7,303 (31.5) |
| Seasons, n (%) | Spring | 1,668 (29.8) | 2,102 (33.9) | 2,002 (27.6) | 955 (26.8) | 163 (24.6) | 6,890 (29.6) |
| | Summer | 1,400 (25.0) | 1,463 (23.6) | 1,880 (25.9) | 915 (25.6) | 147 (22.2) | 5,805 (24.9) |
| | Autumn | 1,485 (26.6) | 1,640 (26.4) | 1,851 (25.5) | 973 (27.3) | 195 (29.4) | 6,144 (26.4) |
| | Winter | 1,040 (18.6) | 1,002 (16.1) | 1,519 (20.9) | 727 (20.4) | 158 (23.8) | 4,446 (19.1) |
| Place of injury | Outside | 3,928 (70.5) | 4,876 (78.8) | 5,989 (82.7) | 2,946 (82.9) | 479 (72.6) | 18,218 (78.5) |
| Sport type, n (%) | Soccer | 1,814 (32.4) | 2,667 (43.0) | 2,375 (32.7) | 676 (18.9) | 18 (2.7) | 7,550 (32.4) |
| | Basketball | 693 (12.4) | 1,141 (18.4) | 715 (9.9) | 39 (1.1) | 2 (0.3) | 2,590 (11.1) |
| | Baseball | 179 (3.2) | 157 (2.5) | 793 (10.9) | 114 (3.2) | 1 (0.2) | 1,244 (5.3) |
| | Other ball sports | 287 (5.1) | 306 (4.9) | 310 (4.3) | 311 (8.7) | 6 (0.9) | 1,220 (5.2) |
| | Hiking | 29 (0.5) | 38 (0.6) | 239 (3.3) | 841 (23.6) | 252 (38.0) | 1,399 (6.0) |
| | Combat sports | 870 (15.6) | 408 (6.6) | 193 (2.7) | 22 (0.6) | 2 (0.3) | 1,495 (6.4) |
| | Snow sports | 452 (8.1) | 345 (5.6) | 740 (10.2) | 163 (4.6) | 13 (2.0) | 1,713 (7.4) |
| | Stick/racket sports | 108 (1.9) | 198 (3.2) | 402 (5.5) | 368 (10.3) | 44 (6.6) | 1,120 (4.8) |
| | Fitness/running | 308 (5.5) | 429 (6.9) | 657 (9.1) | 391 (11.0) | 185 (27.9) | 1,970 (8.5) |
| | Others | 853 (15.3) | 518 (8.3) | 828 (11.4) | 645 (18.1) | 140 (21.1) | 2,984 (12.8) |
| Injury mechanism, n (%) | Fall | 2,245 (40.1) | 1,838 (29.6) | 2,224 (30.7) | 1,472 (41.2) | 410 (61.8) | 8,189 (35.2) |
| | Overuse | 1.071 (19.1) | 2.155 (34.7) | 2.883 (39.8) | 1.249 (35.0) | 112 (16.9) | 7,470 (32.1) |
| | Contact with sport materials | 1,517 (27.1) | 1,156 (18.6) | 1,195 (16.5) | 450 (12.6) | 72 (10.9) | 4,390 (18.9) |
| | Contact with other players | 628 (11.2) | 935 (15.1) | 697 (9.6) | 165 (4.6) | 19 (2.9) | 2,444 (10.5) |
| | Others | 132 (2.4) | 123 (2.0) | 253 (3.5) | 234 (6.6) | 50 (7.5) | 792 (3.4) |
| Injury site, n (%) | Shoulder and upper arm | 686 (12.3) | 793 (12.8) | 986 (13.6) | 526 (14.7) | 82 (12.4) | 3,073 (13.2) |
| | Elbow and forearm | 1,070 (19.1) | 598 (9.6) | 681 (9.4) | 492 (13.8) | 127 (19.2) | 2,968 (12.7) |
| | Wrist and hand | 1,384 (24.7) | 1,196 (19.3) | 1,146 (15.8) | 433 (12.1) | 81 (12.2) | 4,240 (18.2) |
| | Hip and thigh | 200 (3.6) | 224 (3.6) | 269 (3.7) | 204 (5.7) | 128 (19.3) | 1,025 (4.4) |
| | Knee and lower leg | 988 (17.7) | 1,492 (24.0) | 2,512 (34.6) | 1,456 (40.8) | 191 (28.8) | 6,639 (28.5) |
| | Ankle and foot | 1,265 (22.6) | 1,904 (30.7) | 1,658 (22.9) | 459 (12.9) | 54 (8.1) | 5,340 (22.9) |
| Injury nature, n (%) | Fracture | 2,536 (45.3) | 1,840 (29.6) | 2,045 (28.2) | 1,420 (39.8) | 384 (57.9) | 8,225 (35.3) |
| | Dislocation | 84 (1.5) | 436 (7.0) | 455 (6.3) | 135 (3.8) | 13 (2.0) | 1,123 (4.8) |
| | Contusion | 1,381 (24.7) | 1,501 (24.2) | 1,567 (21.6) | 629 (17.6) | 107 (16.1) | 5,185 (22.3) |
| | Sprain or strain | 1,078 (19.3) | 1,917 (30.9) | 1,796 (24.8) | 644 (18.0) | 75 (11.3) | 5,510 (23.7) |
| | Superficial wound | 415 (7.4) | 315 (5.1) | 487 (6.7) | 277 (7.8) | 60 (9.0) | 1,554 (6.7) |
| | Deep Wound | 37 (0.7) | 102 (1.7) | 737 (10.2) | 387 (10.8) | 15 (2.3) | 1,278 (5.5) |
| | Others | 62 (1.1) | 96 (1.5) | 165 (2.3) | 78 (2.2) | 9 (1.4) | 410 (1.8) |
| Disposition, n (%) | Discharge | 4,869 (87.1) | 5,389 (86.8) | 5,935 (81.8) | ,.642 (74.0) | 432 (65.2) | 19,267 (82.7) |
| | Admitted to general ward | 608 (10.9) | 601 (9.7) | 933 (12.9) | 707 (19.8) | 186 (28.1) | 3,035 (13.0) |
| | Admitted to intensive care unit | 0 (0.0) | 0 (0.0) | 3 (0.0) | 6 (0.2) | 2 (0.3) | 11 (0.0) |
| | Others | 116 (2.1) | 217 (3.5) | 381 (5.3) | 215 (6.0) | 43 (6.5) | 972 (4.2) |

In the multivariate analysis adjusted for sex, time and season of injury, place of injury, sports type, and injury mechanism, the primary risk factor for fracture was male and female sex among patients aged ≤44 and ≥45 yr, respectively. The fracture risk was higher during winter than during spring

in all age groups, and no significant difference was observed in other seasons. In the 5–14-year age group, the risk of fracture was high for injuries that occurred during the 6–12-h period. However, there was no association between fracture risk and timing of injury in the other age groups. No difference in place of injury was observed in the 5–14-year age group; however, the fracture risk was higher during outdoor activities. In those aged ≤25 yr, the incidence of fracture injuries was significantly high; however, there were no significant differences in those aged >25 years. Moreover, falling was most common mechanism of injury in all age groups, showing a clinical correlation between fall-induced fracture risk and increasing age (Table 2).

**Table 2:** Multivariate analysis of sports-related extremity fracture by age group

| *Variable* | *Age 5-14 years N=5,593* | | *Age 15-24 years N=6,207* | | *Age 24-44 years N=7,252* | | *Age 45-64 years N=3,570* | | *Age 65+ years N=663* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of fractures (%) | aOR (95% CI) | No. of fractures (%) | aOR (95% CI) | No. of fractures (%) | aOR (95% CI) | No. of fractures (%) | aOR (95% CI) | No. of fractures (%) | aOR (95% CI) |
| Sex | | | | | | | | | | |
| Male | 2,060 (45.8) | 1.19 (1.02-1.38) | 1,614 (30.3) | 1.38 (1.16-1.66) | 1,754 (28.2) | 1.25 (1.05-1.48) | 857 (34.2) | 0.54 (0.45-0.64) | 167 (51.9) | 0.49 (0.34-0.72) |
| Season | | | | | | | | | | |
| Spring | 712 (42.7) | 1 | 582 (27.7) | 1 | 454 (22.7) | 1 | 372 (39.0) | 1 | 90 (55.2) | 1 |
| Summer | 596 (42.6) | 1.03 (0.89-1.20) | 400 (27.3) | 0.99 (0.85-1.16) | 510 (27.1) | 1.24 (1.06-1.44) | 324 (35.4) | 0.87 (0.71-1.08) | 77 (52.4) | 0.94 (0.56-1.57) |
| Autumn | 717 (48.3) | 1.30 (1.12-1.51) | 455 (27.7) | 1.05 (0.90-1.22) | 481 (26.0) | 1.17 (1.01-1.37) | 373 (38.3) | 0.93 (0.76-1.14) | 105 (53.8) | 1.02 (0.63-1.65) |
| Winter | 511 (49.1) | 1.17 (0.99-1.39) | 403 (40.2) | 1.51 (1.27-1.80) | 600 (39.5) | 1.65 (1.40-1.94) | 351 (48.3) | 1.09 (0.87-1.37) | 112 (70.9) | 2.02 (1.19-3.45) |
| Time | | | | | | | | | | |
| 00:00-06:00 | 78 (35.3) | 1 | 117 (34.1) | 1 | 167 (32.1) | 1 | 64 (34.2) | 1 | 12 (40.0) | 1 |
| 06:00-12:00 | 441 (54.4) | 2.19 (1.58-3.04) | 323 (32.6) | 1.13 (0.86-1.49) | 461 (30.9) | 1.19 (0.94-1.50) | 360 (42.9) | 1.20 (0.83-1.74) | 145 (61.4) | 1.88 (0.77-4.59) |
| 12:00-18:00 | 1,297 (46.4) | 1.53 (1.13-2.07) | 835 (31.7) | 1.06 (0.83-1.37) | 789 (28.7) | 1.05 (0.84-1.30) | 742 (42.8) | 1.24 (0.87-1.77) | 197 (62.9) | 2.12 (0.88-5.11) |
| 18:00-24:00 | 713 (40.8) | 1.28(0.94-1.74) | 557 (25.2) | 0.80 (0.62-1.04) | 623 (25.2) | 0.96 (0.77-1.20) | 248 (31.3) | 0.96 (0.66-1.40) | 28 (34.6) | 0.78 (0.29-2.09) |
| Place | | | | | | | | | | |
| Outdoor | 1,791 (45.6) | 1.00 (0.87-1.15) | 1,504 (30.8) | 1.24 (1.05-1.47) | 1,804 (30.1) | 1.40 (1.18-1.66) | 1,251 (42.5) | 1.55 (1.24-1.95) | 293 (61.2) | 1.49 (0.97-2.30) |
| Sports | | | | | | | | | | |
| Team | 1,262 (42.0) | 0.82 (0.71-0.94) | 1,240 (28.6) | 0.78 (0.66-0.91) | 1,084 (25.7) | 0.91 (0.79-1.05) | 364 (31.9) | 0.89 (0.73-1.08) | 16 (50) | 1.08 (0.46-2.55) |
| Injury mechanism | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| training load error | 315 (29.4) | 1 | | 335 (15.5) | 1 | 411 (14.3) | 1 | 214 (17.1) | 1 | 28 (25.0) | 1 |
| Fall | 1,382 (61.6) | 3.70 (3.15-4.35) | | 814 (44.3) | 3.98 (3.41-4.63) | 1,066 (47.9) | 4.96 (4.31-5.69) | 896 (60.9) | 6.32 (5.24-7.61) | 302 (73.7) | 6.32 (5.24-7.61) |
| Contact with sport materials | 525 (34.6) | 1.31 (1.10-1.56) | | 395 (34.2) | 2.98 (2.51-3.53) | 292 (24.4) | 1.99 (1.68-2.36) | 112 (24.9) | 1.65 (1.26-2.15) | 17 (23.6) | 1.65 (1.26-2.15) |
| Contact with other players | 278 (44.3) | 1.92 (1.56-2.36) | | 265 (28.3) | 2.14 (1.78-2.58) | 170 (24.4) | 1.87 (1.52-2.29) | 69 (41.8) | 3.74 (2.62-5.33) | 10 (52.6) | 3.74 (2.62-5.33) |
| Others | 36 (27.3) | 0.89 (0.59-1.35) | | 31 (25.2) | 1.50 (0.98-2.33) | 106 (41.9) | 4.07 (3.06-5.43) | 129 (55.1) | 5.46 (3.98-7.48) | 27 (54.0) | 5.46 (3.98-7.48) |

*Adjusted for sex, injury season, injury time, injury place, sports type, and mechanism of injury
a OR, adjusted odds ratio; CI, confidence interval

In the 5–14-year age group, the fracture rate of shoulder and upper arm was the highest at 82.1%, but it decreased in later ages. Fracture rate of elbow and forearm was the highest in the ≥65-year age group (90.6%). The injury and fracture rates of the wrist and hand decreased with age. In contrast, the injury rate and fracture rate of hip and thigh increased in those older than 15–24 years. The knee and lower leg injury rates increased up to the 45–64-year group, and the fracture rate was highest in the ≥65-year group. The injury rate of ankle and foot decreased with age (Fig. 2).

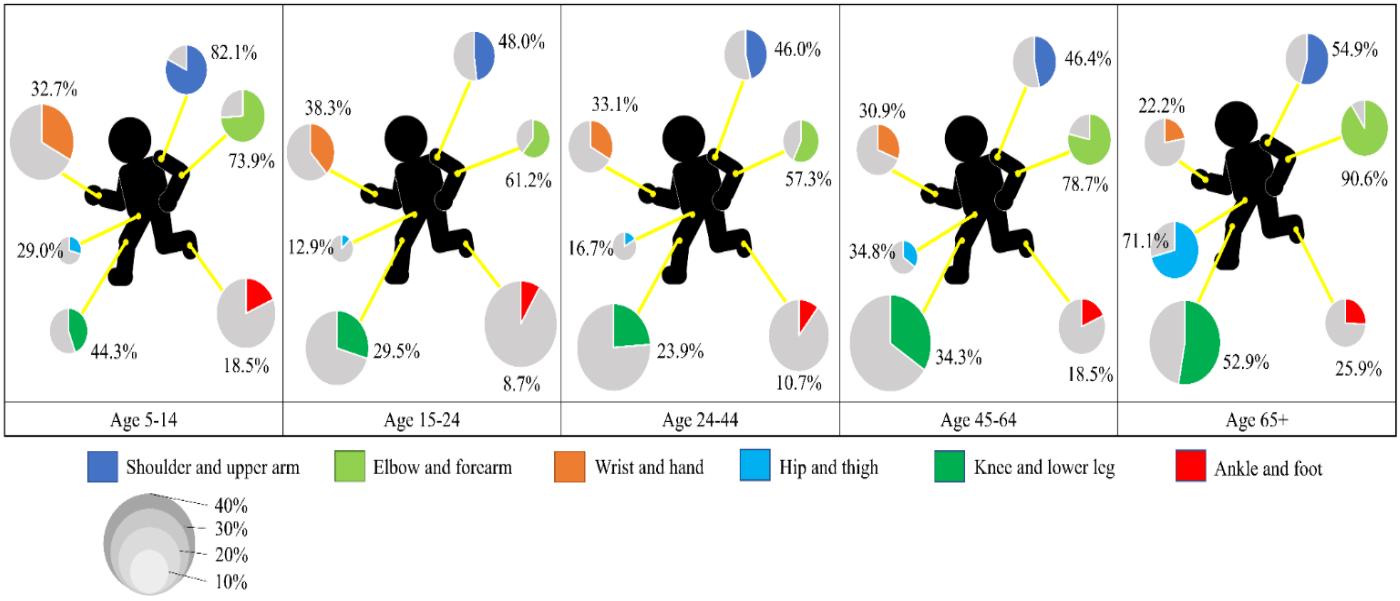


**Fig. 2:** Changes of injury rate and fracture rate by body part according to life course.
(The size of the circle reflects the proportion of the total injury that corresponds to the body part.)

## Discussion

In this study, we showed that with increasing age, the probability of fracture increased in female participants and in falls. By injury site, the rate of upper extremity injury was high in the younger-age group, but the rate of injury and fracture of the lower extremities increased with increasing age. Moreover, the rate of hip and thigh fractures increased significantly in the ≥65-year age group.

Growing participation in health-promoting physical activities has ironically led to an increase in sports injuries (16). Injury is caused by intrinsic factors, such as age, sex, body composition, health, physical fitness, anatomy, skill level, and psychological factors, and by external factors, such as sports factors, protective equipment, sports equipment, and environment (17). Age affects intrinsic and extrinsic factors. The former includes bone density, medical condition, technical skills, balance, coordination, and reaction time, while the latter includes sports type, role, and duration of activity (18). Therefore, we investigated the characteristics of sports injuries among patients admitted to the ED by grouping them according to the life course.

### *Sports-related extremity injuries by life course*

In the present study, the rate of sports-induced extremity injuries was 48.8%. Patients aged <15 yr showed higher rates of upper extremity fractures, as in previous studies (19,20). This is probably related to the skeletal immaturity of pediatric patients (21).

Male patients had more extremity injuries than female patients aged <65 yr, because men are more involved in sports. The rate of injuries in female individuals increased in the ≥65-year age group. Female individuals having more risk factors are more susceptible to sports injuries than male individuals (22). As a result of higher estrogen levels, female individuals have less muscle mass, more body fat, and inadequate calcium and vitamin D levels, thus, making them more prone to injuries (23).

The present study showed that soccer injuries were the most common. The types of sports activities are influenced by age and social environments. Basketball and football led to the most common sports-related injuries in the US and Australia, respectively (3,5). Soccer injuries were the most common in Europe, as in the present study (19,20). Hiking injuries were the most common in those aged ≥45 years. Geologically, mountains are easily accessible even in urban areas, and hiking trails are well-established, thereby making hiking a popular physical activity. Middle-aged and older adults tended to be less active with respect to initiating team sports play, which contributed to the popularity of individual sports in those age groups. In this study, combat sports were the most common injury-related activity (15.6%) in the 5–14-year age group. The long-standing popularity of taekwondo appears to be the main reason.

As previous studies were based on ED data (19), fracture was the most common nature of injury in all age groups except for the 15–24-year age group.

### *Extremity fracture at the age of 5–14 years*

According to the multivariate analysis, sports-related extremity fracture risk factors include male sex, 6–12-h time period as the timing of injury, and falls as the mechanism of injury in the 5–14-year age group. Several previous studies have also reported higher injury rates for boys. However, some studies on athletes' sports injuries reported that the severity of injuries was higher in girls (24).

### *Extremity fracture at the ages of 15–24 and 25–44 years*

The risk factors were similar in the 25–44-year and 15–24-year age groups. Fracture risk factors included male sex, winter season, outdoors, and falls as the injury mechanism. The risk for extremity fracture was significantly higher among male individuals (21). This finding is attributable

to greater participation in football and basketball, which commonly involve aggressive physical contact, skipping a warm-up, lack of safety gear, and playing sports in an unsuitable place. In winter, the incidence of fracture was 1.5 times higher than that in spring, probably because of the high fracture risk associated with snow sports. Because of icy and slippery surfaces, the risk of falling, as the mechanism of injury, increases with outdoor sports activities during the winter (25).
Regarding the detail of fracture sites, varying study results have been reported. The fracture rates in the elbow and forearm were significantly higher in the 15–24 and 25–44-year age groups, in line with another results (26).

### *Extremity fracture at the ages of 45-64 and 65+ years*

Regarding fracture injuries, those aged ≥45 yr showed different patterns compared to those of the younger age groups. The fracture risk steeply increased among risk factors including female sex and fall injury mechanisms. In those aged <45 yr, male sex was one of the fracture risk factors. However, female individuals had 1.85- and 2.04-times higher risks of fracture compared to female individuals in the 45–64- and ≥65-yr age groups, respectively. These findings were consistent with the results of existing studies. In particular, the fracture risk further increases in postmenopausal female individuals (27). Osteoporotic changes can result in severe injuries in response to external forces of the same magnitude. Falls, as a mechanism of injury, increased the risk of fracture in patients of advancing age in this study. Similar to other age groups, the fracture risk in the elbow and forearm was higher among the injury sites. However, the risk of hip and thigh fracture was higher in the ≥65-years age group.
This study had several limitations. First, a major limitation was its retrospective design. The factors of individuals' skill level, psychological factors, weather, and opponents' behaviors that have effects on sports-related injuries could not be reflected. Second, the magnitude of injuries was not identified. This study was initiated to develop strategies for preventing sports injuries, we examined patients who were already injured. Therefore, we could not identify community population- or participant-based incidences. Finally, it is possible that the severity of injuries might have been overestimated because of measurements during ED visits. As injured patients often seek medical care at local outpatient clinics when their pain is not severe and there is no motion restriction, the number of patients with fractures presenting to the ED may become skewed.

## Conclusion

Sports activity is influenced by age and by social and cultural aspects. In addition, medical and physiologic changes according to age affect the site of injury and the risk of fracture. The strategy and policy aimed at preventing sports injuries must be established for each age group by country. To more accurately identify the magnitude and the cause of the sport injury, we suggest adding variables for risk factors and prospective registration.

## Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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## Conflict of interest

The authors declare that there is no conflict of interests.

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