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Age, gender, and etiology differences of sports-related fractures in children and adolescents

A retrospective observational study

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Abstract

To investigate the age, gender, and etiology differences of sports-related fractures in children and adolescents (6–18 years old).

We retrospectively reviewed 410 child and adolescent patients (335 males and 75 females aged 13.5 ± 3.1 years old) with sports-related fractures admitted to our university-affiliated hospitals from 2001 to 2010. The incidence and pattern were summarized with respect to different age groups, genders, etiologies.

Playing basketball (97, 23.7%) and running (90, 22.0%) were the most common etiologies. Radius (102, 24.9%) was the most common fracture site. The most common etiologies and fracture sites were biking (19.6%) and humerus fractures (28.0%) in the ≤12 age range group, playing basketball (34.0%) and radius fractures (26.2%) in the 12–15 age range group, playing basketball (31.7%) and radius fractures (23.0%) in the 15–18 age range group. The most common etiologies were playing basketball (27.5%) in the male group and running (24.0%) in the female group. The male presented with significantly higher rate of radius fractures and nerve injury, significantly lower rate of femoral fractures than the female. The most common fracture sites were radius fractures in the basketball group (28.9%) and cricket group (37.5%), humerus fracture in the running group (20.0%), biking group (23.3%), and climbing group (45.0%), tibia fractures in the football group (28.9%) and playing SP bars group (50.0%), and ulna fractures (37.5%) in the ice skating group.

Sports-related fractures are common in children and adolescents, particularly in males. Basketball, running, and biking were the most common etiologies; radius, ulna, and humerus were the most common fracture sites.

Abbreviations: CFF = craniofacial fracture, CT = computed tomography, LEF = lower extremity fracture, MRI = magnetic resonance imaging, NI = nerve injury, SF = spine fracture, SP = single parallel, UEF = upper extremity fracture.

Keywords: adolescent, child, fracture, sports, traumatic

1. Introduction

Fractures are common among all types of pediatric injuries and comprise 10% to 25%.[1,2] The patterns of fractures vary between countries and even regions within a country, depending on the local climate, culture, and leisure-time activities.[3,4] We have previously analyzed the epidemiology of traumatic fractures in children and adolescents caused by falls[5] and motor vehicle collisions[6]; the incidence and pattern has its own characteristics with respect to different age groups, etiologies, and genders. Sporting activities are the third most common cause of fractures and they were the main causes of fracture-related hospitalizations and presentations to emergency departments among children.[7–17]

Editor: Stuart Polisner.

HW, HL, and JW contributed equally to this work.

Conflicts of interest and source of funding: All listed authors have made substantial contributions to the manuscript and do not have any conflicts of interest. This work was supported by the Foundation of the Liaoning Province Doctor Startup Fund (201601389), the State Key Laboratory of Robotics (2017-O01), the Open Project Program of the State Key Lab of CAD&CG (A1718), the Open Project Program of the State Key Laboratory of Trauma, Burn and Combined Injury (SKLKF201705), and the State Key Laboratory of Materials Processing and Die & Mould Technology (P2018-011).

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Medicine (2019) 98:4(e13961)

Received: 17 September 2018 / Received in final form: 10 November 2018 / Accepted: 10 December 2018

http://dx.doi.org/10.1097/MD.0000000000013961

Although fractures due to sports account for a small proportion of injuries among children, many of them are preventable by modifying the environment and strengthening the education. Further research may help to identify preventive measures to reduce the number of fractures, in particular those involving sports in China. In the present study, we reviewed a multicenter (two tertiary hospitals in Chongqing, China) database of sports-related fractures in a population of children and teenagers ≤ 18 years of age that happened over a 10-year period between 2001 and 2010. The incidence and pattern were summarized with respect to different age groups, gender, and etiologies.

2. Materials and methods

2.1. Study population

Our study included 410 child and adolescent patients (≤18 years old) with sports-related traumatic fractures between January 2001 and December 2010 and who were admitted to our university-affiliated hospitals. We made a definite diagnosis of traumatic fractures in child and adolescent patients (≤18 years old) using X-rays, computed tomography (CT), and magnetic resonance imaging (MRI). The sports (etiologies) including playing basketball, running, biking, playing football, playing single parallel bars (SP bars), climbing, cricket, ice skating, rollerblading, long jumping, playing table tennis, and others. The fracture regions include upper extremity fracture (UEF), lower extremity fracture (LEF), craniofacial fracture (CFF) and spine fracture (SF). There were 6 children presented with multiple fractures from two fracture regions and 1 child presented with multiple fractures from three fracture regions. The study protocol and this manuscript were approved by the committee on ethics and the institutional review board of our institution.

2.2. Statistical analysis

All statistical analyses were performed using SPSS version 22.0 (SPSS, Inc., Chicago, IL). We used Pearson chi-square tests to assess differences in frequency and independent samples t-tests to assess differences in the continuous variables.

3. Results

3.1. Demographic features and general characteristics

The study included 335 males and 75 female patients with a mean age of 13.5 ± 3.1 years old and a sex ratio of 4.5. The most common etiologies and fracture sites were playing basketball (23.7%) and radius fractures (24.9%). The most common fracture regions were UEF (59.0%) and LEF (33.4%). A total of 35 (8.5%) patients suffered a nerve injury. A total of 30 (7.3%) patients sustained complications (Fig. 1).

Playing SP bars and rollerblading presented with the highest frequency of UEF. Long jumping and ice skating presented with highest frequency of LEF (Fig. 2) Biking and climbing presented with highest frequency of CFF. Biking and Playing SP bars presented with highest frequency of nerve injury (NI) (Table 1). The incidences had a little seasonal variation and an obvious time and week variation, with peaks in summer (26.1%), 12:00–16:00 PM (33.8%), 16:00–20:00 PM (33.8%), and Friday (17.3%) (Fig. 3).

3.2. Characteristics respect to different age groups

The most common age group was ≤12 age range group (34.9% of all patients) and the patients in the age group had the smallest sex ratio of 2.4. The frequency of playing basketball in the ≤12 age range group presented with the lowest rate with 6.3%. Playing SP bars, climbing, and cricket in the ≤12 age range group presented with the highest rate of 10.5%, 9.8%, and 9.1%. Humerus fractures in the ≤12 age range group presented with the highest rate of 28.0%. Clavicle fracture in the 12–15 age range group presented with the highest rate of 10.6%.

The most common etiologies were biking (19.6%) and running (16.1%) in the ≤12 age range group, playing basketball (34.0%) and running (22.0%) in the 12–15 age range group, playing basketball (31.7%) and running (28.6%) in the 15–18 age range group. The most common fracture sites were humerus fractures (28.0%) in the ≤12 age range group, radius fractures (26.2%) and ulna fractures (19.9%) in the 12–15 age range group, and radius fracture (23.0%) and humerus fractures (17.5%) in the 15–18 age range group.

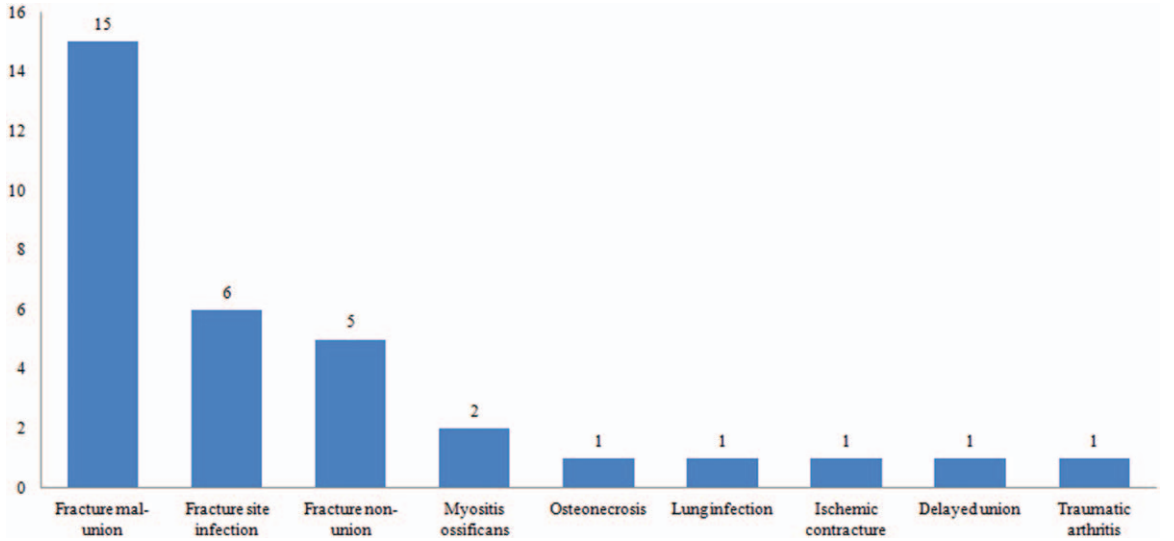

Figure 1. Complication distribution of all the fractures.

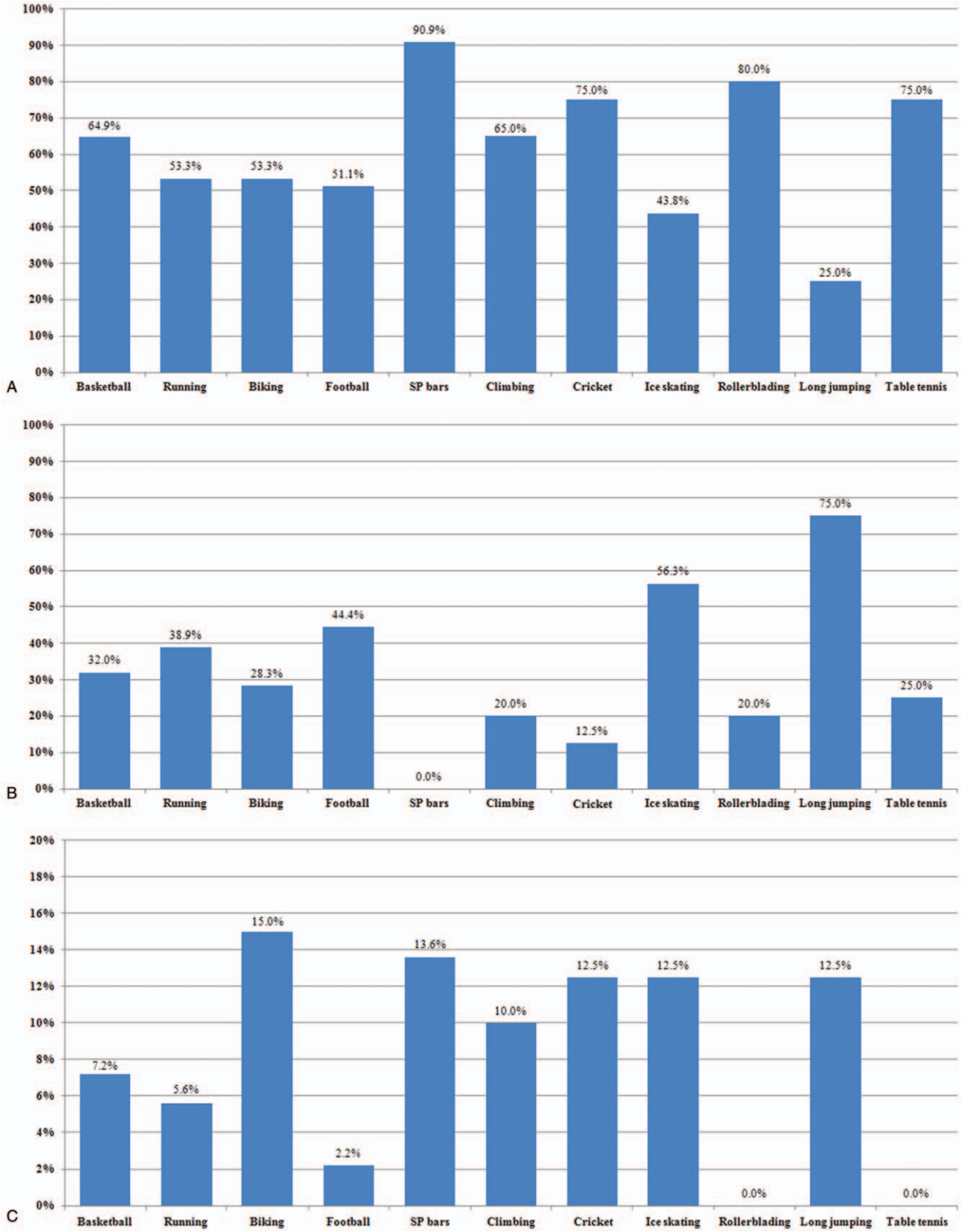

Figure 2. Frequencies of UEF (A), LEF (B), and NI (C) according to different etiologies.

Table 1

The epidemiology of sports associated with a fracture prevalence of ≥1%. The number and prevalence of each fracture are shown together with the average age, gender ratio, and ratio of different sites fractures. The common fractures associated with each sport are shown.

Sport	Number (%)	M/F (ratio)	Age	UEF (%)	LEF (%)	CFF (%)	SF (%)	NI (%)	Commonest fracture
Basketball	97 (23.7)	92/5 (18.4)	14.9±2.0	63 (64.9)	31 (32.0)	3 (3.1)	0	7 (7.2)	Radius 28.9%
Running	90 (22.0)	72/18 (4.0)	14.2±3.0	48 (53.3)	35 (38.9)	7 (7.8)	1 (1.1)	5 (5.6)	Humerus 20.0%
Biking	60 (14.6)	45/15 (3.0)	12.8±3.0	32 (53.3)	17 (28.3)	13 (21.7)	2 (3.3)	9 (15.0)	Humerus 23.3%
Football	45 (11.0)	44/1 (44.0)	14.7±2.4	23 (51.1)	20 (44.4)	2 (4.4)	0	1 (2.2)	Tibia 28.9%
SP bars	22 (5.4)	17/5 (3.4)	11.3±2.5	20 (90.9)	0	2 (9.1)	0	3 (13.6)	Radius 50.0%
Climbing	20 (4.9)	15/5 (3.0)	11.1±3.4	13 (65.0)	4 (20.0)	3 (15.0)	1 (5.0)	2 (10.0)	Humerus 45.0%
Cricket	16 (3.9)	13/3 (4.3)	10.3±2.9	12 (75.0)	2 (12.5)	1 (6.3)	1 (6.3)	2 (12.5)	Humerus/Radius 37.5%
Ice skating	16 (3.9)	7/9 (0.8)	13.2±3.3	7 (43.8)	9 (56.3)	1 (6.3)	0	2 (12.5)	Ulnar 37.5%
Rollerblading	10 (2.4)	9/1 (9.0)	10.8±3.3	8 (80.0)	2 (20.0)	0	0	0	Radius/Ulnar 60.0%
Long jumping	8 (2.0)	7/1 (7.0)	13.6±1.9	2 (25.0)	6 (75.0)	0	0	1 (12.5)	Tibia 37.5%
Table tennis	4 (1.0)	4/0	13.0±0.8	3 (75.0)	1 (25.0)	0	0	0	Radius/Ulnar 50.0%
Others	18 (4.4)	10/12 (0.8)	12.3±4.0	11 (61.1)	10 (55.6)	0	1 (5.6)	3 (16.7)	Ulnar 27.8%
Total	410 (100)	335/75 (4.5)	13.5±3.1	242 (59.0)	137 (33.4)	32 (7.8)	6 (1.5)	35 (8.5)	Radius 24.9%

CFF = craniofacial fracture, LEF = lower extremity fracture, NI = nerve injury, SF = spine fracture, SP = single parallel, UEF = upper extremity fracture.

3.3. Characteristics respect to different genders

The most common etiologies were playing basketball (27.5%) and running (21.5%) in the male group, and running (24.0%) and biking (20.0%) in the female group. The most common fracture sites were radius fractures (28.4%) in the male group and humerus fractures (28.0%) in the female group (Table 2). Fractures caused by playing basketball and football presented with significant higher rates in the male than the female. Fractures caused by ice skating presented with significant higher rate in the female than the male. Radius fractures and NI presented with significant higher rate in the male than the female. Femoral fractures presented with significant higher rate in the female than the male.

3.4. Characteristics respect to different etiologies

The most common fracture sites were radius fractures (28.9%) in the playing basketball group, humerus fracture (20.0%) in the running group, humerus fracture (23.3%) in the biking group, tibia fractures (28.9%) in the playing football group, radius fractures (50.0%) in the playing SP bars group, humerus fractures (45.0%) in the climbing group, radius fractures (37.5%) in the cricket group, and ulna fractures (37.5%) in the ice skating group (Table 3).

4. Discussion

Pediatric sports-related fractures are preventable occurrences, which may result in serious injury such as nerve injury (8.5%); we can prevent the happening of sports-related fractures through strengthening the protective measures and improving the sports equipment and environment. The most common etiologies were basketball (23.7%) and running (22.0%) in China, which were different from other studies, which showed football and rugby.[10,12,13] The most common fracture regions were upper limb fractures (59.0%) and lower limb fractures (33.4%); the most common fracture sites were radius (24.9%) in the current study. In some study, 84% were upper limb fractures for adolescents aged 10–19 years.[13] The previous study also showed that sports fractures comprised 16.5% of upper limb fractures and 7.5% of lower limb fractures,[12] the most common fracture sites were hand/finger,[10] distal radius and metacar-

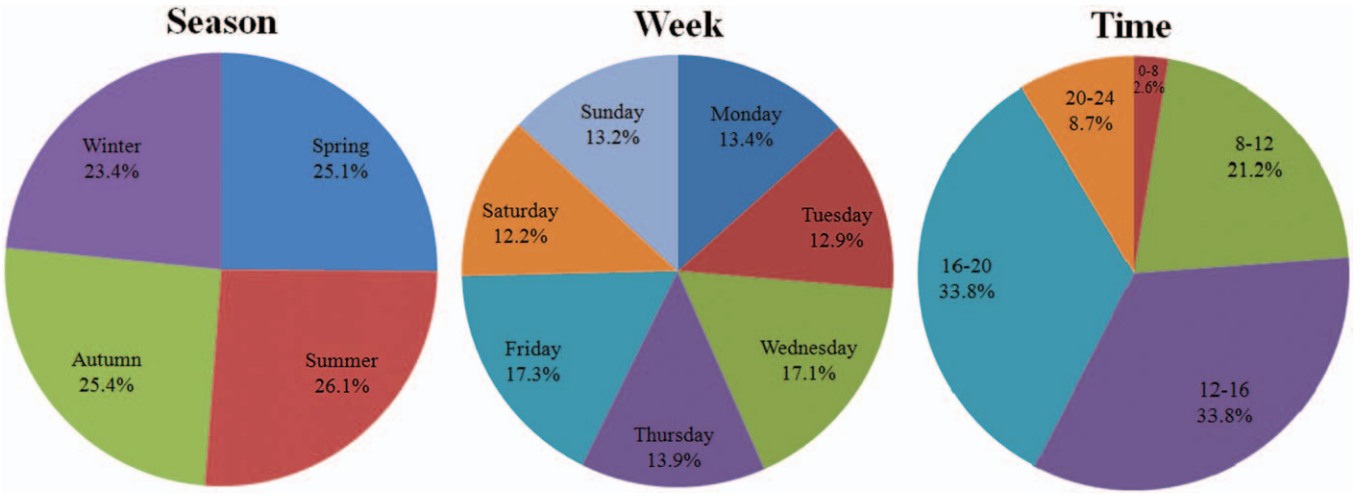

Figure 3. Season, week, and time distribution.

Table 2

Characteristics of 410 patients presented with sports-related fractures according to different age range and gender groups.

Data	Age range (years)			Gender		Total
	≤12	12–15	15–18	Male	Female	
Total	143	141	126	335	75	410
Male/female	101/42	124/17*	110/16*	335/0	0/75‡	335/75
Mean age	10.0±1.8	14.0±0.8*	16.9±0.9*,†	13.8±3.0	12.4±3.4	13.5±3.1
Etiologies						
Basketball	9 (6.3)	48 (34.0)*	40 (31.7)*	92 (27.5)	5 (6.7)‡	97 (23.7)
Running	23 (16.1)	31 (22.0)	36 (28.6)*	72 (21.5)	18 (24.0)	90 (22.0)
Biking	28 (19.6)	20 (14.2)	12 (9.5)*	45 (13.4)	15 (20.0)	60 (14.6)
Football	8 (5.6)	18 (12.8)	19 (15.1)*	44 (13.1)	1 (1.3)‡	45 (11.0)
SP bars	15 (10.5)	5 (3.5)*	2 (1.6)*	17 (5.1)	5 (6.7)	22 (5.4)
Climbing	14 (9.8)	3 (2.1)*	3 (2.4)*	15 (4.5)	5 (6.7)	20 (4.9)
Cricket	13 (9.1)	2 (1.4)*	1 (0.8)*	13 (3.9)	3 (4.0)	16 (3.9)
Ice skating	9 (6.3)	3 (2.1)	4 (3.2)	7 (2.1)	9 (12.0)‡	16 (3.9)
Rollerblading	7 (4.9)	2 (1.4)	1 (0.8)	9 (2.7)	1 (1.3)	10 (2.4)
Long jumping	3 (2.1)	3 (2.1)	2 (1.6)	7 (2.1)	1 (1.3)	8 (2.0)
Table tennis	1 (0.7)	3 (2.1)	0	4 (1.2)	0	4 (1.0)
Fractures						
Radius	36 (25.2)	37 (26.2)	29 (23.0)	95 (28.4)	7 (9.3)‡	102 (24.9)
Ulna	36 (25.2)	28 (19.9)	20 (15.9)	73 (21.8)	11 (14.7)	84 (20.5)
Humerus	40 (28.0)	23 (16.3)*	22 (17.5)*	64 (19.1)	21 (28.0)	85 (20.7)
Clavicle	6 (4.2)	15 (10.6)*	4 (3.2)†	23 (6.9)	2 (2.7)	25 (6.1)
Metacarpal	0	3 (2.1)	6 (4.8)*	8 (2.4)	1 (1.3)	9 (2.2)
Finger	0	1 (0.7)	0	1 (0.3)	0	1 (0.2)
Tibia	16 (11.2)	20 (14.2)	20 (15.9)	45 (13.4)	11 (14.7)	56 (13.7)
Ankle	1 (0.7)	7 (5.0)	7 (5.6)*	12 (3.6)	3 (4.0)	15 (3.7)
Femoral	13 (9.1)	15 (10.6)	9 (7.1)	25 (7.5)	12 (16.0)‡	37 (9.0)
Fibula	6 (4.2)	9 (6.4)	8 (6.3)	16 (4.8)	7 (9.3)	23 (5.6)
Patellar	2 (1.4)	4 (2.8)	4 (3.2)	6 (1.8)	4 (5.3)	10 (2.4)
NI	12 (8.4)	10 (7.1)	13 (10.3)	33 (9.9)	2 (2.7)‡	35 (8.5)

NI = nerve injury.

* Significant difference compared to ≤12 range group.

† Significant difference compared to 12–15 range group.

‡ Significant difference compared to male group.

pus,[12] finger phalanges, and distal radius.[13] Although it is more difficult to change the intensity or conditions of a game, many strategies can be used during practice to limit player-to-player contact and other potentially injurious behaviors.[8,9] Sports-related fractures are common in children and adolescents, particularly in males. They tend to be low energy injuries affecting the upper limb in particular. Preventive measures should be considered, including increasing public awareness and caregiver education especially the schools and public premises.

Fractures caused by rollerblading presented with highest frequencies of upper extremity fracture with 80.0%, which was consistent with previous study (upper limb fracture: lower limb fracture = 68:11).[11] Fractures caused by ice skating presented with highest frequencies of lower extremity fracture with 75.0%, which was not consistent with previous study, which showed that upper limb fractures were the most common facture sites in the ice skating injuries (upper limb fracture: lower limb fracture = 91:9).[12] Fractures caused by biking presented with highest frequency of craniofacial fracture with 21.7%. It may be because the patients caused by biking are easy to fall down and hurt their faces. The most common fracture sites were radius fractures in the playing basketball group (28.9%) and cricket group (37.5%), humerus fracture in the running group (20.0%), biking group (23.3%), and climbing group (45.0%), tibia fractures in the playing football group (28.9%) and playing SP bars group (50.0%), and ulna fractures (37.5%) in the ice skating group. So, we can prevent the happening of sports-related fractures through improving the sports equipment such as protective gear on upper limb when playing basketball and protective gear on lower limb when playing football.

The most common etiologies were biking (19.6%) in the ≤12 age range group, playing basketball in the 12–15 age range group (34.0%), and the 15–18 age range group (31.7%). The most common fracture sites were humerus fractures (28.0%) in the ≤12 age range group, radius fractures in the 12–15 age range group (26.2%), and the 15–18 age range group (23.0%). For children and adolescents 20 years of age and younger, pediatric bicycle-related hospitalizations are a significant public health problem; the morbidity and mortality among children and the economic costs to society are large.[16] So, we should pay much attention to fractures caused by biking and humerus fractures in the ≤12 age range group, fractures caused by playing basketball and radius fractures in the 12–18 age range group.

Fractures caused by playing basketball and football presented with significant higher rates in the male than the female. Fractures caused by ice skating presented with significant higher rate in the female than the male. Radius fractures and nerve injury presented with significant higher rate in the male than the female. So, we can see that the pattern of fractures among the patients caused by sports has its own characteristics; targeted intervention strategies should be taken to decrease the incidence and burden of sports-related fractures. This study has several limitations. First, it was

Table 3

The epidemiology of fractures caused by sport with a prevalence of ≥1%.

Fracture (n/%)	Basketball (n=97)	Running (n=90)	Biking (n=60)	Football (n=45)	SP bars (n=22)	Climbing (n=20)	Cricket (n=16)	Ice skating (n=16)	Rollerblading (n=10)	Long jumping (n=8)	Table tennis (n=4)
Radius	28 (28.9)	14 (15.6)	10 (16.7)	12 (26.7)	11 (50.0)	4 (20.0)	6 (37.5)	5 (31.3)	6 (60.0)	1 (12.5)	2 (50.0)
Ulna	21 (21.6)	9 (10.0)	12 (20.0)	9 (20.0)	7 (31.8)	3 (15.0)	5 (31.3)	6 (37.5)	6 (60.0)	1 (12.5)	2 (50.0)
Humerus	17 (17.5)	18 (20.0)	14 (23.3)	3 (6.7)	9 (40.9)	9 (45.0)	6 (37.5)	1 (6.3)	2 (20.0)	1 (12.5)	1 (25.0)
Clavicle	7 (7.0)	12 (13.0)	2 (3.0)	4 (9.0)	0	0	0	0	0	0	0
Metacarpal	4 (4.0)	1 (1.1)	1 (2.0)	2 (4.0)	0	0	0	0	0	0	0
Finger	1 (1.0)	0	0	0	0	0	0	0	0	0	0
Tibia	16 (16.5)	9 (10.0)	8 (13.3)	13 (28.9)	0	0	0	3 (18.8)	1 (10.0)	3 (37.5)	0
Ankle	10 (10.3)	1 (1.1)	0	2 (4.4)	0	0	0	2 (12.5)	0	0	0
Femoral	6 (6.2)	8 (8.9)	5 (8.3)	4 (8.9)	0	4 (20.0)	1 (6.3)	4 (25.0)	1 (10.0)	0	1 (25.0)
Fibula	5 (5.0)	5 (6.0)	1 (2.0)	5 (11.0)	0	0	0	4 (25.0)	1 (10.0)	0	0
Patellar	1 (1.0)	1 (1.1)	3 (5.0)	0	0	0	0	0	0	1 (12.5)	0

limited by the retrospective study design and the small number of patients. Second, there may be selection bias because this study includes patients referred to our hospitals.

5. Conclusions

Sports-related fractures are common in children and adolescents, particularly in males. Basketball and running were the most common etiologies; radius, ulna, and humerus were the most common fracture sites. The patient characteristics and fracture types identified by this study should be used to develop targeted prevention strategies.

Author contributions

Conceptualization: Hongwei Wang, Changqing Li, Yue Zhou, Jun Liu, Liangbi Xiang.
Data curation: Hongwei Wang, Huan Liu, Jun Wu, Changqing Li, Yue Zhou, Lan Ou.
Formal analysis: Hongwei Wang, Huan Liu, Jun Wu, Changqing Li, Yue Zhou, Jun Liu, Lan Ou, Liangbi Xiang.
Funding acquisition: Hongwei Wang.
Investigation: Hongwei Wang, Huan Liu, Changqing Li, Yue Zhou, Jun Liu, Liangbi Xiang.
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Project administration: Hongwei Wang, Jun Wu.
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Writing – original draft: Hongwei Wang, Jun Wu, Changqing Li, Yue Zhou, Jun Liu, Lan Ou, Liangbi Xiang.
Writing – review & editing: Hongwei Wang, Huan Liu, Changqing Li, Yue Zhou, Jun Liu, Liangbi Xiang.

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