






# Ankle Sprain in Young Athletes: A 2-Year Retrospective Study at a Multisport Club

## *Entorse no tornozelo em jovens atletas: Um estudo retrospectivo de 2 anos em um clube multiesportivo*

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### Abstract

**Objective** The present study aimed to analyze ankle sprains in young athletes of basketball, futsal, artistic gymnastics, trampoline, tennis, judo, and volleyball athletes over 2 seasons.

**Methods** Data of 529 athletes in the 1<sup>st</sup> year and of 495 athletes in the 2<sup>nd</sup> year of analysis were investigated from the injury record database of a sports club. The following data were considered: the demographic characteristics (age, body mass, height, and sex), the mechanism (contact or noncontact), the severity, the moment at which the injury occurred, and the recurrence. Also, the incidence rate, the injury risk of the first ankle sprain, and the incidence rate ratio between sports were calculated.

**Results** The athletes sustained 124 ankle sprains in the 2 years of analysis. The majority occurred during training (76.6%) and lead to absence from sports practice (75.8%). The injury recurrence was low: 2 athletes (1.6%) had a recurrence in the same year and 5 (4.0%) in the following year. The incidence rate (0.79 to 12.81 per 1,000 hours) and the injury risk (1.14 to 19.44%) varied among sports. Volleyball, basketball, and futsal presented the highest injury rate incidence. Tennis, gymnastics, and trampoline showed the lowest injury rate incidence. Judo showed an incidence rate

### Keywords

- ▶ ankle injuries
- ▶ athletes
- ▶ sports
- ▶ sprains and strains

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different from those of basketball and volleyball in the 1<sup>st</sup> year and similar to those of other sports in the 2<sup>nd</sup> year.

**Conclusion** Ankle sprain greatly impacted sports practice and presented characteristics that differ among the investigated sports. These findings may contribute to developing preventive injury programs.

## Resumo

**Objetivo** O presente estudo teve como objetivo analisar entorses no tornozelo em jovens atletas de basquete, futsal, ginástica artística, trampolim, tênis, judô e vôlei ao longo de duas temporadas.

**Métodos** Foram investigados dados de 529 atletas no 1<sup>o</sup> ano e 495 atletas no 2<sup>o</sup> ano de análise a partir do banco de dados de registros de lesões de um clube esportivo. Foram considerados os seguintes dados: as características demográficas (idade, massa corporal, altura e sexo), o mecanismo (contato ou não contato), a severidade, o momento em que ocorreu a lesão e a recorrência. Além disso, foram calculadas a taxa de incidência, o risco de lesão da primeira entorse no tornozelo e a razão da taxa de incidência entre os esportes.

**Resultados** Os atletas sofreram 124 entorses no tornozelo nos 2 anos de análise. A maioria ocorreu durante o treinamento (76,6%) e levou à interrupção da prática esportiva (75,8%). A recorrência da lesão foi baixa: 2 atletas (1,6%) tiveram recorrência no mesmo ano e 5 (4,0%) no ano seguinte. A taxa de incidência (0,79 a 12,81 por 1.000 horas) e o risco de lesão (1,14 a 19,44%) variaram entre os esportes. Vôlei, basquete e futsal apresentaram a maior incidência de lesões. Tênis, ginástica e trampolim apresentaram a menor incidência de lesões. O judô apresentou uma taxa de incidência diferente das do basquete e do vôlei no 1<sup>o</sup> ano e semelhante às dos outros esportes no 2<sup>o</sup> ano.

**Conclusão** A entorse no tornozelo impactou muito a prática esportiva e apresentou características que diferem entre os esportes investigados. Esses achados podem contribuir para o desenvolvimento de programas de prevenção de lesões.

## Palavras-chave

- ▶ lesões do tornozelo
- ▶ atletas
- ▶ esportes
- ▶ entorses e distensões

## Introduction

The concerns about sports injuries in young athletes are increasing since children and adolescents are participating in sports careers earlier and are exposed to substantial training and competition demands.<sup>1</sup> Most of these injuries occur in the lower limbs, especially in the knee and the ankle.<sup>2,3</sup> Studies showed that the prevalence of ankle injury is of ~ 34%.<sup>4</sup> However, in sports, such as volleyball, the prevalence increases to ~ 45% of all musculoskeletal injuries.<sup>4</sup> Besides, the incidence of ankle sprains is higher in young children and adolescents than in adults.<sup>5</sup> Children and adolescents are more susceptible to ankle sprains than adults due to characteristics of body development, such as muscle mass, ability to perform sports movements, and hormonal factors.<sup>5-7</sup> Therefore, the ankle is one of the most injured joints among young athletes.

Sprain is the most common ankle injury, which often happens with inversion and plantar flexion affecting the lateral collateral ligament complex.<sup>5</sup> Inversion ankle sprain is typical in sports involving acceleration, deceleration, and changing directions.<sup>5</sup> This injury is frequent in sports requiring jumps, such as volleyball and basketball, in which the injury mechanism of landing on the foot of a teammate or of an opponent player is usual.<sup>5</sup> After the injury, the athlete

may present multiple impairments that impact performance and result in absence from training sessions and matches.<sup>5</sup> Adequate recovery with rehabilitation is necessary since residual symptoms could be present in 40 to 50% of patients.<sup>5</sup> Furthermore, athletes who have had a previous ankle sprain are more likely to have another injury and develop chronic ankle instability.<sup>7,8</sup> This chronic instability is a common outcome of lateral ankle sprains in young athletes; therefore, clinical efforts should be made to prevent it.<sup>9</sup> Understanding the epidemiology of ankle sprain according to the sport practiced by young athletes may help planning specific interventions to prevent this injury and its complications and to reduce its impact on athletes.

Few studies investigate young athletes, especially in sports such as futsal and judo. Also, in the sports medicine field, understanding the incidence and severity of injuries is essential.<sup>10</sup> Knowing the severity of a specific injury directs more effectively the preventive and rehabilitation efforts. Therefore, the present study aimed to analyze ankle sprains in young basketball, futsal, artistic gymnastics, trampoline, tennis, judo, and volleyball athletes over 2 seasons. The results of the present investigation may offer reference data about young athletes in sports not yet reported or with fewer epidemiological studies.

## Methods

The present observational retrospective study analyzed the injuries registered in 2016 and 2017 of a database of a sports club. The members of this club are athletes of different ages who practice various sports and participate in regional and national competitions. The inclusion criteria were athletes  $\leq$  18 years old who practice basketball, futsal, artistic gymnastics, trampoline, judo, volleyball, and tennis. Data of 529 athletes (402 males and 127 females) in 2016 and 495 athletes (354 males and 141 females) in 2017 were analyzed. Any ankle sprain sustained during training or competition that received medical treatment from a staff sports physical therapist or team physician was included in the analyses. If the record presented any inconsistency, it was excluded from the analyses. The Ethics Research Committee of the university approved this research (number 97206918.8.0000.5093).

The diagnosis of ankle sprain was based on clinical history and physical examination.<sup>11</sup> All injuries were evaluated and monitored by the physician and physical therapist. The mechanism and its anatomic site were determinants for the definition of the type of ankle sprain. Also, the following clinical symptoms contributed to the diagnosis of the injury: pain location, presence of swelling or ecchymoses, ability to bear weight, ligament injury, reaction to manual stress, and evidence of instability.<sup>12</sup> The imaging methods were performed to aid in diagnosis following the Ottawa rules.<sup>13</sup> Magnetic resonance imaging (MRI) was considered in ankle sprains that are symptomatic after 6 to 8 weeks of standard treatment.

The analysis of ankle sprain considered the demographic characteristics of the athlete (age, body mass, height, and sex), sport practiced (basketball, futsal, artistic gymnastics and trampoline, judo, volleyball, and tennis), and hours of exposure to training. The analysis also considered the injury mechanism (contact or noncontact), the moment in which the injury occurred (match, training, or another moment in the sports club, such as physical training), and injury recurrence<sup>14</sup> (that is, ankle sprain occurred on the same side after the player returned to full participation in sports). Furthermore, the analysis considered injury severity according to the number of days lost and if the athlete (1) stopped all sports practice, (2) modified their training due to the injury (such as reduced training time), or (3) did not stop the sports practice.

## Statistical Analysis

For all data analyses, artistic gymnastics and trampoline were investigated together due to the low number of athletes in these sports and to their similarities. Descriptive analyses consisted of calculating means and standard deviations (SDs) of age, body mass, and height according to the sex of the athlete and to the sport practiced. The observed frequency for each category of the following variables was calculated according to the sport practiced: ankle sprain mechanism, severity, and moment in which it occurred. The incidence rate of ankle sprain was calculated and reported as the number of injuries per 1,000 hours of exposure.<sup>5,15</sup> The injury risk of the first ankle sprain was calculated as the number of injured athletes per total number of athletes at

**Table 1** Sample characteristics by year and sport

<i>1<sup>st</sup> year of analysis (2016)</i>				
<i>Sport</i>	<i>Age (years old)</i>	<i>Body mass (kg)</i>	<i>Height (cm)</i>	<i>Sex M (%) / F (%)</i>
Basketball ( <i>n</i> = 108; 20.9%)	14.3 (2.1)	67.1 (18.4)	176.0 (14.4)	108 (100) / 0 (0)
Futsal ( <i>n</i> = 88; 17.1%)	14.4 (2.4)	56.1 (14.1)	165.0 (12.6)	88 (100) / 0 (0)
Gymnastics and trampoline ( <i>n</i> = 57; 11.0%)	10.3 (2.7)	34.3 (12.6)	138.2 (15.4)	31 (54.3) / 26 (45.7)
Judo ( <i>n</i> = 88; 17.1%)	13.0 (1.9)	56.8 (17.8)	159.8 (13.6)	79 (89.8) / 9 (10.2)
Volleyball ( <i>n</i> = 155; 30.0%)	15.4 (2.0)	68.9 (11.3)	180.4 (9.1)	70 (45.2) / 85 (54.8)
Tennis ( <i>n</i> = 33; 6.4%)	13.5 (2.4)	54.4 (15.5)	162.0 (13.5)	26 (78.8) / 7 (21.2)
<i>All athletes (n</i> = 529; 100%)	14.0 (2.7)	59.8 (18.6)	167.9 (18.6)	402 (76.0) / 127 (24.0)
<i>2<sup>nd</sup> year of analysis (2017)</i>				
<i>Sport</i>	<i>Age (years old)</i>	<i>Body mass (kg)</i>	<i>Height (cm)</i>	<i>Sex M (%) / F (%)</i>
Basketball ( <i>n</i> = 108; 21.8%)	14.6 (2.2)	69.3 (17.7)	177.8 (14.8)	108 (100) / 0 (0)
Futsal ( <i>n</i> = 90; 18.2%)	13.6 (1.8)	53.7 (13.8)	163.3 (12.6)	90 (100) / 0 (0)
Gymnastics and trampoline ( <i>n</i> = 62; 12.5%)	9.9 (2.5)	32.9 (12.4)	136.8 (15.0)	32 (51.6) / 30 (48.4)
Judo ( <i>n</i> = 51; 10.3%)	13.3 (2.2)	55.5 (16.5)	160.2 (13.0)	32 (62.8) / 19 (37.3)
Volleyball ( <i>n</i> = 151; 30.5%)	15.1 (2.1)	69.0 (12.2)	180.1 (10.0)	70 (46.4) / 81 (53.6)
Tennis ( <i>n</i> = 33; 6.7%)	13.0 (2.2)	49.0 (12.9)	159.2 (13.5)	22 (66.7) / 11 (33.3)
<i>All athletes (n</i> = 495; 100%)	13.8 (2.3)	59.4 (18.6)	167.9 (18.6)	354 (71.5) / 141 (28.5)

Abbreviations: F, females; M, males.

risk.<sup>15</sup> The 95% confidence intervals (CIs) were calculated for both incidence rate and injury risk.<sup>15</sup> The incidence rate ratio was computed to compare the ankle sprain rate between sports.<sup>15</sup> All 95% CIs of incidence rate ratio not containing 1.00 were considered statistically significant.

## Results

A total of 124 records of ankle sprains were observed in the 2 years of analysis. Most of them occurred during training (95; 76.6%), followed by matches (22; 17.7%), and others (7; 5.6%). Ninety-four athletes (75.8%) stopped all their sports

practice; 12 (9.6%) did not interrupt all their practice but modified their training, and 18 (14.52%) did not stop or modified their sports practice. During the 2 years of analysis, a total of 2,295 days of time loss were observed. Two athletes (1.6%; 1 basketball and 1 futsal player) had a recurrence in the same year, and 5 (4.0%; 1 basketball, 1 futsal, and 3 volleyball players) in the following year. Regarding the injury mechanism, 60 (48.4%) were classified as contact and 64 (51.6%) as noncontact ankle sprains. Data were organized according to sport and year of analysis for sample characteristics (► **Table 1**) and ankle sprain mechanism, severity, and moment in which it occurred (► **Table 2**).

**Table 2** Ankle sprain mechanism, severity, and moment in which it occurred by year and sport

1 <sup>st</sup> year of analysis (2016)							
	Basketball (n = 108)	Futsal (n = 88)	Gymnastics and trampoline (n = 57)	Judo (n = 88)	Volleyball (n = 155)	Tennis (n = 33)	All (n = 516)
Total of injuries	20	11	2	1	20	2	56
Mechanism							
Contact	13	5	2	1	11	2	34
Noncontact	7	6	0	0	9	0	22
Severity							
Stopped all sport practice	12	8	0	0	14	1	35
Modified sport practice	4	0	2	0	2	1	9
Did not stop sport practice	4	3	0	1	4	0	12
Time loss (Days)	330	151	50	0	354	5	890
When did it happen?							
Training	14	8	2	0	18	1	43
Matches	5	2	0	0	1	1	9
Others	1	1	0	1	1	0	4
2 <sup>nd</sup> year of analysis (2017)							
	Basketball (n = 108)	Futsal (n = 90)	Gymnastics and trampoline (n = 62)	Judo (n = 51)	Volleyball (n = 151)	Tennis (n = 33)	All (n = 495)
Total of injuries	23	10	3	5	26	1	68
Mechanism							
Contact	11	8	1	1	8	1	30
Noncontact	12	2	2	4	18	0	38
Severity							
Stopped all sport practice	21	9	3	5	20	1	59
Modified sport practice	0	1	0	0	2	0	3
Did not stop sport practice	2	0	0	0	4	0	6
Time loss (Days)	655	124	39	131	443	13	1405
When did it happen?							
Training	17	7	3	4	21	0	52
Matches	4	3	0	0	5	1	13
Others	2	0	0	1	0	0	3

**Note:** Others refers to when the injury happened in the sports club out of training or of a match, such as during physical training. Injury severity was analyzed as time loss (i.e., number of days lost due to ankle sprain) and according to the following classification: (1) the athlete stopped all sports practice, (2) the athlete modified training due to the injury (e.g., reduced training time) or (3) the athlete did not stop sports practice.

**Table 3** Ankle sprain incidence rate and injury risk per year and sport

1 <sup>st</sup> year of analysis (2016)					
Sport	Injured athletes (n)	Injuries (n)	Training exposure (h)	Incidence rate per 1000h of exposure (95%CI)	Injury risk 95% CI
Basketball (n = 108)	17	20	2044	9.78 (5.50–14.07)	15.74% (8.87–22.61%)
Futsal (n = 88)	10	11	1572	7.00 (2.86–11.13)	11.36% (4.73–17.99%)
Gymnastics and trampoline (n = 57)	2	2	1872	1.07 (- 0.41–2.55)	3.51% (- 1.27–8.29%)
Judo (n = 88)	1	1	780	1.28 (- 1.23–3.79)	1.14% (- 1.08–3.35%)
Volleyball (n = 155)	20	20	1920	10.42 (5.85–14.98)	12.90% (7.63–18.18%)
Tennis (n = 33)	2	2	1258	1.59 (- 0.61–3.79)	6.06% (- 2.08–14.20%)
All (n = 516)	52	56	9446	5.93 (4.38–7.48)	9.83% (7.29–12.37%)
2 <sup>nd</sup> year of analysis (2017)					
Sport	Injured athletes (n)	Injuries (n)	Training exposure (h)	Incidence rate per 1000h of exposure (95%CI)	Injury risk 95% CI
Basketball (n = 108)	21	23	2044	11.25 (6.65–15.85)	19.44% (11.98–26.91%)
Futsal (n = 90)	10	10	1572	6.36 (2.42–10.30)	11.11% (4.62–17.60%)
Gymnastics and trampoline (n = 62)	3	3	1872	1.60 (- 0.21–3.42)	4.84% (- 0.50–10.18%)
Judo (n = 51)	5	5	780	6.41 (0.79–12.03)	9.80% (1.64–17.97%)
Volleyball (n = 151)	25	26	2030	12.81 (7.88–17.73)	16.56% (10.63–22.48%)
Tennis (n = 33)	1	1	1258	0.79 (- 0.76–2.35)	3.03% (- 2.82–8.88%)
All (n = 495)	65	68	9556	7.12 (5.42–8.81)	13.13% (10.16–16.11%)

Abbreviations: CI, confidence interval; h, hours.

The incidence rate and the injury risk of an ankle sprain are presented in ►Table 3. The incidence rate ratio between sports is shown in ►Table 4. The 95%CI of the rate ratio between sports that did not present 1.00 (statistically different) were highlighted.

## Discussion

The present study analyzed ankle sprains sustained by young athletes according to the sport practiced. Basketball, volleyball, and futsal players had a higher ankle sprain incidence rate and risk during the 2 years of analysis. Also, most cases sustained the injury during training and were absent from sports practice. Furthermore, the recurrence rate was low. The present study provides data that may contribute to design preventive programs according to the sport practiced since knowing the injury profile is the first step in this planning.<sup>10</sup>

The incidence rate of combined sports was of 5.93 injuries/1,000 hours in the 1<sup>st</sup> year and of 7.12 injuries/1,000 hours in the 2<sup>nd</sup> year. The incidence rate of the 2<sup>nd</sup> year is similar to a that of a review that pooled cumulative incidence organized as indoor and court sports in the general population and identified 7.00 injuries/1,000 exposures.<sup>5</sup> The incidence rate varied among the investigated sports. The highest incidence rates of ankle sprain observed in

volleyball, basketball, and futsal corroborate other studies showing that sports characterized by movements with a quick change of direction and jumps have a greater chance of ankle sprain.<sup>5</sup> Also, the difference in incidences among sports corroborates another study that found that, in the general population, basketball was most commonly associated with an injury.<sup>16</sup>

Basketball presented one of the highest incidence rates and injury risks in the 2 years of analysis. The observed incidence rate was higher than that reported in adolescent basketball players by Pasanen et al.<sup>17</sup> Also, considering the limits of the 95%CI, the risk in the 1<sup>st</sup> year of analysis (15.74%; 95%CI: 8.87–22.61%) was lower, but in the 2<sup>nd</sup> year (19.44%; 95%CI: 11.98–26.91%), it was similar to the 25% (95%CI: 23.9–28.0%) reported in a single season of the National Basketball Association (NBA).<sup>18</sup> The highly competitive games of the NBA would probably be one factor that could explain the difference mainly in the 1<sup>st</sup> year of analysis. Furthermore, the incidence rates of volleyball were not different from those of basketball in the 2 years of analysis. The observed incidence rate was higher than that reported by another study with amateur teams of adult volleyball players.<sup>19</sup> On the other hand, the observed incidence rates in both years are similar to that reported by the International Volleyball Federation (FIVB) during their tournaments.<sup>20</sup> Therefore, basketball and volleyball are two of the investigated sports in which athletes

**Table 4** Incidence rate ratio (95% confidence interval) of ankle sprain between sports per year

<i>1<sup>st</sup> year of analysis (2016)</i>						
<i>Sport</i>	<i>Basketball</i>	<i>Futsal</i>	<i>Gymnastics and trampoline</i>	<i>Judo</i>	<i>Volleyball</i>	<i>Tennis</i>
Basketball (n = 108)	-	1.40 (0.67-2.92)	9.16 (2.14-39.18)	7.63 (1.02-56.87)	0.94 (0.51-1.75)	6.15 (1.44-26.33)
Futsal (n = 88)	0.72 (0.34-1.49)	-	6.55 (2.14-39.18)	5.46 (0.70-42.28)	0.67 (0.32-1.40)	4.40 (0.98-19.86)
Gymnastics and trampoline (n = 57)	<b>0.11 (0.03-0.47)</b>	<b>0.15 (0.03-0.69)</b>	-	0.83 (0.08-9.19)	<b>0.10 (0.02-0.44)</b>	0.67 (0.09-4.77)
Judo (n = 88)	<b>0.13 (0.02-0.98)</b>	0.18 (0.02-1.42)	1.20 (0.11-13.23)	-	<b>0.12 (0.02-0.92)</b>	0.81 (0.07-8.89)
Volleyball (n = 155)	1.06 (0.57-1.98)	1.49 (0.71-3.11)	<b>9.75 (2.28-41.71)</b>	<b>8.13 (1.09-60.54)</b>	-	<b>6.55 (1.53-28.03)</b>
Tennis (n = 33)	<b>0.16 (0.04-0.70)</b>	0.77 (0.05-1.03)	1.49 (0.21-10.56)	1.24 (0.11-13.68)	<b>0.15 (0.04-0.65)</b>	-
<i>2<sup>nd</sup> year of analysis (2017)</i>						
<i>Sport</i>	<i>Basketball</i>	<i>Futsal</i>	<i>Gymnastics and trampoline</i>	<i>Judo</i>	<i>Volleyball</i>	<i>Tennis</i>
Basketball (n = 108)	-	1.77 (0.84-3.72)	7.02 (2.11-23.39)	1.76 (0.67-4.62)	0.88 (0.50-1.54)	14.16 (1.91-104.82)
Futsal (n = 90)	0.57 (0.27-1.19)	-	3.97 (1.09-14.42)	0.99 (0.34-2.90)	0.50 (0.24-1.03)	8.00 (1.02-62.52)
Gymnastics and trampoline (n = 62)	<b>0.14 (0.04-0.47)</b>	<b>0.25 (0.07-0.92)</b>	-	0.25 (0.06-1.05)	<b>0.13 (0.04-0.41)</b>	2.02 (0.21-19.38)
Judo (n = 51)	0.57 (0.22-1.50)	1.01 (0.34-2.95)	4.00 (0.96-16.74)	-	0.50 (0.19-1.30)	8.06 (0.94-69.03)
Volleyball (n = 151)	1.14 (0.65-1.99)	2.01 (0.97-4.18)	<b>7.99 (2.42-26.41)</b>	2.00 (0.77-5.20)	-	<b>16.11 (2.19-118.74)</b>
Tennis (n = 33)	<b>0.07 (0.01-0.52)</b>	<b>0.12 (0.02-0.98)</b>	0.50 (0.05-4.77)	0.12 (0.01-1.06)	<b>0.06 (0.01-0.46)</b>	-

Note: Rate ratios in bold were without 1.00 in their 95% confidence interval and, therefore, are statistically different. The table could be read as to how much higher the sports ankle sprain rate in the row is relative to the sports ankle sprain rate in the column according to the year of analysis.



were more prone to sustain ankle sprains and should receive attention from the staff during preventive measures.

Futsal injuries were investigated by few studies in the literature; therefore, the comparison between the findings of the present research with those of others is limited. Also, to our knowledge, the present study is the first that analyzed the epidemiology of ankle sprain in young futsal athletes. A study with adult futsal players showed that the ankle is one of the most injured joints, and ligament sprains are among the most common types of injury.<sup>21</sup> One study indicated that ankle sprain was one of the most prevalent diagnoses of time loss during the analysis of three Futsal World Cups.<sup>22</sup> Therefore, the current results add important information about ankle sprain in young futsal players and highlight its impact on the sport.

Judo presented an incidence rate different only from those of basketball and volleyball in the 1<sup>st</sup> year (judo had a lower incidence rate than those of basketball and volleyball) and an incidence rate similar to those of other sports in the second year. The injury risk was 1.14% in the 1<sup>st</sup> year and 9.80% in the 2<sup>nd</sup> year. Few studies have investigated young judo athletes, as has already been indicated in a previous review;<sup>23</sup> therefore, the comparison with our results is limited. One study showed that the ankle was one of the most common places and that sprains were among the most common injuries that result in presenting to emergency departments by children who practice judo.<sup>24</sup> Another study indicated that ankle sprain is one of the most common injuries in young and adult judo athletes.<sup>25</sup> Judo involves throwing, joint locks, and also striking.<sup>23</sup> These sports motions may result more frequently in injuries in the upper extremity, which may be one reason for the limited number of studies about ankle sprains.<sup>23</sup> Therefore, the current results add to the literature about judo injuries in young athletes.

The other investigated sports presented low incidence rates. Artistic gymnastics and trampoline showed a lower incidence rate than the those of most of the investigated sports. This result corroborates a study that found that these sports were less associated with ankle sprains in the general population.<sup>16</sup> Also, the observed incidence rate in artistic gymnastics and trampoline was similar to those of some of the investigations reported in the review by Hart et al.<sup>26</sup> The findings could contribute to the epidemiology of the young athletes in these sports since, as indicated by Hart et al.,<sup>26</sup> there is also limited research about them. Furthermore, tennis was one of the sports with lower incidence rates. In contrast, two studies showed that ankle sprain was one of the most common injuries among young tennis players.<sup>27,28</sup> The observed incidence rates were lower than that reported for adult tennis players.<sup>28</sup> Therefore, although ankle sprain was described as one of the most common injuries among tennis players, the observed incidence rate was lower than those of the other investigated sports.

Low recurrence rates were observed in the present study. The recurrence rate was of only 1.6% in the 1<sup>st</sup> year and of 4.0% in the 2<sup>nd</sup> year. These results may be related to the close supervision of the athletes investigated in the present study, in whom all injuries are referred to the medical staff. This context, in which all the sprains received medical attention, contrasts

with the literature, which reports that 50% of individuals with ankle sprain do not seek medical care.<sup>29</sup> Also, the observed recurrence rates were lower than those reported by another study.<sup>30</sup> Thus, the medical supervision of the sports club may be a factor that positively impacted the low recurrence rate.

The most common injury mechanism was contact sprain in the 1<sup>st</sup> year and noncontact sprain in the 2<sup>nd</sup> year. The difference between the 1<sup>st</sup> and the 2<sup>nd</sup> years may be mostly related to the mechanism changes, especially for basketball and volleyball. In both sports, the 1<sup>st</sup> year presented a substantial contribution of contact injuries. In the 2<sup>nd</sup> year, the distribution between mechanisms was almost equal for basketball, and noncontact injury was more common for volleyball. Other studies reported more contact injuries for basketball<sup>2</sup> and noncontact injuries for volleyball.<sup>3</sup> Furthermore, most ankle sprains occurred during training sessions. This may be related to the number of hours of exposure to training, which is higher than that of matches. This result corroborates the reported for young basketball<sup>17</sup> and volleyball<sup>3,31</sup> players. However, this result is different from those of other studies that showed a considerable number of injuries during matches in young basketball athletes.<sup>2,31</sup>

In most injuries, the athlete stopped all sports practice due to ankle sprain. This result corroborates those of other studies.<sup>2,3,19</sup> The ankle sprains observed in the present study resulted in an average of 18.5 days of absence from sports practice. Other studies showed that most injuries resulted in a time loss of up to 7 days, and the ~30% of ankle sprains result in between 7 and 21 days of time loss.<sup>2,3</sup> Therefore, the time loss from participation highlighted the importance of adopting preventive strategies to minimize ankle sprain injuries.

Some limitations apply to the present study. Although it investigated several variables contributing to understanding ankle sprains in young athletes, other factors not investigated may be related to this injury. For example, variables related to the history of the athlete, including injuries sustained before the investigation period, and years of sports practice. Also, musculoskeletal impairments (such as dorsiflexion deficits) could contribute to the development of ankle sprains. Since the present study is based on a database, other factors were unavailable or not systematically registered for all the investigated athletes. Besides, the training features (such as duration of the training session, structure of the training session, and periodization plan) may have influenced the results. Future studies may investigate if factors not considered in the present study may explain differences in the incidence rates of ankle sprain in different sports.

## Conclusion

Basketball, volleyball, and futsal had the highest ankle sprain incidence rates among the investigated sports. During the 2 years of analysis, most injuries happened during training and lead to absence from sports practice. Also, the injury recurrence was low. These findings may help developing effective prevention programs through strategies to reduce the risk of injury and their severity, benefiting the athlete, the technical staff, and the sports club.

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**Conflict of Interests**

The authors have no conflict of interests to declare.

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