

# Descriptive Epidemiology of Injuries in Japanese Collegiate Men's Basketball: 2013/2014 to 2019/2020

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## Original Contribution

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# Abstract

## Background

Basketball is one of the most played sports in the world. However, only a few studies have examined the epidemiology of Japanese collegiate men's basketball injuries. This study investigated the incidence of injury among Japanese collegiate men's basketball from the 2013/2014 to the 2019/2020 seasons and identified unique patterns by comparing our data with the National Collegiate Athletic Association (NCAA) men's basketball data.

## Methods

Data from Japanese collegiate basketball teams of the Kanto Collegiate Basketball Federation Division I League during the 2013/2014 to 2019/2020 academic years (23 team seasons) were used in this study. Injury rates per 1000 athlete exposures (AEs) and injury proportions were calculated according to events, injury types, body parts, and common injury mechanisms. The injury rate ratio (IRR) with a 95% confidence interval (CI) was compared with that from the time-loss injury data from the NCAA's previous reports.

## Results

In total, 480 injuries during 97,515 AEs were reported, leading to an injury rate of 4.92 per 1,000 AEs (95% CI = 4.48–5.36). The overall injury rate was higher in Japan than in the NCAA (IRR = 1.55; 95% CI = 1.39–1.73). Lower extremity injuries occurred most frequently (73.5%). Ankle sprain was the most common injury in Japan, with higher injury rates than in the NCAA (IRR = 2.10; 95% CI = 1.72–2.57). The injury rate of concussion was lower in Japan than in the NCAA (IRR = 0.28; 95% CI = 0.14–0.55).

## Conclusions

The rates of overall injury and ankle sprain were higher and that of concussion was lower in Japan than in the NCAA. These results might have been influenced by the environment and level of medical support surrounding Japanese basketball players and indicate an urgent need to improve the medical support systems to protect basketball players from injury.

## Background

Basketball, with over 450 million players, is one of the most played sports in the world. As a high-intensity sport, basketball is characterized by high aerobic and anaerobic demands, continuous changes in direction, acceleration and deceleration, jumps, sprints, contacts, and specific skills.<sup>1,2</sup> The nature of

basketball, such as changes in direction, player contact, repetitive jumping, and landing activities, might affect the incidence of lower extremity injury,<sup>3</sup> particularly ankle sprain.<sup>4</sup>

Various epidemiological studies on sports-related injuries have been reported from the injury surveillance program of the National Collegiate Athletic Association (NCAA-ISP).<sup>3-6</sup> The studies from the NCAA-ISP emphasize a high level of evidence-based practices related to injury prevention and are a vital resource for further research.<sup>7,8</sup> In Japan, the Japan Association of University Athletics and Sport (UNIVAS) was established in 2019 by the Japan Sports Agency, an external bureau of the Ministry of Education, Culture, Sports, Science and Technology.<sup>9</sup> One of the chief projects of the UNIVAS is to improve the environment for collegiate athletic activities and to increase engagement in sports, safely and securely. To achieve these objectives, surveys and research on the aspects related to sports activity-related accidents are required.

A total of 597,375 basketball players registered with the Japan Basketball Association in 2019 comprised over 8,000 collegiate men.<sup>10</sup> To prevent injury and illness and to improve the athletic performance of the Japanese collegiate basketball players, the Department of Medicine and Science attached to the Kanto collegiate basketball federation (KCBF) was established, comprising the area including the Tokyo, Kanagawa, Chiba, Saitama, Gunma, Ibaraki, and Tochigi prefectures. Currently, there is only one epidemiological study, although the participants included elementary school mini-basketball players, with a mean age of  $10.9 \pm 1.0$  years; the rules and standards for mini-basketball vastly differ from those of general basketball (such as, ball size, goal height, and game time).<sup>11</sup> For preventive intervention research in basketball players, accurate epidemiological data are needed. Therefore, we aimed to describe the incidence of injuries in Japanese collegiate men's basketball from the 2013/2014 to the 2019/2020 seasons. We further aimed to investigate unique patterns by comparing our data with the NCAA's men's basketball data, reported in previous research.

## Methods

### Data source

Data managed by the Department of Medicine and Science of the KCBF were used in this study. The duration of the investigation was from the 2013/2014 to the 2019/2020 academic years in Japan (April 1st – March 31st). A total of seven teams from the KCBF Division I League participated in the investigation. As some teams were unable to continue the survey due to factors such as dropping out of the survey and replacing divisions, this study was conducted using mixed data (23 team-seasons). This study was approved by the Human Ethics Review Committee of Teikyo Heisei University (No. R01-080-1). The study was conducted according to the tenets of the Declaration of Helsinki.

### Data collection

The injury and exposure data collected under the supervision of an athletic trainer certified by the Japan Sports Association in each team were aggregated for each season. Any individual weight training conditioning session or illness was excluded from the study. Thus, we excluded 4 injury incidents during weight training conditioning and 51 illnesses.

## Definitions

Based on previous studies,<sup>11,12</sup> an injury was defined as any event that (1) occurred as a result of participation in regular practice or competition in sports, (2) caused the player to seek medical care from a physician or alternative medical specialist, or (3) resulted in the restriction of student-athlete participation or performance for one or more calendar days since the day of injury. Injuries that required > 3 weeks to heal and to regain complete fitness for playing basketball or led to retirement were defined as severe injuries. Athlete-exposure (AE) was defined as one athlete participating in the practice or official competition organized by KCBF and the All Japan University Basketball Federation, wherein the player was exposed to the possibility of athletic injury, regardless of the time of participation. The player who warmed up before the match but did not play was not considered an AE.

Body parts were classified as head/face, neck, shoulder, arm/elbow, hand/wrist, trunk (including the chest, abdomen, upper back, and lower back), hip/groin, upper leg, knee, lower leg, ankle, and foot. Injury types were classified as sprain/ligament tears, muscle strains/rupture/tears, contusions, concussions, fractures, dislocation/ subluxation, laceration, tendonitis, nerve injury, cartilage injury (including meniscus injury), and others. To compare with previous research, isolated or a combination of anterior cruciate ligament (ACL), posterior cruciate ligament, collateral ligament (medial or lateral, not differentiated), or meniscus (medial or lateral, not differentiated) injury was also categorized as “knee internal derangement”.<sup>3</sup> The mechanism of injury was classified as contact with another player, contact with an object (e.g., ball, surface, equipment), no contact, and overuse.

## Statistical analyses

The calculation of injury rates and rate ratios was analyzed with 95% confidence intervals (CIs) using Microsoft® Excel for Mac (version 16.45, Microsoft Corp, Redmond, WA).<sup>13</sup> The injury rate was calculated as the number of injuries per 1,000 AEs. In the injury rate ratio, all 95% CIs, not including 1.0, were considered statistically significant. The distribution of the mechanisms of injury and proportion of severity in each mechanism of injury were compared using the  $\chi^2$  test, using SPSS® software (version 27.0; IBM Corporation, Armonk, NY, USA). The alpha level was set to  $p < 0.05$ . We attempted to compare basketball injuries reported by Zuckerman et al. (2018).<sup>3</sup> Since non-time-loss injuries, which were defined as injuries resulting in participation restriction for < 24 hours, were counted in this previous study<sup>3</sup>, the reference results from previous studies were recalculated and applied.

## Results

### Overall injury rates

Over the period of 7 years, a total of 480 injuries across 23 team-seasons were reported, of which 346 (72.1%) occurred in practice, 130 (27.1%) occurred in competition, and 4 (0.8%) had missing event information (Table 1). These injuries occurred during 97,515 AEs (practice: 89,559 AEs; competition: 7,956 AEs), and a total of 87 (18.1% of overall injuries) were considered severe injuries (> 21 days lost), one of which led to forced medical retirement. A total of 57 (65.5% of severe injuries) occurred in practice, 29 (33.3% of severe injuries) occurred in competition, and 1 (0.2%) was missing the event information. Injury rates in competition were higher than those in practice among all injuries (IRR = 4.23, 95% CI = 3.46–5.17) and severe injuries (IRR = 5.73, 95% CI = 3.66–8.96).

Table 1

Injury Rates and 95% CIs by the Events in Japanese Collegiate Men's Basketball, 2013/2014–2019/2020 and Comparison with NCAA Men's Basketball

	Japan		NCAA		Japan vs. NCAA
	n	IR and 95% CI (per 1,000 AEs)	n	IR and 95% CI (per 1,000 AEs)	IRR (95% CI)
<i>Practice</i>					
Injuries	346	3.86 (3.46–4.27)	635	2.80 (2.58–3.02)	1.38 (1.21–1.57)*
Severe injuries	57	0.64 (0.47–0.80)	65	0.29 (0.22–0.36)	2.19 (1.60–3.01)*
<i>Competition</i>					
Injuries	130	16.34 (13.53–19.15) <sup>†</sup>	286	4.56 (4.03–5.09)	3.58 (2.91–4.41)*
Severe injuries	29	3.65 (2.32–4.97) <sup>†</sup>	52	0.83 (0.60–1.05)	4.39 (3.00–6.43)*
<i>Overall<sup>a</sup></i>					
Injuries	480	4.92 (4.48–5.36)	921	3.18 (2.98–3.39)	1.55 (1.39–1.73)*
Severe injuries	87	0.89 (0.71–1.08)	117	0.40 (0.33–0.48)	2.23 (1.69–2.94)*
AEs; athlete exposure(s): <i>Practice</i> = 89,559, <i>Competition</i> = 7,956, CI; confidence interval, IR; injury rate, IRR; injury rate ratio					
<sup>a</sup> ; <i>Overall</i> injuries do not equal sum of <i>Practice</i> and <i>Competition</i> injuries due to four injuries missing the event information.					
*Japan versus the NCAA data reported by Zuckerman et al., 2018 <sup>3</sup> injury rate ratio > 1.00 and does not include 1.00 in the 95% CI.					
<sup>†</sup> Competition versus Practice injury rate ratio > 1.00 and does not include 1.00 in the 95% CI.					

## Mechanisms of injury

Figure 1 shows the distribution of the mechanisms of injury for all injuries and the severe proportion in each mechanism of injury. The most common mechanism of injury was contact with another player (n = 228, 47.5%), followed by no contact (n = 124, 25.8%), overuse (n = 93, 19.4%), and contact with an object (n = 27, 5.6%) ( $\chi^2 = 320.02$ ,  $p < 0.001$ ). A total of 53.1% of injuries were contact-related (n = 255). The severe proportion was as follows: overuse (n = 21, 22.6%), contact with an object (n = 6, 22.2%), no contact (n = 23, 18.5%), and contact with another player (n = 37, 16.2%).

## **Injury in body part**

Lower extremity (including hip/groin, upper leg, knee, lower leg, ankle, and foot) injuries accounted for the majority of total injuries (73.5%) (Table 2). In particular, the ankle had the highest proportion of injuries (35.8%), followed by the upper leg (12.1%) and the trunk (11.0%). Injury occurrence in all body parts, except for the arm/elbow and hip/groin, was higher in competitions than during practice. Knees had the most severe injuries (40.8% of all knee injuries; median, range of days lost = 77, 24–500).

Table 2

Injury Counts, Rates (per 1,000 Athletes Exposures), and Percentage of Severity by Body Part and Type of Event in Japanese Collegiate Men's Basketball, 2013/2014–2019/2020

	<i>Practice</i>		<i>Competition</i>		<i>Overall<sup>a</sup></i>		
	n	IR and 95% CI (per 1,000 AEs)	n	IR and 95% CI (per 1,000 AEs)	n	IR and 95% CI (per 1,000 AEs)	% Severe (median of days loss, range)
Head/face	13	0.15 (0.07–0.22)	12	1.51 (0.65–2.36)*	25	0.26 (0.16–0.36)	8 (29.5, 28–31)
Neck	2	0.02 (–0.01–0.05)	0	0	2	0.02 (–0.01–0.05)	50 <sup>b</sup>
Shoulder	11	0.12 (0.05–0.20)	9	1.13 (0.39–1.87)*	20	0.21 (0.12–0.29)	30 (93.5, 42–180)
Arm/elbow	7	0.08 (0.02–0.14)	2	0.25 (–0.10–0.60)	9	0.09 (0.03–0.15)	33.3 (25, 25–60)
Hand/wrist	10	0.11 (0.04–0.18)	8	1.01 (0.31–1.70)*	18	0.18 (0.10–0.27)	33.3 (49, 37–81)
Trunk <sup>c</sup>	40	0.45 (0.31–0.59)	11	1.38 (0.57–2.20)*	53	0.54 (0.40–0.69)	15.1 (25, 24–44)
Hip/groin	13	0.15 (0.07–0.22)	1	0.13 (–0.12–0.37)	14	0.14 (0.07–0.22)	0
Upper leg	44	0.49 (0.35–0.64)	14	1.76 (0.84–2.68)*	58	0.59 (0.44–0.75)	15.5 (36, 22–120)
Knee	34	0.38 (0.25–0.51)	15	1.89 (0.93–2.84)*	49	0.50 (0.36–0.64)	40.8 (77, 24–500)
Lower leg	26	0.29 (0.18–0.40)	8	1.01 (0.31–1.70)*	34	0.35 (0.23–0.47)	17.6 (36.5, 30–65)
Ankle	127	1.42 (1.17–1.66)	43	5.40 (3.79–7.02)*	172	1.76 (1.50–2.03)	13.4 (30, 22–104)
Foot	19	0.21 (0.12–0.31)	7	0.88 (0.23–1.53)*	26	0.27 (0.16–0.37)	15.4 (95, 30–139)

<i>Practice</i>	<i>Competition</i>	<i>Overall</i> <sup>a</sup>
<p>AEs; athlete exposure(s): <i>Practice</i> = 89,559, <i>Competition</i> = 7,956, CI; confidence interval, IR; injury rate, IRR; injury rate ratio.</p> <p>*Competition versus Practice injury rate ratio &gt; 1.00 and does not include 1.00 in the 95% CI.</p> <p><sup>a</sup>Overall injuries do not equal the sum of Practice and Competition injuries due to four injuries missing the event information (two are in the ankle and two are in the trunk).</p> <p><sup>b</sup>One player retired due to the injury.</p> <p><sup>c</sup>Including the chest, abdomen, upper back, and lower back.</p>		

## Injury types

All injuries except for tendonitis occurred more frequently in competitions than during practice (Table 3). Sprain (44.8%), contusion (13.5%), and strain (10.0%) accounted for the largest proportion of overall injuries. The most severe injury was cartilage injury (72.7% of all cartilage injuries; median, range of days lost = 60.5, 45–109).



Table 3

Injury Counts, Percentages and Rates (per 1,000 Athletes Exposures) by Type of Injury and Event in Japanese Collegiate Men's Basketball, 2013/2014–2019/2020

	<i>Practice</i>		<i>Competition</i>		<i>Overall</i>		% Severe (median of days loss, range)
	n	IR and 95% CI  (per 1,000 AEs)	n	IR and 95% CI  (per 1,000 AEs)	n	IR and 95% CI  (per 1,000 AEs)	
Sprain	155	1.73 (1.46– 2.00)	60	7.54 (5.63– 9.45)*	215	2.20 (1.91– 2.50)	15.8 (30, 22– 500)
Strain	39	0.44 (0.30– 0.57)	9	1.13 (0.39– 1.87)*	48	0.49 (0.35– 0.63)	16.7 (36, 22–82)
Contusion	38	0.42 (0.29– 0.56)	27	3.39 (2.11– 4.67)*	65	0.67 (0.50– 0.83)	9.2 (34, 24–120)
Concussion	5	0.06 (0.01– 0.10)	4	0.50 (0.01– 1.00)*	9	0.09 (0.03– 0.15)	11.1 (22)
Fracture	19	0.21 (0.12– 0.31)	8	1.01 (0.31– 1.70)*	27	0.28 (0.17– 0.38)	51.9 (49, 25– 139)
Dislocation / subluxation	7	0.08 (0.02– 0.14)	6	0.75 (0.15– 1.36)*	13	0.13 (0.06– 0.21)	30.8 (96, 87– 180)
Laceration	6	0.07 (0.01– 0.12)	6	0.75 (0.15– 1.36)*	12	0.12 (0.05– 0.19)	0
Tendonitis	31	0.35 (0.22– 0.47)	4	0.50 (0.01– 1.00)	35	0.36 (0.24– 0.48)	17.1 (32, 25–83)
Nerve injury	8	0.09 (0.03– 0.15)	0	0	8	0.08 (0.03– 0.14)	37.5 (24, 24–25) b
Cartilage injury	7	0.08 (0.02– 0.14)	3	0.38 (– 0.05–0.80)*	11 <sup>a</sup>	0.11 (0.05– 0.18)	72.7 (60.5, 45– 109)
Other	31	0.35 (0.22– 0.47)	3	0.38 (– 0.05–0.80)	37 <sup>a</sup>	0.38 (0.26– 0.50)	10.8 (65.5, 33– 96)

<i>Practice</i>	<i>Competition</i>	<i>Overall</i>
<p>AEs; athlete exposure(s): <i>Practice</i> = 89,559, <i>Competition</i> = 7,956, CI; confidence interval, IR; injury rate, IRR; injury rate ratio.</p> <p>*Competition versus Practice injury rate ratio &gt; 1.00 and does not include 1.00 in the 95% CI.</p> <p><sup>a</sup>Overall injuries do not equal sum of Practice and Competition injuries due to missing event information.</p> <p><sup>b</sup>One player retired due to the injury.</p>		

## Common injuries

Ankle sprain occurred most frequently (Table 4). Other common injuries occurred in the following order of frequency: lower back injury, thigh contusion, knee internal derangement, and hamstring strain. Ankle sprain, thigh contusion, and knee internal derangement were more frequent in competitions than during practice.

Table 4  
Common Injuries in Japanese Collegiate Men's Basketball, 2013/2014–2019/2020

Injury	<i>Practice</i>		<i>Competition</i>		<i>Overall</i>		
	n	IR and 95% CI (per 1000 AEs)	n	IR and 95% CI (per 1000 AEs)	n	IR and 95% CI (per 1000 AEs)	% Severe (median of days loss, range)
Ankle sprain	120	1.34 (1.10–1.58)	43	5.40 (3.79–7.02)*	163	1.67 (1.41–1.93)	11.7 (30, 22–104)
Lower back injury <sup>a</sup>	36	0.40 (0.27–0.53)	7	0.88 (0.23–1.53)	45	0.46 (0.33–0.60)	18.2 (25, 24–44)
Thigh contusion	25	0.28 (0.17–0.39)	12	1.51 (0.65–2.36)*	37	0.38 (0.26–0.50)	8.1 (36, 32–120)
Knee internal derangement	14	0.16 (0.07–0.24)	9	1.13 (0.39–1.87)*	23	0.24 (0.14–0.33)	65.2 (106, 30–500)
Hamstring strain	13	0.15 (0.07–0.22)	2	0.25 (–0.10–0.60)	15	0.15 (0.08–0.23)	33.3 (36, 22–82)
<p>AEs; athlete exposure(s): <i>Practice</i> = 89,559, <i>Competition</i> = 7956, CI; confidence interval, IR; injury rate, IRR; injury rate ratio.</p> <p>*Competition versus Practice injury rate ratio &gt; 1.00 and does not include 1.00 in the 95% CI.</p> <p><sup>a</sup>Overall injuries do not equal sum of Practice and Competition injuries due to 2 lower back injuries missing the event information.</p>							

## Comparison with the NCAA data (overall injury rates, common injuries)

Compared with the NCAA data, injury rates were higher in Japan (practice IRR = 1.38, 95% CI = 1.21–1.57, competition IRR = 3.58, 95% CI = 2.91–4.41, and overall IRR = 1.55, 95% CI = 1.39–1.73). Severe injury rates were also higher in Japan than in the NCAA (practice IRR = 2.19, 95% CI = 1.60–3.01, competition IRR = 4.39, 95% CI = 3.00–6.43, and overall IRR = 2.23, 95% CI = 1.69–2.94) (Table 1). Ankle sprains constituted the largest proportion of injuries in Japan, as in the NCAA; however, the rate was higher in Japan than that reported by the NCAA (IRR = 2.10, 95% CI = 1.72–2.57) (Table 5). The concussion rate in Japan was less than that reported by the NCAA (IRR = 0.28, 95% CI = 0.14–0.55).

Table 5  
Comparison of Common Injuries in Japan and NCAA Men's Basketball

Injury	Japan		NCAA		Japan vs. NCAA
	n	IR and 95% CI (per 1,000 AEs)	n	IR and 95% CI (per 1,000 AEs)	IRR and 95% CI
Ankle sprain	163	1.67 (1.41–1.93)	230	0.80 (0.69–0.90)	2.10 (1.72–2.57)*
Hand/wrist sprain	7	0.07 (0.02–0.13)	30	0.10 (0.07–0.14)	0.69 (0.30–1.58)
Concussion	9	0.09 (0.03–0.15)	97	0.34 (0.27–0.40)	0.28 (0.14–0.55) <sup>†</sup>
Hip/groin strain	5	0.05 (0.01–0.10)	30	0.10 (0.07–0.14)	0.49 (0.19–1.27)
Knee internal derangement	23	0.24 (0.14–0.33)	59	0.20 (0.15–0.26)	1.16 (0.71–1.87)
<p>AEs; athlete exposure(s): Overall in Japan = 97,515, CI; confidence interval, IR; injury rate, IRR; injury rate ratio.</p> <p>* Japan versus the NCAA data reported by Zuckerman et al., 2018<sup>3</sup> injury rate ratio &gt; 1.00 and does not include 1.00 in the 95% CI.</p> <p><sup>†</sup>The NCAA data reported by Zuckerman et al., 2018<sup>3</sup> versus Japan injury rate ratio &gt; 1.00 and does not include 1.00 in the 95% CI.</p>					

## Discussion

This study primarily aimed to describe the incidence of injuries in Japanese collegiate men's basketball between the 2013/2014 and 2019/2020 seasons. The incidence of injury was approximately four times higher in competitions than during practice. This result corresponded to previous reports that concluded that intensity demands are greater during competitions than during practice.<sup>5,14</sup> In particular, the severe IRR might accentuate the high activity intensity in competitions rather than in practice (IRR = 5.73, 95% CI = 3.66–8.96). Practice was not a separate entity in our investigation, although it included a variety of intensity contents (e.g., shooting drill, offensive or defensive moves, and scrimmages). The subdivision of events in practice would allow us to clarify the proportion of injuries.

Compared with a previous report,<sup>3</sup> the overall injury rates in Japan were 1.55 times higher than those reported in the NCAA. Additionally, overall severe injury (time lost for more than 21 days) in Japan was 2.23 times higher than that reported in the NCAA. A previous study concluded that more skilled athletes might be at a greater risk of potential injury.<sup>5</sup> Furthermore, the height and strength of basketball players would be directly proportionate to the impact of the force generated during play, which would thereby

potentially increase the risk of injury.<sup>5</sup> The present results were not consistent with those of previous studies, although there was a difference in performance levels between Japan (lacked participation in the 30th Universiade in 2019) and the United States (victors of the 30th Universiade in 2019) collegiate basketball. This might be due to insufficient medical support systems for Japanese collegiate athletes. Clifton et al. discussed that the possibility of lesser implementation of injury prevention strategies, such as coverage by full-time athletic trainers, in schools with relatively fewer resources might have resulted in their higher injury rate.<sup>5</sup> Our results indicate the necessity to recognize the deficiency of the availability of medical support for collegiate athletes in Japan.

## Injury mechanisms

The leading cause of injury was contact with another player (n = 228, 47.5%), and no contact was the second most common injury mechanism (n = 124, 25.8%). The present results support previous findings in collegiate men's basketball players.<sup>5, 6</sup> Details of the mechanism of injury may provide an important basis for injury prevention strategies.<sup>8, 15, 16</sup> A previous study reviewed 10-year epidemiology data of ankle injuries in the NCAA's basketball players and reported that 57.6% of ankle injuries were due to contact with another player, and 34.4% occurred during rebounding,<sup>4</sup> which is a specific activity among basketball players. In this study, the mechanisms of injury and activities were not recorded, thus indicating the need for a detailed description during data collection. According to the consensus statement of injury and illness surveillance from the International Olympic Committee, the contact mechanism was classified as direct or indirect (defined as any injury sustained through external forces that did not directly cause the injury but influenced the natural process of movement)<sup>17</sup> contact mechanisms.<sup>18</sup> A previous study reported that the majority of ACL injuries are due to no contact or indirect contact and involves uncontrolled biomechanics.<sup>19</sup> In particular, injuries caused by indirect external forces might be characteristic of basketball due to its specific activities (e.g., landing from aerial contact during a rebound or shot). The definition of the injury mechanism needs to be further clarified in future studies.

## Body site

Lower extremity injuries occurred most frequently (n = 353, 73.5% of total injuries). Similar to previous studies,<sup>3, 5</sup> the ankle was the most frequently injured part in this study on Japanese basketball players (35.8% of total injuries). However, injury of the knee, which was the second most frequent injury in NCAA men's basketball players,<sup>3, 5</sup> was not the second most common injury after injury of the ankle in Japan. A previous study examined the predictors of the knee valgus angle, which is a risk factor for ACL injury during drop-jump landing and reported the possibility that body height was associated with the knee valgus angle during landing.<sup>20</sup> The authors concluded that a greater body height, which correlated with femur and tibia length, provided longer lever arms and greater demands of strength to control the knee joint. It is inferred that the lesser proportion of knee injuries of the Japanese collegiate men's basketball players ( $189.0 \pm 7.0$  cm)<sup>21</sup> was on account of body height, which on average, was less than that of the NCAA men's basketball players ( $197.6 \pm 7.1$  cm).<sup>22</sup>

In the injury surveillance between the 2013/2014 and 2019/2020 seasons, only two cases of neck injuries that occurred in practice were reported. In one case, the player reportedly was forced to retire due to injury. Our results suggest the necessity to be mindful not only of the magnitude of the injury rate, but also of the possibility of serious incidence, even if it is lower than others. This awareness is also required while preparing for emergencies for all the staff, as well as spectators, on the basketball court.

## **Injury type**

Previous studies have reported that the most frequent injury types were sprain, strain, and concussion in NCAA men's basketball.<sup>5,6</sup> In Japan, sprain and strain were most frequent, as in the NCAA, although the frequency of concussion was different. The rate of concussion in Japan was significantly lower than that in the NCAA (Table 5). We believe that the concussion rate is not simply affected by the difference in activity intensity. In the NCAA, increasing sports-related concussions were observed after the new concussion policy<sup>23</sup> was adopted, and it was concluded that the increased sensitivity to concussion in players and medical personnel and reporting might reflect an increase in concussion incidence.<sup>24</sup> There is a possibility that in this study in Japan, such injuries that appeared mild but should have been considered as a "concussion," may have been overlooked. The rate of concussion in our study highlights the importance of judging appropriately. In 2015, the Japanese Society of Clinical Sports Medicine released "Ten articles for first-aid for head injury 2nd edition," which included contents based on recent findings in head injuries to help the decisions and actions of people who stand by the athletes (i.e., coaches and parents).<sup>25</sup> To continue the investigation, we could obtain more accurate findings for further research, addressing the incidence, prevention, and evaluation of public awareness of the importance of head injury.

## **Common injury**

Consistent with previous epidemiologic studies from the NCAA of collegiate basketball players, ankle sprain was the most frequent injury in Japan, as well. Interestingly, however, the incidence rate in Japan was 2.10 times higher than that reported by the NCAA. This apparent difference indicates the necessity to improve the recognition of ankle sprain in Japanese basketball players, especially for those below the collegiate category, which urgently needs improvement. Since a history of ankle sprain is the most common risk factor for recurrence (with an almost fivefold increased risk),<sup>26</sup> screening the history of ankle injury is the best way to identify the risk factor.<sup>4</sup> The high incidence of ankle sprains in Japan might be due to the environment surrounding young athletes. Moreover, some players, who had an ankle sprain, might have developed chronic ankle instability, which is characterized by recurrent ankle sprain.<sup>27</sup> Our results showed that the higher incidence of ankle sprain in Japan might be influenced by the history or process of treatment in younger generations. This study did not examine the history of ankle sprains, which is a potential risk factor. For an appropriate prevention program for the extremely high incidence of ankle sprain in Japanese collegiate basketball players, an investigation of the history of ankle sprain and prospective studies on the injury in youth basketball players are required.

## **Limitations**

To the best of our knowledge, this study is the first descriptive epidemiological study of Japanese collegiate men's basketball players. However, the surveillance size (7 years; 23 team-seasons; 97,515 AEs) was less than that in the NCAA report (6 years; 176 team-seasons; 289,406 AEs).<sup>3</sup> Since the epidemiological data would be an important outcome measure for further intervention investigation, expanding the scale of the survey and creating an appropriate environment for conducting it are necessary. We did not record the details of the activity, mechanism, or events during the injury. In particular, ankle injury, which had the highest incidence in this study, might be attributed to the nature of basketball, which involves rapid changes in direction, contacts, repetitive jumping, and landing activities.<sup>4</sup> The definition of each item should be carefully reviewed to develop additional research.

## Conclusion

We aimed to describe the incidence of injuries in Japanese collegiate men's basketball from the 2013/2014 to the 2019/2020 season and to investigate the unique patterns emerging from comparing the data with the men's NCAA basketball data, from their current research. The findings that the injury rate during competition is higher than that during practice, and that ankle sprain was the most common injury, were consistent. However, the rate of overall injury was 1.55 times and the rate of ankle sprain was 2.10 times higher in Japanese collegiate men's basketball players than in NCAA men's basketball players. Moreover, the rate of concussion was 0.28 times lower. We concluded that these results may have been influenced by the environment surrounding basketball players and the level of medical support available for various generations of Japanese athletes. Our results provide a foundation for future research aimed at injury prevention and suggest the urgent necessity to improve the medical support systems to protect basketball players from injury.

## Abbreviations

ACL: anterior cruciate ligament; AE: Athlete exposure; IRR: Injury rate ratio; KCBF: Kanto Collegiate Basketball Federation; NCAA: National Collegiate Athletic Association; NCAA-ISP: National Collegiate Athletic Association Injury Surveillance Program; UNIVAS: Japan Association of University Athletics and Sport; 95% CI: 95% confidence interval

## Declarations

### Ethics approval and consent to participate

Ethical approval for this study was obtained from the Human Ethics Review Committee of Teikyo Heisei University (No. R01-080-1).

### Consent for publication

Not applicable.

## Availability of data and material

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

## Competing interests

No potential conflicts of interest were reported by the authors.

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## Author's contributions

YS led to the study design, the statistical analysis, contributed to the interpretation of results, and oversaw the development of the manuscript. KK contributed to the study design, interpreted the results, and contributed to the development of the manuscript. TK contributed to the study design, interpretation of results, and development of the manuscript. SH contributed to the study design, interpretation of results, and development of the manuscript. TK co-led to the study design, supervised the statistical analysis, contributed to the interpretation of results, and oversaw the development of the manuscript. All authors read and approved the final manuscript.

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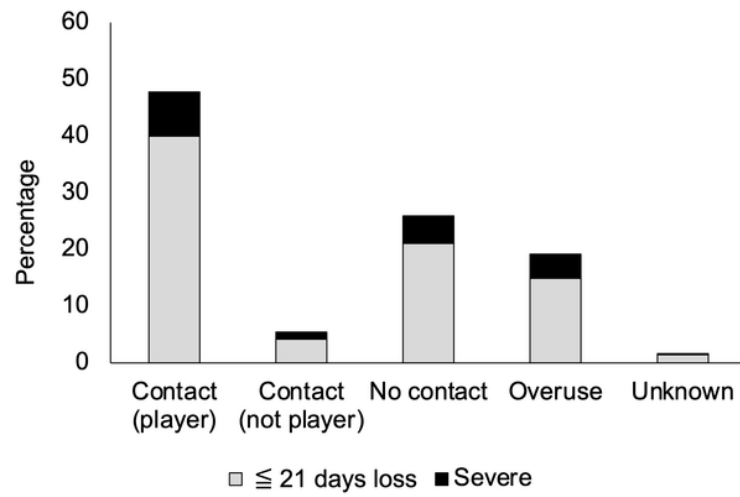
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## Figures



**Figure 1**

The Distribution of the Mechanisms of Injury Note: One injury in each of contact (player), contact (not player), no contact, and overuse had no time-loss recorded.