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Injury incidence and athlete availability through a single-season in an elite rugby union team in Japan

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ABSTRACT

Context: No studies report injury incidence for an elite rugby union team in Japan during the entire season. Also, no studies examine how athlete availability is affected because of injuries.

Objective: This investigation reported the injury incidence and athlete availability of the elite rugby union team in Japan and identified the injury characteristics. **Design:** Descriptive Epidemiology Study. **Setting:** Elite rugby union team in Japan. **Patients or Other Participants:** Fifty-seven players from one elite rugby union team participated in this study. The team participated in Japan's first elite rugby union league division. These consisted of 41 Japanese players, 8 South African players, 5 Tongan players, 2 New Zealand players, and 1 Australian player. **Data Collection and Analysis:** Injuries were recorded prospectively over 1 season. Athlete-exposure (AE), athlete-hour (AH), injury burden, and availability was analyzed. **Results:** As a result of this study, 72 time-loss injuries were identified throughout the single-season. Injury incidence in Japan's elite rugby union team is indicated as high in the field training and low during the official match compared to foreign leagues. Type of injury, muscle strain injuries in the lower leg and thigh, and concussion occurred most frequently. Athlete availability during the in-season phase was high throughout but tended to decline toward the latter half of the season. **Conclusions:** This investigation revealed the characteristics and incidence of injury and athlete availability of Japan's elite rugby union team. These data reveal focus points for injury prevention and provide beneficial information for strength and conditioning coaches and athletic trainers.

Keywords: athlete-exposure, athlete-hour, injury prevention

Keypoints: The lower in-season injury incidence compared to other national leagues may be due to pre-season training; The high injury burden of props in forwards and center in backs requires consideration when recruiting and conditioning for these positions

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Introduction

In an elite sports team, injuries influence the team's performance and financial burden on the organization. Therefore, injury prevention plays a critical role in the team's success.

The Qatari professional football league study reported that lower injury incidence was strongly correlated with team ranking position, more matches won, more goals scored, greater goal difference, and total points.[1] According to the investigation of European football clubs, there was a positive correlation between league standing and team success.[2] In rugby union, a negative correlation between injury and team success in English Premiership teams was reported.[3] The average cost of injuries increased by 56% from $25,603 in 2003 to $40,021 in 2012 due to hamstring strain injuries in Australian football league players despite little change in hamstring strain injury rates during the period.[4] Therefore, injury prevention impacts success in an elite sports team. Thus, strength and conditioning coaches and athletic trainers play a critical role in team performance due to the design of injury prevention training strategies.

As a fundamental injury prevention strategy, van Mechelen et al. suggested the sequence of prevention model,[5,] while Finch et al. explained translating research into injury prevention which indicated that injury prevention strategy should begin with the survey of injury incidence and severity.[6] Several investigations on injury incidence within rugby union exist, including systematic review through meta-analysis.[7] Through the systematic review, 91 injuries occurred per 1000 hours in rugby union official matches, which is greater than in other team sports. Also, 2.8 injuries occurred in 1000 hours of rugby union training.[7] However, this meta-analysis only collected data in Europe and South Africa, excluding Japan's elite rugby union teams.

Injury incidence and severity provide key information to prevent injuries. In addition, athlete availability is strongly correlated with injury incidence and severity, but it has not been reported in the literature. Analyzing chronological injury incidence and athlete availability through the season should be employed to provide insight into injury prevention strategies.

Considering the usefulness of injury data provided throughout the season, this investigation reported injury incidence and athlete availability in an elite rugby union team in Japan and compared these data with other leagues to identify the characteristics of injury incidence in the rugby union team in Japan.

Methods

Participants

This study was approved by the ethics committee of the University of Marketing and Distribution Sciences (approval number: 20210011). Fifty-seven players (mean ± standard deviation (SD); age, 26.7 ± 3.3 years; height, 178.6 ± 5.1 cm; body mass, 97.6 ± 13.3 kg) from one elite rugby union team participated in this investigation. The team participated in Japan's first elite rugby union league division. Participants consisted of 41 Japanese players, 8

South African players, 5 Tongan players, 2 New Zealand players, and 1 Australian player. Data were collected through the single-season in 2021 (from January to May).

Injury definition

Team doctors and the senior athletic trainer, who was certified through the Board of Certification, recorded and classified injuries. Injuries/pain which the team doctors and senior athletic trainers provided any treatment were subjected in this survey as the medical attention injury which utilized injuries with time-loss[8, 9]. Medical attention injury is classified into non-time-loss and time-loss. Bahr et al. defined time-loss as any injury that resulted in single or multiple absences from field training and match.[8] In this study, the doctor suggested the date of return to play and determined by both athletic training and strength and conditioning staff when players returned in the training after athletic rehabilitation provided by athletic trainers and reconditioning sessions provided by strength and conditioning coaches.

Subjected activities

All matches and field training sessions scheduled in the team activities were subjected. The field training sessions included rugby strategies and skills, as well as strength and conditioning training, such as fitness, speed, and agility training, were included. Off-field training, such as resistance training, was excluded. Moreover, injuries that occurred during the other matches and training (e.g., the national team training) that participated players joined were subjected to.

Injury classification

Subjected injuries were classified into location and type of injury, and severity. The location of injury was referred to the international standards according to Bahr et al.[8] Type of injury was based on the IOC Daily Medical Report on Injuries and Illnesses.[8] Injury severity was classified as the number of days that have elapsed from the injury date to the players' return to full match and training participation. Injuries were grouped as minimal (1–7 days), moderate (8–28 days), and severe (more than 29 days).[10]

Data analysis

Playing positions were grouped as forwards and backs. Moreover, all ten positions were analyzed. Injury incidence was calculated by athlete-exposure (AE) and athlete-hour (AH).[11, 12] Injury burden was also calculated to analyze injury severity.[13]

AE indicates injury incidence per 1000 times of match or training and its formula is below.

AE = (the number of injuries/athlete-exposure)×1000

AH indicates injury incidence per 1000 hours of match or training and its formula is below.

AH = (the number of injuries/athlete-hour)×1000

Strength and conditioning coaches recorded the number of participating players and the duration of the training and match play to calculate athlete-exposure and athlete-hour. The duration of training was sorted into entire duration and active duration. The entire duration was recorded from the beginning of the training, such as warm-up through the last training drill. Active duration excluded any time players were inactive, such as water breaks or coaches' explanations for the training drills on the field.

Injury burden indicated injury severity and influences and was calculated using the following formula.

Injury burden = injury incidence (how frequently injuries occur) ×injury severity (how many days are missed due to the injury)

Athlete availability

Athlete availability indicates the number or rate of players available for matches or training. In this study, athlete availability was the rate of players who were available to be selected as a member for the official match. There were 16 official matches in the 2021 season, so athlete availability was calculated for every match.

Statistical analysis

The mean and SD was used to display the study population data. Injury incidence was calculated for each position and phase. Injury severity indicated mean and 95% confidence interval. Quasi-Poisson generalized linear models estimated comparison of injury incidence.[14] Comparison of injury burden was evaluated as if the 95% CIs between comparisons did not overlap; it was deemed that the injury burden comparisons were significantly different.[15] Chi-square test was utilized to test the comparison for athlete availability. Statistical significance was set at $p < 0.05$. Effect sizes of <0.09, 0.10–0.49, 0.50–0.79, and >0.80 were considered trivial, small, moderate, and large, respectively.[16]

Results

Table 1 shows each position's 1000 AE, 1000 AH, and injury burden. Seventy-two time-loss injuries were identified throughout Japan's single-season of the elite rugby union team. While there was no significant difference between forwards (12.5/1000 AE, 12.6/1000 AH) and backs (12.1/1000 AE, 12.8/1000 AH), injury burden tended to be greater in backs (872.2 injury days/1000 AH, 95% CI (461.4 to 1279.4) than forwards (551.0 injury days/1000 AH, 95% CI (355.7 to 744.3). In 10 position comparison, props (267.3 injury days/1000 AH) and centers (403.1 injury days/1000 AH) were higher than each position group.

Table 2 shows 1000 AE, 1000 AH, and injury burden for activity type and phase. Match (practice match: 43.4/1000 AH, official match: 43.8/1000 AH) was higher significance than field training (9.2/1000 AH) (practice match; IRR: 4.798, 95% CI (2.274 to 9.114, $p < 0.001$, official match; IRR: 4.818, 95% CI (2.597 to 8.423, $p < 0.001$). Also, in the phase, pre-season (17.2/1000 AH) was significantly higher than in-season (IRR: 1.668, 95% CI (1.014 to 2.752, $p = 0.043$).

Results identified leg, knee, and thigh as frequently occurring injury locations, and these three types of injuries occupied 57% of total injuries (Figure 1). Results also identified that more than half of the injuries were severe (Figure 2). The cause of injury did not show significance between contact and non-contact (Figure 3). Soft tissue injuries occurred the most

(Figure 4).

Athlete availability averaged 76.4% ± 4.5% throughout all 16 official matches. The early official match phase (First 5 official matches) was significantly higher than the later phase (p = 0.01, d = 0.1, Figure 5).

Table1. Injury incidence and injury burden by each position for elite rugby union team in Japan

	Injury count (n)	Incidece (/1000AE)	Exposure time (active duration, h)	Incidence (/1000AH)	Severity[95%CI] (days missed)	Injury burden (days/1000AH)
Position group						
All player	72	12.4	5668	12.7	54.3 [37.7-70.9]	689.7
Forwards	41	12.5	3252	12.6	43.7 [28.2-59.1]	551.0
Backs	31	12.1	2417	12.8	68 [36.0-100.0]	872.2
Position						
Props	22	6.7		6.8	39.5 [29.2-49.9]	267.3
Hooker	7	2.1		2.2	28.3 [15.1-41.5]	60.9
Lokcs	4	1.2		1.2	51.7 [5.3-98.1]	63.6
Flankers	4	1.2		1.2	143.5 [9.2-277.8]	176.5
Number eight	5	1.5		1.5	31.4 [19.3-43.5]	48.3
Scrum half	3	1.2		1.2	7.3 [5.6-9.1]	9.1
Flay half	5	2.0		2.1	77.6 [17.7-137.5]	160.5
Centres	12	4.7		5.0	81.2 [11.2-151.2]	403.1
Wingers	6	2.3		2.5	40.5 [23.6-57.4]	100.5
Full backs	4	1.6		1.7	68.3 [-22.3-158.8]	113.0

Table2. Injury incidence and injury burden by each activity and each phase for elite rugby union team in Japan

	Injury count (n)	Incidece (/1000AE)	Exposure time (active duration, h)	Incidence (/1000AH)	Severity[95%CI] (days missed)	Injury burden (days/1000AH)
Activity type						
Field training	47	8.7	5136	9.2	42.1 [27.1-57.0]	385.2
Practice match	10	57.8	231	43.4	80.6 [1.2-160]	3494.2
Offcial match	15	59.3	343	43.8	68.5 [33.8-103.2]	2998.5
Season						
Off-season	9	7.3	850	10.6	60.8 [38.2-83.3]	643.4
Pre-season	33	18.2	1914	17.2	57.8 [26.7-88.9]	996.6
In-season	30	10.9	2904	10.3	45.2 [26.3-64.2]	467.0

Discussion

This investigation characterized injury incidence and athlete availability during a single-season of elite rugby union team play in Japan. Results from this investigation further support the need for adequate strength and conditioning training to prevent common injuries that afflict players and team success.

The number of injury occurrences and injury incidence

Seventy-two time-loss injuries were identified. Injury incidence was 12.4 in 1000 AE, and 12.7 in 1000 AH (Table 1). In activities, 47 injuries (8.7/1000 AE, 9.2/1000 AH) occurred during the field training, which consisted of 65% of total injuries, while 15 injuries (59.3/1000 AE, 43.8/1000 AH) during the official match, 10 injuries (57.8/1000 AE, 43.3/1000 AH) during practice match (Table 2). A previous review on senior men's professional rugby union showed 81/1000 AH (95% CI 63 to 105), 52/1000AH (95% CI 42 to 65) for New Zealand premier club rugby union, and another review in Australian rugby union players resulted in 74/1000 AH.[17-19] The survey from the Rugby World Cup 2015 indicated 90/1000 AH.[20] Therefore, this investigation shows a lower injury incidence in Japan's elite rugby union team. Nevertheless, in terms of injury incidence during the field training, a systematic review showed 6/1000 training hours, and English professionals resulted in 2/1000 AH (95% CI 1.8 to 2.2).[21, 22] These two investigations show lower injury incidence than the present study. Thus, injury incidence in the elite rugby union team is indicated as high in the field training and low during the official match.

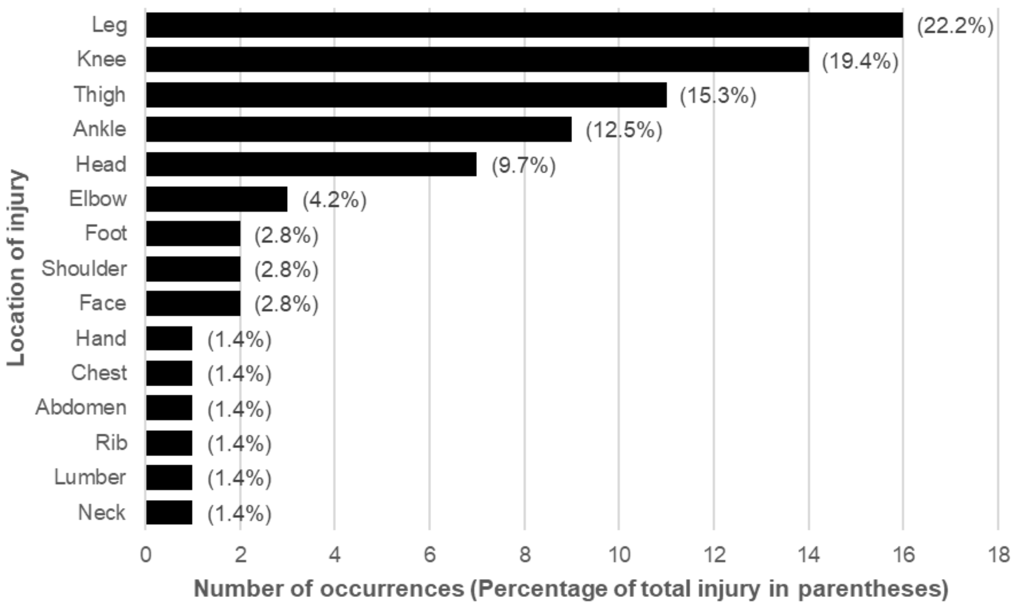

Figure 1. Location of injury in an elite rugby union team in Japan

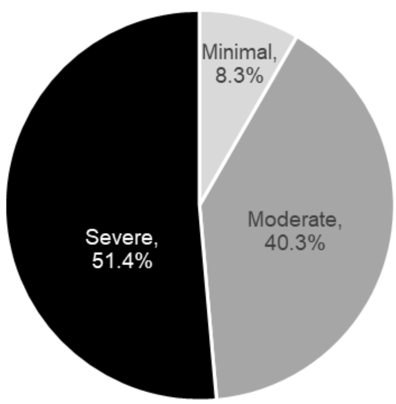

Figure 2. Injury severity in an elite rugby union team in Japan

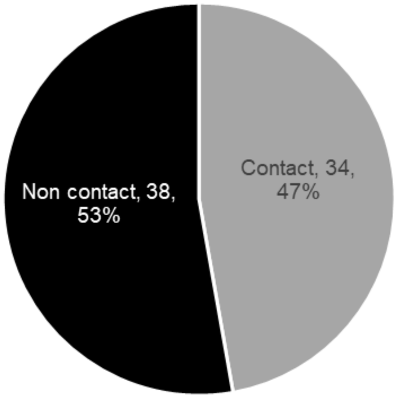

Figure 3. The rate between contact and non-contact in the elite rugby union team in Japan

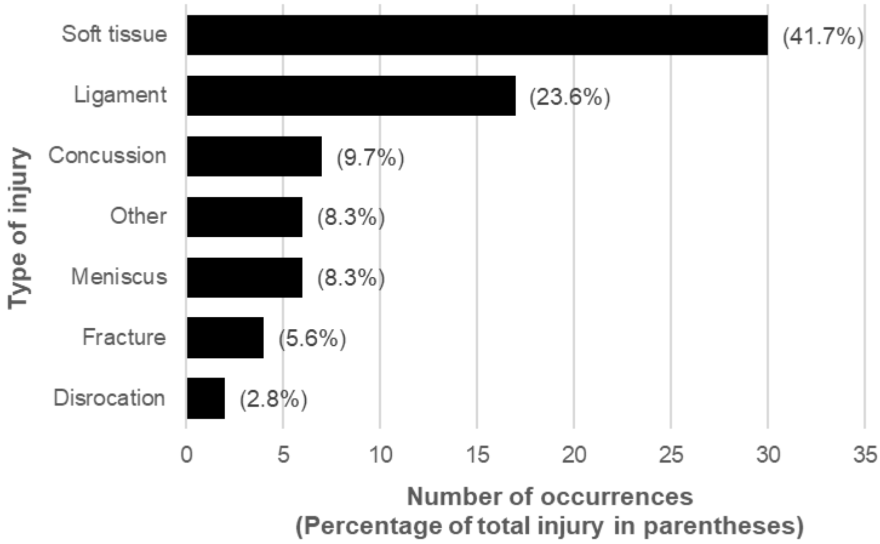

Figure 4. Injury types in the elite rugby union team in Japan

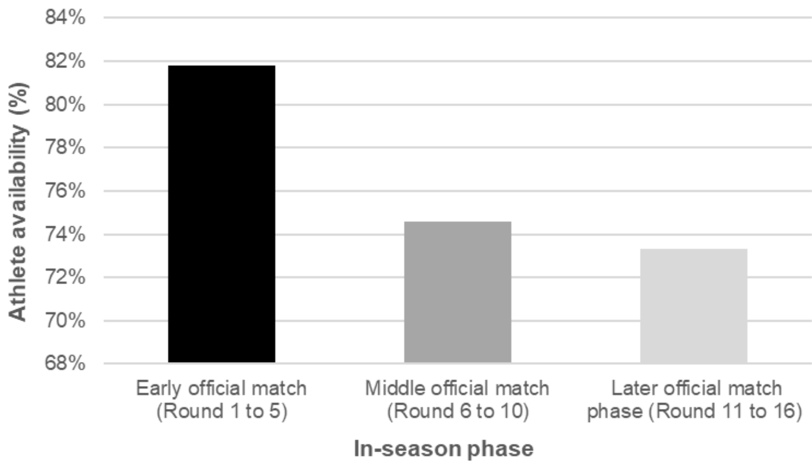

Figure 5. Athlete availability of official match phase in the elite rugby union team in Japan

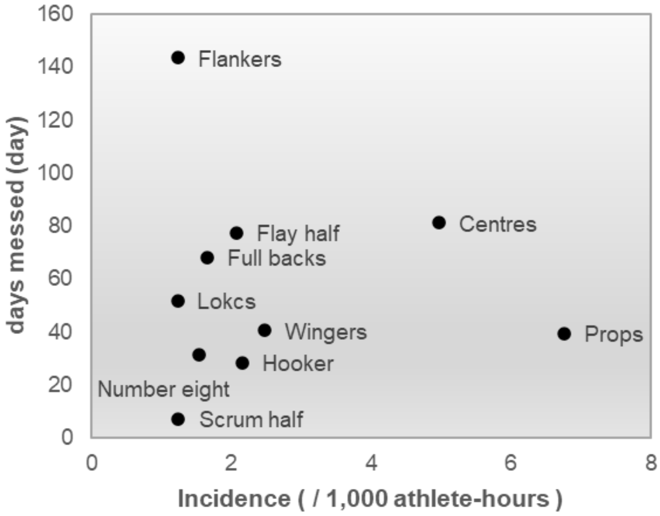

Figure 6. Scatter plots with injury incidence and severity as variables

Japan's elite rugby union annual schedule may impact these results. For example, Gaelic football players with higher chronic workloads were more robust to given increases in workload.[23] In some cases, athletes with greater pre-season training volumes have been shown to have a lower risk of injury during the season.[24, 25] As a characteristic of rugby teams in Japan, pre-season duration tends to be longer; this team had 19 weeks, which was more than the 10-week pre-season model from other literature.[26] Therefore, chronic load seemed high due to the longer pre-season, where the team spent a long time preparing for the season, causing lower injury incidence during the official match. However, longer pre-season, where the team had more training sessions, caused higher injury incidence during the field training.

Athlete position

Since there was no statistically significant relationship between forwards and backs in 1000 AE or 1000 AH, their injury incidence was not different. However, the injury burden was higher for backs, with 872.2 injury days per 1000 AH compared to 551.0 injury days per 1000 AH for forwards. Although there was no significant difference between forwards and backs in injury incidence, backs tended to suffer more severe injuries than forwards. When injury incidence was compared among 10 positions, prop from forwards and centers from backs had higher. As these two positions seemed to have more injuries than other positions, they tended to have higher body weight and more frequent contact than other positions.[27] Thus, these positions might have a higher load on lower extremity muscles due to their positional characteristics, leading to higher injury incidence. Flankers had a significantly greater injury severity than the other 10 positions. This is likely because flankers make frequent high-speed contact during attack and defense situations. High-speed contact increases momentum, so injury severity could be higher.

Figure 6 shows injury incidence and severity in a scatter plot, which clarifies the relationship between injury incidence and injury severity in Japan's elite rugby union. The variable goes toward the right in the chart, suggesting higher injury incidence.

Location of and type of injury

Anatomically, an injury occurred 72.2% (52 injuries) in the lower limb, 13.9% (10 injuries) in the head and neck, 9.7% (7 injuries) in the upper limb, and 4.2% (3 injuries) in the trunk. These findings are similar to that reported on Australian rugby union players.[19] While injury incidence is different in each league, the location of the injury may have similarities between Japan and other countries. Lower limb injuries were also detailed as a lower leg (16 injuries), knee (14 injuries), and thigh (11 injuries, Figure 1). In the lower leg, there were 8 muscle strains (50%) and 4 Achilles tendinitis (25%). Knee injuries included 6 ligamentous injuries (3 ACL; 3 MCL), 5 meniscal injuries (2 occurred with ligamentous injuries), and 3 cartilage injuries. 9 of 11 thigh injuries were hamstring strain injuries (82%). As a result, muscle strain injuries in the lower leg and thigh were the most injuries in the elite rugby union team.

Concussions occurred only in matches, and injury incidence was 13.0/1000 AH in a practice match and 11.7/1000 AH in an official match. Since the systematic review of concussion injury incidence was 4.7/1000 AH, Japan's elite rugby union team had more concussions.[28] While injuries that occurred during matches were fewer than in previous literature; concussions seemed to occur more frequently. A characteristic of the elite rugby union team in Japan was a lower rate of injuries during the in-season due to a longer pre-season with a high chronic load, leading to less influence on concussion. Preventive training for concussions may be necessary during pre-season, as a concussion is not usually related to workload.

Athlete availability

Athlete availability was 76.4% in the team during the season in this study. To our knowledge, there are no previous reports on the availability of rugby union teams throughout the season. This study showed athlete availability throughout the season, which may provide a new perspective on team sports success. Compared to other sports, European football clubs (match: 86%, training: 77%) or Swedish athletics athletes (78%) resulted similarly to this study.[2, 29] Considering that injury incidence tends to be high in rugby union, the elite rugby union team in Japan seemed to have higher athlete availability. However, as the season went on, athlete availability was dropping.

Calculation of injury incidence

Since 1000 AE and 1000 AH calculated injury incidence, analysis of playing positions did not confirm significant differences in each variable. This may be because of the active duration in exposure time utilized to calculate 1000 AH. The active duration is shorter than the entire duration because it excludes coaches' explanations and hydration time. Therefore, when active duration is utilized for exposure time, 1000 AH is higher than when the entire duration is used.

Conceptually, 1000 AE shows a higher value, but 1000 AH, based on active duration, calculates a higher value. Thus, the difference between these variables was reduced. On the other hand, differences between the 1000 AE and 1000 AH variables are observed when classifying by activity type or phase. The calculation of injury incidence requires using variables appropriate to the analysis method.

This novel study revealed the characteristics of injury incidence and athlete availability of Japan's elite rugby union team. However, this study is limited due to the small sample size collected over one competition season. Future investigations should examine multiple seasons and teams, which may provide beneficial information to inform strength and conditioning coaches and athletic trainers. In addition, these types of investigations may afford an improved understanding of the relationship between athlete availability and performance.

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