Epidemiology of Injury in a Japanese Women’s Collegiate Football Team: A Nine-Year Study

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Football is a sport where lower limb injuries are common in both genders. However, injury investigations have primarily focused on male players, with fewer studies addressing women. Specifically, there is limited research on injury epidemiology among women’s collegiate football players, leaving the current situation unclear. This study examines the epidemiology of injuries in women’s collegiate football over a nine-year period, focusing on (1) overall injury incidence, (2) injury location and type, (3) injury mechanism and circumstance, (4) injury severity and burden, and (5) recurrent injuries. The aim is to contribute to the existing knowledge on sports injuries and provide practical insights to mitigate injury risks and enhance the safety of women’s collegiate football players. Over nine seasons, a total of 357 injuries were recorded, of which 281 (78.7%) were classified as traumatic injuries and 76 (21.3%) as overuse injuries. The overall injury incidence rate was 5.4/1000 player hours. Data analysis revealed that ankle sprains were the most frequent injury, while ACL injuries caused the highest injury burden. Injury rates and burdens were significantly higher during matches compared to training. To mitigate match-related injuries, strategies should include monitoring individual player factors, adjusting training parameters (frequency, intensity, volume, type), and differentiating warm-up routines between training and matches.

Keywords: women, incidence, injury burden

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1. Introduction

Football is a high-intensity intermittent team sport that requires players to perform a variety of high-intensity movements, including repeated changes of direction, sprints, and accelerations/decelerations, physical contact and physically demanding technical actions in both sexes (Mohr et al.,2003; Bloomfield et al., 2007).

Football is a sport where lower limb injuries are common regardless of gender, but it has been reported that women’s players tend to suffer from injuries of greater severity compared to men’s players (Roos et al., 2016). It has been reported that women’s soccer players experience a higher incidence of anterior cruciate ligament (ACL) injuries compared to male soccer players (Clausen et al., 2014; Arendt et al., 2014).

As there are few reports on injury investigations among women’s collegiate football players, and the actual situation is not clear. Further, the current situation is that football injury investigations are more prevalent among men, with fewer reports focusing on women’s players. In particular, there are few reports on injury burden among women’s collegiate football players, as calculating burden requires detailed severity data, which is often difficult to collect in large-scale studies. This study focuses on a team with on-site medical staff, enabling the collection of precise severity data and providing valuable insights.

As a first step in injury prevention, investigating the incidence and severity of injuries to clarify the current status and characteristics is recommended (Mechelen et al., 1992). The epidemiology of injuries among female collegiate football players would be invaluable for tailoring prevention programs, developing return-to-play strategies, and generating hypotheses about plausible risk factors. Given these considerations, there is a pressing need for comprehensive, long-term studies focusing specifically on women’s collegiate

football players to gain deeper insights into injury patterns and inform the development of effective prevention strategies.

The aim of this study is to comprehensively investigate injury epidemiology among women's collegiate football players, with a focusing on several key areas: (1) the overall incidence of injuries, (2) the incidence of injuries location and type (3) injury mechanism and circumstance (4) injury severity and injury burden (5) recurrent injury.

By examining these aspects, the study seeks to provide a detailed understanding of the patterns and impacts of injuries within this group. The ultimate goal is to utilize the findings to aid in the development and refinement of injury prevention strategies. This research aims to contribute to existing knowledge on sports injuries and offer practical insights to mitigate injury risks and enhance the safety and well-being of women's collegiate football players.

2. Methods

2.1. Participants and study period

This prospective cohort study involved one Japanese women's collegiate football team over the years 2014–2022, spanning nine consecutive seasons (February to December). (**Table 1**) Presents the group characteristics for the study period. The participants were all competitors in significant tournaments, including the Empress's Cup (Japan Women's Football Championship) and the All-Japan University Women's Football Tournament. The ethics committee of Sendai University approved all procedures conducted in this study (approval number: 2022-kaku08). Informed consent was obtained from all subjects participating in the study. Informed consent was obtained from all subjects participating in the study. Informed consent was obtained from all participants annually before the start of each season.

2.2. Data collection

Data were collected and analyzed following the international consensus on epidemiological studies in professional football (Fuller et al., 2006). Injuries causing absence from at least one scheduled training session or match were recorded by the team's physiotherapist and assistant trainer and diagnosed by an orthopedic surgeon. An injury was defined as any incident during team-related activities (training or match-play) that prevented participation for one or more days. Injuries outside formal training and match-play were excluded.

2.3. Exposure

The individual player's exposure time during training sessions and matches (both training and competitive matches) was documented daily in minutes, considering only soccer-specific activities conducted on the field and excluding off-field or non-soccer-related training

2.4. Injury mechanism and situation

In this study, we examined the incidence of injuries during matches and training sessions. Acute injuries with identifiable onset were classified as traumatic, while those developing gradually were defined as overuse injuries. Additionally, injuries were categorized as contact or non-contact based on whether they involved contact with another player or object.

2.5. Injury location and type

Injury locations were documented as follows: head/face, neck/cervical spine, upper limbs, trunk, and lower limbs, with lower limbs further categorized into hip/groin, thigh, knee, lower leg, ankle, and foot.

Injury types were recorded as: concussion/brain injury, nerve injury, dislocation/subluxation, bone fracture, bone stress fracture, meniscus/cartilage injury, joint sprain/ligament injury, chronic instability, tendon injury, muscle strain/injury, muscle contusion, muscle compartment syndrome, laceration, contusion/bruise (superficial), arthritis, overuse injury and other injury (Fuller et al., 2006). Additionally, specific diagnoses for each injury were also recorded.

2.6. Injury severity

The severity of an injury was classified based on the number of days elapsed from the date of the injury to the date of the player's return to full participation. Injuries were categorized as minimal (1-3 days), mild (4-7 days), moderate (8-28 days), and severe (more than 28 days) according to the days lost (Fuller et al., 2006).

2.7. Injury burden

The burden of injuries, expressed as days lost per 1000 player-hours (Fuller et al., 2018), was determined by multiplying the incidence rate of injuries by their average severity (days lost per 1000 player-hours, days/1000ph).

2.8. Recurrent injury

The definition of a recurrent injury was established as "an injury of the same type and at the same site as an index injury, which occurs after a player's return to full participation from the index injury (Fuller et al.,2006). Recurrent injuries are classified based on the timing of their recurrence after a player's return to full participation: early recurrences (0-2 months), late recurrences (2-12 months), and delayed recurrences (more than 12 months) (Hagglund et al., 2024).

2.9. Data analysis

The incidences are reported as the number of injuries per 1000 player hours(1000ph) and calculated based on the value obtained by dividing the number of occurrences (No.) by the exposure time (h) and multiplying that value by 1000. The 95% confidence interval (95% CI) was also calculated for the incidence.

The 95% confidence intervals (95% CI) were calculated for incidence rates stratified by injury rate, mechanism, situation, location, type, injury burden, and recurrent injuries. Differences were considered statistically significant if the 95% CIs did not overlap.

3. Results

3.1. Exposure

The total exposure over the duration of the study period was 66,490.2 hours consisting of 13,746.7 match hours and 52,743.5 training hours.

3.2. Injury incidence

Over nine seasons, a total of 357 injuries were recorded. Of these, 281 (78.7%) were classified as traumatic injuries, while 76 (21.3%) were identified as overuse injuries.

The overall injury incidence rate was 5.4/1000ph (95%CI: 4.8-5.9), with significantly higher incidence observed during the matches (9.5/1000ph, 95%CI: 7.9-11.2) than during the training sessions (4.3/1000ph, 95%CI: 3.7-4.8).

The incidence rate of traumatic injuries (4.2/1000ph, 95%CI: 3.7-4.7) was significantly higher than that of overuse injuries (1.1/1000ph, 95%CI: 0.9-1.4).

Table 1 Team's players characteristics and exposure time from 2014 to 2022

Seasons	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Total**
Total number of players	23	28	35	27	28	23	19	27	26	236
Position*										
GK	2	2	5	4	4	3	2	2	2	26
DF	9	10	11	8	9	7	6	9	7	76
MF	7	11	12	8	7	4	6	10	11	76
FW	5	5	7	7	8	9	5	6	6	58
Physical characteristics										
Height (cm)	159.3±7.1	160.0±7.7	160.2±6.8	160.4±4.8	161.6±3.9	161.7±3.8	161.9±5.6	162.5±5.3	161.6±5.2	161.0±1.1
Weight (kg)	57.0±7.2	56.1±7.5	55.2±3.7	54.9±6.7	56.4±5.9	57.2±5.9	57.1±5.1	57.1±4.5	57.6±5.0	56.5±0.9
Body fat (%)	25.4±6.0	24.6±5.7	25.2±6.9	24.1±3.9	25.9±4.5	25.6±3.6	25.3±3.7	24.0±4.0	25.0±3.2	25.0±0.7
Exposure date										
Training	5661.5	5976.9	6866.7	5263.7	5992.3	5563.6	3933.2	7224.6	6261.0	52743.5
Match	2208.4	2671.5	2259.8	1318.7	1121.1	1714.1	480.0	894.2	1078.9	13746.7
total	**7869.9**	**8648.42**	**9126.5**	**6582.4**	**7113.4**	**7277.7**	**4413.2**	**8118.8**	**7339.9**	**66490.2**

*Position: GK (Goal keeper), DF (Defender), MF (Mid fielder), FW (Forward)

Table 2 Injury incidence according to mechanism and situation

	Total		Match		Training	
	Number	Incidence (95%CI)	Number	Incidence (95%CI)	Number	Incidence (95%CI)
All injuries	357	5.4 (4.8-5.9)	131	9.5 (7.9-11.2)	226	4.3 (3.7-4.8)
Mechanism						
Trauma	281	4.2 (3.7-4.7)	109	7.9 (6.4-9.4)	172	3.3 (2.8-3.7)
Overuse	76	1.1 (0.9-1.4)	23	1.7 (1.0-2.4)	53	1.0 (0.7-1.3)
Situation						
Contact	133	2.0 (1.7-2.3)	56	4.1 (3.0-5.1)	77	1.5 (1.1-1.8)
Non-contact	224	3.4 (2.9-3.8)	74	5.4 (4.2-6.6)	150	2.8 (2.4-3.3)

Injury incidence is defined as the number of injuries per 1000 hours.

Moreover, the incidence of non-contact injuries (3.4/1000ph, 95%CI: 2.9-3.8) was significantly higher than contact injuries (2.0/1000ph, 95%CI: 1.7-2.3). This pattern was also evident in the injury rate for matches, which were significantly higher (9.5/1000ph, 95%CI: 7.9-11.2) compared to the training sessions (4.3/1000ph, 95%CI: 3.7-4.8).

3.3. Injury location and type

Injury date for location and type are shown in **Table 3**.

A total 320 (89.6%) of injuries were in the lower extremities. The most common injury locations of injury were ankle (1.4/1000ph, 95%CI: 1.1-1.7), followed by knee (1.2/1000ph, 95%CI: 0.9-1.4), thigh (1.1/1000ph, 95%CI:0.9-1.4), were also frequently observed.

The most common injury types were joint sprain/ligament tear (2.1/1000ph, 95%CI:1.7-2.4), followed by muscle strain/rupture/tear (1.1/1000ph, 95%CI: 0.9-1.4), contusion/bruise and overuse (0.3/1000ph, 95%CI:0.2-0.5), also being observed frequently.

Injury characteristics and incidence rate are shown in **Table 4**. The most frequent injury characteristics and incidence rate was ankle sprain, according 90 cases (1.4/1000ph, 95%CI: 1.0-1.6) of all injuries.

Other common injury subtypes included thigh strain, with 64 cases (IR: 1.0/1000ph, 95%CI: 0.7-1.2). Among the thigh strains, quadriceps strains were more prevalent, with 33 cases (IR: 0.5/1000ph, 95% CI: 0.3-0.7), compared to hamstrings strains, which accounted for 26 cases (IR: 0.4/1000ph, 95% CI: 0.2-0.5).

3.4. Injury severity

In terms of overall severity incidence rates, moderate injuries (2.1/1000ph, 95%CI: 1.8-2.5) were significantly more frequent than minimal (0.7/1000ph, 95%CI: 0.5-0.9) and mild (0.9/1000ph, 95%CI: 0.6-1.1) injuries. While no significant difference was observed between moderate and severe injuries (1.5/1000ph, 95%CI: 1.2-1.8), moderate injuries tended to occur more frequently. These trends were consistent across both matches and training sessions (**Table 5**).

3.5. Injury burden

Injury burden, categorized by location and type, is detailed in **Table 6**.

The overall injury burden of match injury, among 326.8 days/1000ph, was significantly higher than that of training injuries, which in comparison was 176.7 days/1000ph.

In terms of the location specific injury burden, the ankle experienced a significantly higher CI than during the matches (66.9 days/1000ph) compared to the training sessions (24.0 days/1000ph). Conversely, the lower back had a significantly higher burden during the training sessions (6.6 days/1000ph) compared to the matches (0.2 days/1000ph).

The injury burden for joint sprains and muscle strains was significantly higher when occurring during the matches compared to those sustained during the training sessions.

On the other hand, the injury burden for overuse injuries was significantly higher during the training sessions (9.6 days/1000ph) than during matches (0.7 days/1000ph).

The injury burden for the characteristic described

Table 3 Injury incidence according to location and type

	Total		Match		Training	
	Number	Incidence (95%CI)	Number	incidence (95%CI)	Number	incidence (95%CI)
Injury location						
Head/face	8	0.1 (0.0-0.2)	7	0.5 (0.1-0.9)	1	0.0 (0.0-0.1)
Neck/cervical spine	1	0.0 (0.0-0.0)	0	0.0 (0.0-0.0)	1	0.0 (0.0-0.1)
Upper limb	15	0.2 (0.1-0.3)	2	0.2 (0.0-0.4)	13	0.3 (0.1-0.4)
Abdomen	4	0.1 (0.0-0.1)	0	0.0 (0.0-0.0)	4	0.2 (0.0-0.3)
Lowback	9	0.1 (0.0-0.2)	1	0.1 (0.1-0.2)	8	0.2 (0.0-0.3)
Hip/groin	23	0.3 (0.2-0.5)	7	0.5 (0.1-0.9)	16	0.3 (0.2-0.5)
Thigh	75	1.1 (0.9-1.4)	23	1.7 (1.0-2.4)	52	1.0 (0.7-1.3)
Knee	78	1.2 (0.9-1.4)	26	1.9 (1.2-2.6)	52	1.0 (0.7-1.3)
Lower leg/achilles	27	0.4 (0.3-0.6)	11	0.8 (0.3-1.3)	16	0.3 (0.2-0.5)
Ankle	95	1.4 (1.1-1.7)	44	3.2 (2.3-4.2)	51	1.0 (0.7-1.2)
Foot	22	0.3 (0.2-0.5)	9	0.7 (0.2-1.1)	13	0.2 (0.1-0.4)
Injury type						
Concussion/brain injury	3	0.1 (0.0-0.1)	3	0.2 (0.0-0.5)	0	0.0 (0.0-0.0)
Nerve injury	3	0.0 (0.0-0.4)	0	0.0 (0.0-0.0)	3	0.1 (0.0-0.1)
Dislocation/subluxation	5	0.1 (0.0-0.1)	1	0.1 (0.0-0.5)	4	0.1 (0.0-0.2)
Bone fracture	11	0.2 (0.1-0.3)	3	0.2 (0.0-0.5)	8	0.2 (0.0-0.3)
Bone stress fracture	3	0.1 (0.0-0.1)	1	0.1 (0.1-0.2)	2	0.0 (0.0-0.1)
Other bone injury	10	0.2 (0.1-0.2)	5	0.4 (0.1-0.7)	5	0.1 (0.0-0.2)
Meniscus/cartilage	21	0.3 (0.2-0.5)	5	0.4 (0.0-0.7)	16	0.3 (0.2-0.5)
Joint sprain/ligamet injury	138	2.1 (1.7-2.4)	57	4.1 (3.1-5.2)	81	1.5 (1.2-1.9)
Chronic instability	3	0.1 (0.0-0.1)	1	0.1 (0.1-0.2)	2	0.0 (0.0-0.1)
Tendon injury	7	0.1 (0.0-0.2)	3	0.2 (0.0-0.5)	4	0.1 (0.0-0.2)
Muscle strain/injury	76	1.1 (0.9-1.4)	22	1.6 (0.9-2.3)	54	1.0 (0.8-1.3)
Muscle contusion	17	0.3 (0.1-0.4)	6	0.4 (0.1-0.8)	11	0.2 (0.1-0.3)
Muscle compartment syndrome	1	0.0 (0.0-0.0)	1	0.1 (0.1-0.2)	0	0.0 (0.0-0.0)
Laceration	2	0.0 (0.0-0.1)	2	0.1 (0.1-0.3)	0	0.0 (0.0-0.0)
Contusion/bruise (superficial)	23	0.3 (0.2-0.5)	15	1.1 (0.5-1.6)	8	0.2 (0.0-0.3)
Arthritis	1	0.0 (0.0-0.0)	0	0.0 (0.0-0.0)	1	0.0 (0.0-0.1)
Overuse injury	22	0.3 (0.2-0.5)	4	0.3 (0.0-0.6)	18	0.3 (0.2-0.5)
Other injury	11	0.2 (0.1-0.3)	1	0.1 (0.1-0.2)	10	0.2 (0.1-0.3)
Total injuries	**357**	**5.4 (4.8-5.9)**	**130**	**9.5 (7.9-11.2)**	**227**	**4.3 (3.7-4.8)**

Injury incidence is defined as the number of injuries per 1000 hours.

is shown in **Table 7**. The ACL injury presented the highest frequency and burden, resulting in 82.9 days/1000ph. This was followed by ankle sprains, quadriceps strains, and hamstring strains, which were the most commonly sustained injuries.

3.6. Recurrent injury

Recurrent injuries constituted 17.6% of all injuries.

The overall incidence rate of recurrent injuries was 1.0 /1000ph (95% CI: 0.7-1.2), with a significantly higher incidence observed during the matches (1.9 /1000ph, 95% CI: 1.2-2.6) compared to the training sessions (0.7/1000ph, 95% CI: 0.5-0.9).

The most common location recurrent injury was the ankle, followed by the knee and thigh areas.

Joint sprain/ligament tear was the most common type of recurrent injury, followed by muscle strain/rupture/tear, each contusion/bruise and meniscus, also being observed frequently.

In detail, the most frequently occurring recurrent injury was ankle sprain (31.1%), followed by

Table 4 Injury characteristics and incidence rate

	Total		Match		Training	
	Number	incidence (95%CI)	Number	incidence (95%CI)	Number	incidence (95%CI)
Head						
Concussion	3	0.1（0.0－0.1）	3	0.2 (0.0-0.5)	0	0
Trunk						
Lower back pain	8	0.1（0.0－0.2）	1	0.1 (0.0-0.2)	7	0.1 (0.0-0.2)
Hip/Groin						
Groin pain	11	0.2（0.1－0.3）	1	0.1 (0.0-0.2)	10	0.2 (0.1-0.3)
Thigh						
Quadriceps strain	33	0.5（0.3－0.7）	13	1.0 (0.4-1.5)	20	0.4 (0.2-0.6)
Hamstrings strain	26	0.4（0.2－0.5）	7	0.5 (0.1-0.9)	19	0.4 (0.2-0.5)
Adductor muscle strain	5	0.1（0.0－0.1）	0	0	5	0.1（0.0－0.2）
Knee						
ACL injury	18	0.3 (0.2-0.4)	6	0.4 (0.1-0.8)	12	0.2 (0.1-0.4)
MCL	18	0.3 (0.2-0.4)	7	0.5 (0.1-0.9)	11	0.2 (0.1-0.3)
Meniscus	21	0.3 (0.2-0.5)	5	0.4 (0.0-0.7)	16	0.3 (0.2-0.5)
Lower leg/Achilles						
Shin splints	5	0.1（0.0-0.1）	2	0.2 (0.0-0.4)	3	0.1 (0.0-0.1)
Achilles tendon injury	4	0.1（0.0-0.1）	—	—	4	0.1 (0.0-0.2)
Ankle						
sprain	90	1.4 (1.0-1.6)	42	3.1 (2.1-4.0)	48	0.9 (0.7-1.2)

Injury incidence is defined as the number of injuries per 1000 hours.

Table 5 Injury severity

	Total				Match				Training			
Severity	**Number**	**%**	**Incidence**	**95% CI**	**Number**	**%**	**Incidence**	**95% CI**	**Number**	**%**	**Incidence**	**95% CI**
minimal	49	14.0	0.7	0.5-0.9	26	20.6	1.9	1.2-2.6	23	10.2	0.4	0.3-0.6
mild	58	16.5	0.9	0.6-1.1	19	15.1	1.4	0.8-2.0	39	17.3	0.7	0.5-1.0
moderate	142	40.5	2.1	1.8-2.5	48	38.1	3.5	2.5-4.5	94	41.8	1.8	1.4-2.1
severe	102	29.1	1.5	1.2-1.8	33	26.2	2.4	1.6-3.2	69	30.7	1.3	1.0-1.6

Injury incidence is defined as the number of injuries per 1000 hours.

hamstring strain (23.1%) and quadriceps strain (15.4%). Notably, 60% of recurrent thigh strains occurred within two months after the initial injury, indicating a tendency for earlier recurrence compared to other types of injuries.

4. Discussion

4.1. Injury incidence

The results show that the overall incidence rate was 5.4/1000ph (95%CI: 4.8-5.9). Furthermore, the incidence of injuries during the matches was significantly higher than during the training sessions.

Moreover, injuries resulting from traumatic injuries were significantly more frequent than overuse injuries. Additionally, the incidence of injuries during non-contact play was significantly higher than during contact play. However, during the matches, the incidence of injuries resulting from contact play was significantly higher than those from non-contact play. This can be attributed to the greater physical demands (Bangsbo et al., 2006) and number of collisions present (Hagglund et al., 2009) in matches compared to training.

While the rate of injury incidence found in the current study (5.4/1000ph) was lower than that reported in previous studies, which ranged from 6.7 to

Table 6 Injury burden according to location and type

	Total		Match		Training	
	burden (days/1000ph)	95%CI	burden (days/1000ph)	95%CI	burden (days/1000ph)	95%CI
Injury location						
Head/face	1.1	0.6-2.2	1.5	(0.7-3.2)	0.2	0.0-1.4
Neck/cervical spine	0.2	0.0-1.4	–	–	0.2	0.0-1.4
Upper limb	21.6	13.0-35.8	21.7	12.6-37.4	21	5.3-84.0
Abdomen	1.4	0.5-3.7	—	—	0.1	0.5-3.7
Lowback	3.0	0.5-3.7	0.2	0.0-1.4	6.6	3.3-13.2
Hip/groin	7.0	4.7-10.9	13.1	6.3-27.5	6.7	4.1-10.9
Thigh	15.1	12.0-18.9	21.6	14.4-32.5	14.2	10.8-18.6
Knee	117.6	94.2-146.8	169.3	115.3-248.7	104.2	79.4-136.7
Lower leg/achilles	12.7	8.7-18.5	19.2	10.6-34.7	11.2	6.9-18.3
Ankle	32.3	26.4-39.5	69.9	52.0-93.9	24.0	18.2-31.6
Foot	13.2	8.7-20.1	11.8	6.1-22.7	12.2	7.1-21.0
Injury type						
Concussion/brain injury	3.6	1.2-11.2	7.2	2.3-22.3	—	—
Nerve injury	2.2	0.7-6.7	—	—	4.3	13.3
Dislocation/subluxation	6.7	2.8-16.1	8.2	1.2-58.2	6.4	2.4-6.9
Bone fracture	13.1	7.3-23.7	8.2	1.2-58.2	12.6	6.3-25.2
Bone stress fracture	8.4	2.7-26.1	13	1.8-92.3	7.4	1.9-29.8
Other bone injury	19.2	10.3-35.7	45.8	19.1-110.0	7.8	1.9-29.8
Meniscus/cartilage	23.4	15.3-35.9	27.8	11.6-66.8	24.3	14.9-39.7
Joint sprain/ligamet injury	111.7	94.5-132.1	231.2	178.4-299.8	72.9	58.6-90.8
Chronic instability	0.4	0.1-1.1	1.3	0.2-9.2	0.2	0.0-0.6
Tendon injury	2.7	1.3-5.7	1	0.3-3.1	4.4	1.6-11.6
Muscle strain/injury	16.7	13.3-20.9	21	19.8-45.6	14.2	10.9-18.5
Muscle contusion	2	1.2-3.2	3.3	1.5-7.3	0.9	0.5-1.6
Muscle compartment syndrome	0.4	0.1-3.0	2.1	0.3-14.9	—	—
Laceration	0.2	0.1-0.8	0.7	0.2-2.8	—	—
Contusion/bruise (superficial)	2.8	1.9-4.2	10	6.0-16.6	16.2	8.1-32.7
Arthritis	0.2	0.0-1.4	—	—	0.2	0.0-0.2
Overuse injury	8	5.3-12.1	0.7	0.7-1.8	9.6	6.1-15.2
Other injury	5.7	3.2-10.3	3.1	0.4-22.0	5.7	3.1-10.5
Total	212.8	191.8-236.1	326.8	275.2-388.1	176.7	155.2-201.3

Injury burden is defined as the number of days lost per 1000 hours.

15.3/1000ph (Clausen et al., 2014; Hallén et al., 2024; Horan et al., 2023), the mechanisms and situations of injuries observed in this study were consistent with those identified in prior research (Frank et al., 2007; Faude et al., 2005; Horan et al., 2023).

Specifically, a higher incidence of injuries was observed during matches compared to training sessions, with the majority being non-contact injuries.

Consistent with previous studies, ligament injuries were observed more frequently than muscle injuries. This trend has also been noted in studies comparing male and female players, where ligament injuries are more prevalent among women, while muscle injuries are more common in men (Larruskain et al., 2017; Clausen et al., 2014). These differences may be attributed to biomechanical and hormonal factors, which likely contribute to the varying injury profiles between genders.

These results have been similarly reported in studies of men's soccer (Larruskain et al., 2017), suggesting that the relationship between injury incidence and soccer-related activities is significantly influenced by the unique characteristics of the soccer discipline itself.

Table 7 Injury characteristics and injury burden

	Total		Match		Training	
	burden (days/1000ph)	**95%CI**	**burden (days/1000ph)**	**95%CI**	**burden (days/1000ph)**	**95%CI**
Head						
Concussion	1.7	0.6-5.4	3.46	1.1-10.7	−	
Trunk						
Lower back pain	2.1	1.1-4.2	0.2	0.1-0.8	2.6	1.2-5.5
Hip/Groin						
Groin pain	4.7	2.6-8.5	2.6	0.4-18.5	4.4	2.4-8.2
Thigh						
Quadriceps strain	7.7	5.4-10.8	12	7.0-20.7	6.6	4.3-10.2
Hamstrings strain	5.7	3.9-8.4	9.6	4.6-20.1	4.9	2.7-8.9
Adductor muscle strain	1.8	0.8-4.3	―		1.8	0.7-4.2
Knee						
ACL injury	82.9	52.2-131.6	124.2	55.8-276.5	52.1	29.6-91.7
MCL	4.6	2.9-7.3	9.2	4.4-19.3	3.1	1.7-5.6
Meniscus	5.2	3.4-8.0	8.6	3.6-20.7	4.6	2.8-7.5
Lower leg/Achilles						
Shin splints	3.6	1.5-8.7	11.7	2.9-46.8	0.2	0.1-0.6
Achilles tendon injury	4.4	1.7-11.7	―		4.4	1.7-11.7
Ankle						
sprain	31.5	25.6-38.7	69.8	51.6-94.5	18.5	13.9-24.6

Injury burden is defined as the number of days lost per 1000 hours.

Table 8 Recurrent Injury characteristics and incidence rate

	Total		Match		Training		Classify		
	Number	incidence	Number	incidence	Number	incidence	early	late	delayed
Knee	13	0.2 (0.1-0.3)	6	0.4(0.1-0.8)	7	0.1 (0.0-0.2)	3	6	4
ACL	2	0.0 (0.0-0.1)	2	0.1 (0.1-0.3)	0	-	0	2	0
MCL	3	0.1 (0.0-0.1)	2	0.1 (0.1-0.3)	1	0.0 (0.0-0.1)	0	1	2
Meniscus	5	0.1 (0.0-0.2)	1	0.1 (0.1-0.2)	4	0.1 (0.0-0.4)	1	2	0
Contusion	2	0.0 (0.0-0.1)	1	0.1 (0.1-0.2)	1	0.0 (0.0-0.1)	1	1	0
Overuse	1	0.0 (0.0-0.0)	1	0.0 (0.0-0.0)	0		1	0	0
Thigh	12	0.2 (0.1-0.3)	4	0.3 (0.0-0.6)	8	0.2 (0.0-0.3)	7	5	0
Quadriceps strain	4	0.1 (0.0-0.2)	2	0.1 (0.1-0.3)	2	0.0 (0.0-0.1)	3	1	0
Hamstrings strain	6	0.1 (0.0-0.2)	2	0.1 (0.1-0.3)	4	0.1 (0.0-0.4)	3	3	0
Contusion	2	0.0 (0.0-0.1)	0	-	2	0.0 (0.0-0.1)	1	1	0
Ankle	28	0.4 (0.3-0.6)	13	0.9 (0.4-1.5)	15	1.1 (0.5-1.6)	3	14	11
Sprain	28	0.4 (0.3-0.6)	13	0.9 (0.4-1.5)	15	1.1 (0.5-1.6)	3	14	11

Injury incidence is defined as the number of injuries per 1000 hours.
※Recurrence classify
Recurrence within 2 months after complete recovery = "early recurrence"
Recurrence within 2-12 months after complete recovery = "late recurrence"
Recurrence after more than 1 year since complete recovery = "delayed recurrence"

4.2. Injury location and type

In total, 320 injuries (89.6% of all injuries) occurred in the lower extremities, with the ankle, knee, and thigh being the most commonly, affected areas. Furthermore, there were 138 cases of joint sprains (38.7% of all injuries) and 76 cases of muscle strains (21.3% of all injuries).

The most frequent injuries in our study were ankle sprains, followed by thigh strains.

Previous studies have not reached a consensus on whether ankle sprains or thigh strains have a higher injury incidence (Faude et al., 2005; Tegmander et al., 2008). This variation could be influenced by the level and characteristics of the teams under consideration (Tegmander et al., 2008; Horan et al., 2023). Given that previous studies reporting a high incidence of muscle strains involved competitions at a higher level and demanded greater intensity from the subjects, it was hypothesized that the incidence of ankle sprains would be notably high in this study.

The incidence of thigh strains, including both quadriceps strains and hamstring strains, was approximately equal in this study.

While it has not been clearly established on whether female soccer players are more prone to quadriceps strains (Larruskain et al., 2017; Oda et al., 2023) or hamstring strains (Hallén et al., 2023; Nilstad et al., 2014), reports indicate that there is a tendency for a higher incidence of quadriceps strains compared to male soccer players (Larruskain et al., 2018).

Furthermore, in recent years, women's soccer players are increasingly required to have possess high-speed, high-intensity capabilities (Atasever et al., 2023), which would suggest that prevention of strains has become even more necessary.

4.3. Injury severity

The highest incidence rate of injuries in our study was for moderate injuries. This result is consistent with previous studies at both youth (Beech et al., 2022) and professional levels (Hägglund et al., 2009). However, our results also showed a tendency for a higher incidence of severe injuries compared to other studies.

Severity of injuries is influenced not only by the damage from the injury itself but also by the level of medical support; a delayed diagnosis and/or less optimal rehabilitation of injured players could lead to more severe injuries (Horan et al., 2023; FIFA Benchmarking report., 2021). Therefore, it is considered important to establish a robust medical support system even at the collegiate level.

4.4. Injury burden

This study provides novel evidence that the injury burden associated with collegiate women's football is 212.8 days/1000ph (total), 326.8 days/1000ph (match), and 176.7 days/1000ph (training).

Injury burden is not commonly reported in Japanese collegiate women's football, with a large proportion of studies focusing on the incidence of injuries. In the absence of any comparable data in women's soccer, injury burden in foreign countries women's football can be used as a benchmark in comparison.

In this study, the injury burden is lower than in other reports. However, the finding that the injury burden is higher during the matches compared to the training is consistent with from previous results (Hallén et al., 2024; Bradley et al., 2020). Furthermore, the injury burden for ankle sprains, ACL injuries, and thigh muscle strains was also higher during the matches compared to the training. These findings demonstrate that the matches pose a greater risk of injury relative to the training.

Injury incidence rates in the matches than the training is common in soccer injury surveillance research. Injury incidence rates in matches compared to training are common in soccer injury surveillance research (Horan et al., 2023; Beech et al., 2022). Similar trends have also been observed in our study of injury burden. In particular, ACL injuries are associated with high severity, suggesting the importance of prevention strategy, especially among female football players.

Furthermore, while ankle sprains are less severe compared to ACL injuries, their higher frequency of occurrence suggests the importance of prevention strategies for ankle sprains.

Injury burden of thigh strains was slightly higher in the quadriceps than in the hamstrings.

While reports suggest that men's football players experience more muscle strains in the hamstrings than in the quadriceps (Larruskain et al., 2017), this trend is not consistent among female football players. Therefore, for women's football players, it is necessary to implement thigh muscle strain

prevention strategies that address both the quadriceps and hamstrings.

4.5. Recurrent injury

The overall recurrence rate was 17.6%, with ankle sprains showing a recurrence rate of 31.1% and hamstring strains having a recurrence rate of 23.1%.

Although recurrent injuries in the ankle and knee were often categorized as late recurrences, muscle strain injuries tended to show a higher tendency of being classified as early recurrences. Recurrence rates following hamstring injuries remain high, with previous studies reporting the highest incidence of re-injury within the first two weeks after returning to play (Orchard 2021; Orchard and Best.,2002; Brooks et al., 2006). Although no significant differences were found in our study, there was a trend observed where thigh strains tended to recur earlier. Therefore, the findings suggest that caution is particularly needed in regard to early return to play for muscle strains.

4.6. Limitation

While this study provides valuable insights into the incidence, severity, and burden of injury in Japanese women's collegiate football, it is not without limitations. Since the study focused on a single team, the injury location and severity may vary depending on the specific characteristics of the team, such as their training methods, physical conditioning programs, and competitive level. Therefore, caution is needed when generalizing the risk factors of injuries, as these factors may differ based on the competitive level and training environment of each team.

Furthermore, it is challenging to comprehensively understand the entire scope of injuries in this category based solely on this study. Future investigations should include a larger number of teams with varying competitive levels and training environments to more accurately elucidate the overall incidence of injuries in collegiate women's football. This will aid in generalizing the data to better represent the entire category and provide more comprehensive insights for injury prevention strategies.

5. Conclusion

This study found that the most common injury was ankle sprain, while the injury with the highest injury burden was an ACL injury. Additionally, the incidence rate and burden were significantly higher during matches compared to training.

These findings underscore the necessity of injury prevention strategies that address the distinct demands of matches and training. Effective prevention requires the systematic monitoring of training loads using tools such as GPS tracking, session RPE (Rate of Perceived Exertion), and heart rate variability.

Warm-up routines should differ between matches and training. For matches, the warm-up should focus on dynamic and high-intensity movements, while training sessions should emphasize controlled movements and gradual intensity.

It is believed that implementing evidence-based injury prevention programs, such as FIFA 11+(Bizzini and Dvorak., 2015), in the regular routines of women's collegiate football teams is necessary.

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