Muramoto et al.
BMC Sports Science, Medicine and Rehabilitation (2024) 16:175
https://doi.org/10.1186/s13102-024-00964-9

BMC Sports Science, Medicine and Rehabilitation

RESEARCH Open Access

Web-based survey on injuries among ultimate frisbee athletes in Japanese college sports: sex differences in injury location and onset

Yuki Muramoto[1], Takeshi Kimura[1], Akira Kinoda[1], Yuichi Yamada[1], Yoshinori Katsumata[1,2*] and Kazuki Sato[1]

Abstract

Background Ultimate Frisbee (Ultimate) has gained significant popularity. However, a comprehensive understanding of injury characteristics, including sex differences in injury location and onset, remains unclear. This study aimed to investigate the injury profile of male and female athletes using data from the Japanese University Athletic Association survey.

Methods Data were collected through a web-based survey conducted between June and October 2022, focusing on injuries sustained within the past year. Athletes provided detailed information, including injury location, severity, and onset pattern. This study utilized data collected through the UNIVAS survey, offering insights into the injury landscape among female Ultimate athletes. The study examined factors influencing lower limb injuries, including training days and the nature of contact during play.

Results A total of 116 athletes participated in the survey with 57 (49.1%) reporting injuries, of which 42 injuries involved the lower limbs. Lower-extremity injuries exhibited a higher likelihood of occurrence in female compared to male athletes ($p=0.05$, $\varphi=0.18$). Athletes with lower limb injuries demonstrated significantly more training days ($p=0.01$, Cohen's $d=0.76$). Non-contact injuries were more prevalent than contact injuries ($p<0.01$, $\varphi=0.53$), with non-contact injuries often causing prolonged interruptions in competition.

Conclusions Female Ultimate athletes experienced a high frequency of severe lower extremity injuries, particularly those stemming from non-contact incidents. More training days were an independent factor associated with these outcomes.

Keywords Japan Association for University Athletics and Sport (UNIVAS), Ultimate frisbee, Web-based injury survey

*Correspondence:
Yoshinori Katsumata
goodcentury21@keio.jp
[1] Institute for Integrated Sports Medicine, Keio University School of Medicine, 35 Shinanomachi Shinju-Ku, Tokyo 160-8582, Japan
[2] Department of Cardiology, Keio University School of Medicine, 35 Shinanomachi Shinju-Ku, Tokyo, Japan

Background

Ultimate frisbee (Ultimate) is a team sport played by seven athletes, involving strategic passing and carrying of a flying disc across a field measuring 100 m by 37 m without allowing it to touch the ground. Scoring is achieved by catching the disc in the end zone [1]. The sport has gained immense popularity with 1.5 million athletes registered with the Ultimate Association in the USA [2]. The number of athletes has been gradually increasing in Japan in the last decade as awareness of the sport has improved [3]. As safety awareness in sports increases, injury prevention has become a notable priority in various sports [4]. Several investigations on the causes of injuries in Ultimate have been reported. Approximately 70% of injury incidents in Ultimate involve the lower limb, likely due to the dynamic movements similar to those seen in football such as dashing, cutting, jumping, pivoting, throwing, and diving [5, 6]. Notably, Ultimate's distinctive self-judgement system promotes fair play and prohibits physical contact, contributing to a higher incidence of non-contact injuries [2, 6, 7]. The risk of injury, including non-contact and contact injuries, is reported to be higher during competition than during practice [6]. Research consistently highlights sex-based differences in lower limb injury rates with females exhibiting a higher risk [5, 8]. In Ultimate, as in other sports such as football, a higher risk of lower limb injury is considered to occur in female athletes due to the high level of jumping and cutting [9]. However, detailed insights into injury onset, circumstances, and timing remain largely unknown.

Therefore, an injury survey among athletes from several teams affiliated with the Japanese Collegiate Athletic Association (UNIVAS) was conducted to examine the sex difference related to the detailed injury information (sites and types of injury) in Ultimate. Based on previous reports, the hypothesis of this study was that female Ultimate athletes would be at higher risk of non-contact lower limb injuries.

Methods

Research design

In this cross-sectional observational study, data were collected through a web-based survey conducted between June and October 2022. This study was approved by the Ethics Committee of our institution (approval number: 20211158). All participant provided informed consent prior to participation in the study. The study was conducted in compliance with the principles of the Declaration of Helsinki, and all reporting followed the guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Extension for Sports Injury and Illness Surveillance (STROBE-SIIS) consensus statement [10, 11].

Athlete recruitment

The survey was sent to the coaches of 128 universities with an Ultimate Club in UNIVAS. Coaches were asked to disseminate surveys to all athletes who were participating in an Ultimate Club at the time of survey distribution. Athletes read the study information sheet and provided written consent before participating in the survey. The inclusion criteria required athletes to be currently participating in competitions.

Survey questions

The survey was administered through a dedicated website created specifically for this research. The survey questions were derived from the Japanese Society of Clinical Sports Medicine and the Japanese Society for Athletic Training consensus document [12] and modified to suit collegiate athletes [13]. The questionnaire used in this study was validated using the Delphi method, which is well agreed upon by experts involved in sports science. The survey encompassed athletic characteristics (age, height, and weight), sports participation (sporting experience and training times per week), and injuries sustained within the past year ("Have you had any injuries in the last year [April 2021–March 2022] in your main sports?"). For the three most serious injuries reported, follow-up questions were posed to gather specific details, including the injury's location, severity, type, time of onset, onset pattern, duration of absence from sports participation, and diagnosis. Injury severity was determined based on the duration of absence from training/competition, and classified using a modified Bahr-Bowen approach [11]. Injury severity was rated as: non-time absence (0 days absence), mild (1 day to 1 week absence), moderate (1 week to 1 month absence), severe (1–6 months absence), and very severe (>6 months absence). The onset patterns of injuries were classified as contact or non-contact [12].

Data analysis

IBM SPSS Statistics (IBM Corp., IBM SPSS Statistics for Macintosh, Version 28.0. Armonk, NY, USA) was used for statistical analysis. This study collected both qualitative and quantitative data, presented as frequency and mean and standard deviation, respectively. Discrete data are presented as counts and percentages.

The chi-squared test was employed to compare differences in injury characteristics, such as location, setting, onset pattern, and injury severity, between female and male athletes. The injury rate ratios (IRR) were calculated as the ratio of female-to-male injury ratios. The phi (φ) coefficient was calculated to measure the effect size between sex and injury ratios. To characterize lower limb injuries among female athletes, an unpaired t-test and a chi-squared test were employed to compare groups with and without lower limb injuries. Severe and very severe injuries in female Ultimate athletes were combined as "severe" as indicated in the figures (Figs. 1, 2, and 3). Statistical significance was set at $p \leq 0.05$.

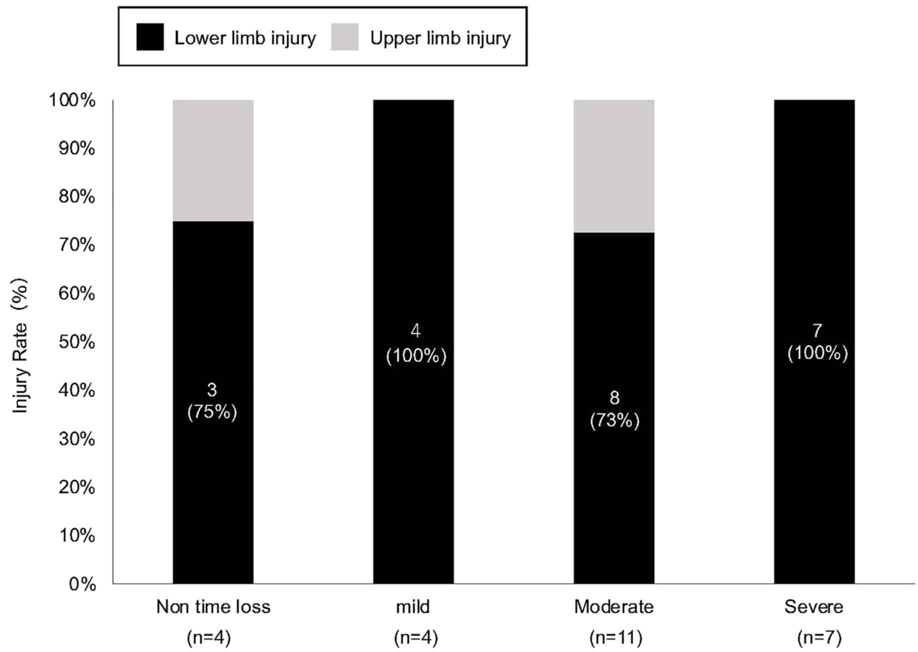

Fig. 1 Injury severity and percentage of upper and lower limb injuries. Injury rates are presented as a bar chart, with the number shown on each bar indicating the number of injured athletes (percentage). Black bars indicate lower limb injuries, and gray bars indicate upper limb injuries

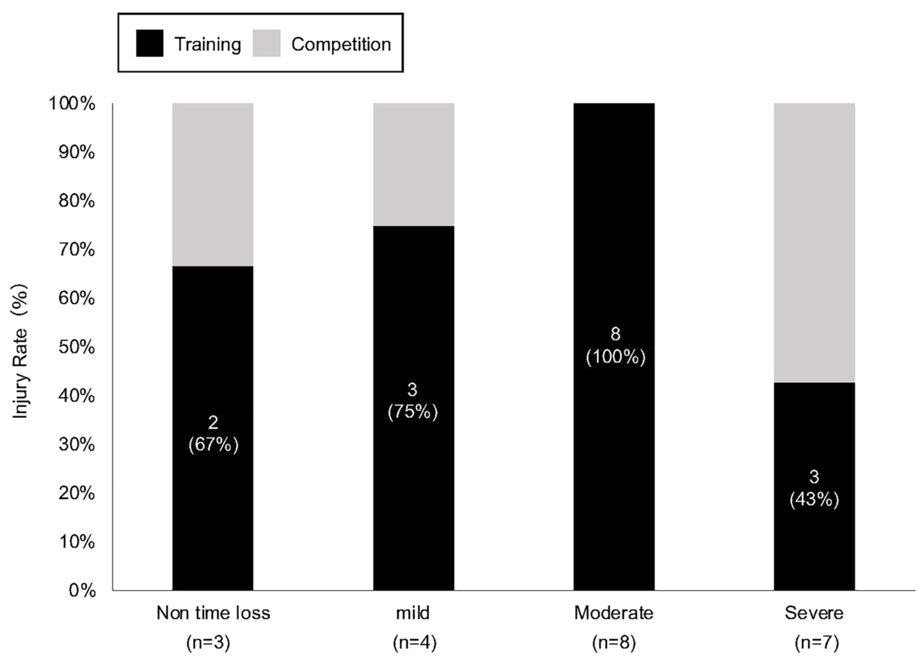

Fig. 2 Lower extremity injury in female athletes—severity and setting. Injury rates are depicted in the bar graph, with the numbers displayed on each bar indicating the number of athletes (percentage). Black bars indicate training, and gray bars indicate competition

Results

A total of 116 athletes (46 female athletes) from 36 of the 128 universities (28%) with Ultimate Clubs completed the web-based survey. The athletes exhibited an average height of 166.4 ± 8.5 cm, average mass of 58.1 ± 8.0 kg, average BMI of 20.9 ± 1.7, average age of 20.4 ± 1.3, and an athletic career spanning an average of 2.4 ± 1.4 years. A comparative analysis was conducted between male and

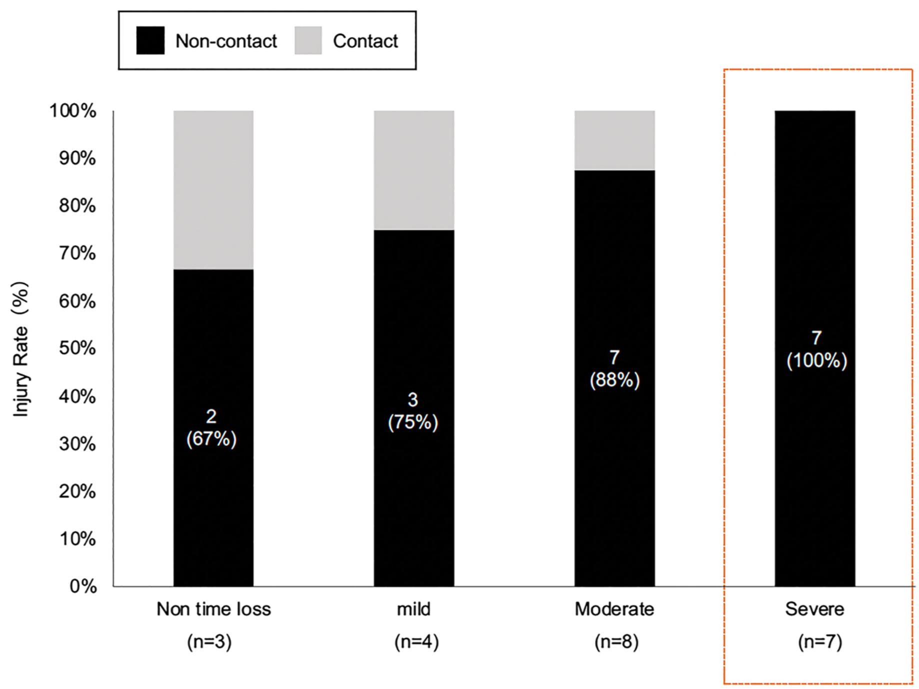

Fig. 3 Lower extremity injury in female athletes—severity and onset pattern. Injury rates are depicted in the bar graph, with the numbers displayed on each bar indicating the number of athletes (percentage). Black bars indicate non-contact, and gray bars indicate contact

female athletes to assess the characteristics of injuries and factors associated with injury incidence.

Characteristics of injuries occurring in ultimate

Among the 116 athletes surveyed, 49.1% (57 of 116) reported sustaining an injury within the past year (April 2021 to March 2022). No significant differences in physical characteristics were found between injured and non-injured athletes (Table 1). No significant sex-related differences were observed in the overall injury percentage ($p = 0.36$, $\phi = 0.08$, IRR = 1.41). However, lower limb injuries, including those affecting the hip, thigh, knee, lower leg, ankle, and foot, were more prevalent in female than in male athletes ($p = 0.05$, $\phi = 0.18$, IRR = 1.37) (Table 2). Self-reported ligament injuries and contusions were the most common injury types (seven and eight of 57, respectively). Undiagnosed injuries accounted for the highest frequency (41 of 57). Regarding the onset pattern of injuries, non-contact injuries were significantly higher in female athletes ($p = 0.03$, $\phi = 0.20$, IRR = 1.46) (Table 2). No significant differences were identified in other factors.

Characteristics of female athletes with lower limb injuries

Among lower and upper extremity injuries observed in female athletes, severe injuries that disrupted competition participation for more than 1 month predominantly occurred in the lower extremities (Fig. 1). Thus, we conducted an additional analysis on the characteristics of female athletes with lower limb injuries causing severe disability. The training day (mean difference = 0.62 day/week, 95% confidence interval [CI] = 0.13–1.1, $p = 0.01$, Cohen's d = 0.76) was significantly higher in athletes with lower limb injuries (Table 3). Other injury-related factors, such as body mass index (mean difference = 0.41 kg/m^2, 95% CI = -0.39 to 0.78, $p = 0.51$, Cohen's d = 0.20) and athletic history (mean difference = -0.62 years, 95% CI = -0.97 to 0.20, $p = 0.09$, Cohen's d = -0.40), did not show significant differences. Furthermore, lower limb injuries in female athletes tended to occur during training sessions ($p = 0.07$, $\phi = 0.36$, IRR = 1.41) (Table 4). The overall injury rate was greater in training than in competition (73%; 16 of 22 injuries). However, considering severe injuries alone, 57% (4 of 7 injuries) of severe injuries occurred during competition (Fig. 2). Additionally, lower limb injuries were more frequent in non-contact than in contact situations ($p < 0.01$, $\phi = 0.53$, IRR = 10.0) (Table 4). Contact injuries were generally minor (mild or lower) without disrupting competition, whereas non-contact injuries frequently led to prolonged competition interruptions (moderate or above). Notably, all severe injuries were non-contact

Table 1 Characteristics of injured and non-injured athletes

All (*n* = 116)	Injured (*n* = 57)	Non-injured (*n* = 59)	Mean difference (95%CI)	*p*-value	Cohen'd (95%CI)
Height (cm)	166.3 ± 8.5	166.6 ± 8.6	-0.25 (-3.39–2.88)	0.87	-0.03 (0.39–0.33)
Mass (kg)	58.3 ± 8.0	57.8 ± 8.1	0.48 (-2.47–3.44)	0.75	0.60 (-0.30–0.42)
BMI (kg/m^2)	21.0 ± 1.9	20.7 ± 1.6	0.26 (-0.38–0.91)	0.42	0.15 (-0.21–0.51)
Age (y/o)	20.5 ± 1.2	20.3 ± 1.4	0.24 (-0.25–0.69)	0.35	0.17 (-0.19–0.54)
Athlete career	2.4 ± 1.0	2.5 ± 1.6	-0.10 (-0.60–0.39)	0.67	-0.07 (-0.44–0.28)
Male (*n* = 70)	Injured (*n* = 32)	Non-injured (*n* = 38)	Mean difference (95%CI)	*p*-value	Cohen'd (95%CI)
Height (cm)	172.2 ± 5.5	171.5 ± 5.8	0.65 (-2.05–3.35)	0.63	0.15 (-0.36–0.58)
Mass (kg)	62.6 ± 6.0	61.6 ± 6.5	1.02 (-2.00–4.04)	0.50	0.16 (-0.31–0.63)
BMI (kg/m^2)	21.1 ± 1.5	20.6 ± 1.1	0.21 (-0.51–0.92)	0.56	0.14 (-0.33–0.61)
Age (y/o)	20.6 ± 1.1	20.2 ± 1.4	0.39 (-0.21–0.98)	0.20	0.31 (-0.16–0.78)
Athlete career	2.4 ± 1.1	2.2 ± 1.2	0.19 (-0.36–0.74)	0.48	0.17 (-0.30–0.64)
Female (*n* = 46)	Injured (*n* = 25)	Non-injured (*n* = 21)	Mean difference (95%CI)	*p*-value	Cohen'd (95%CI)
Height (cm)	158.8 ± 4.8	157.6 ± 4.6	1.21 (− 1.62–4.04)	0.39	0.26 (− 0.33–0.84)
Mass (kg)	52.8 ± 6.8	51.0 ± 5.9	1.78 (− 2.04–5.61)	0.35	0.28 (− 0.31–0.86)
BMI (kg/m^2)	20.9 ± 2.3	20.5 ± 1.8	0.41 (− 0.84–1.66)	0.51	0.20 (− 0.39–0.78)
Age (y/o)	20.4 ± 1.2	20.5 ± 1.5	− 0.04 (− 0.85–0.78)	0.92	− 0.03 (− 0.61–0.55)
Athlete career	2.3 ± 1.0	2.9 ± 2.1	− 0.62 (− 1.59 0.34)	0.19	− 0.39 (− 0.97- 0.20)

Results showed as mean and standard deviation

Athlete career: Years between when the athlete started competing and when the questionnaire is asked

BMI Body mass index

injuries (Fig. 3, area enclosed by the orange dotted square line).

Discussion

This web-based survey conducted among university athletes revealed notable insights into the occurrence and characteristics of lower limb injuries, particularly among female Ultimate athletes. As hypothesized, female Ultimate athletes exhibited a significantly higher incidence of lower limb injuries compared to male Ultimate athletes, many of which were sufficiently severe to cause disruptions to competition lasting > 1 month. Additionally, non-contact incidents were associated with the occurrence of moderate-to-severe injuries.

Characteristics of injuries in ultimate

Among the 116 athletes surveyed, 57 injuries (57 athletes) were recorded, with 42 involving the lower limbs. Ultimate involves various lower extremity movements, such as dashing, cutting, jumping, pivoting, throwing, and diving [5, 14]. Previous research has attributed the high incidence of lower limb injuries to these dynamic movements inherent in Ultimate [6]. Approximately 70% (41 of 57 injuries) were reported as undiagnosed in this study, possibly suggesting inadequate medical support in the surveyed teams. However, approximately half of the National Collegiate Athletes Association (NCAA) affiliated Ultimate teams had access to medical support from athletic trainers with only 21.6% (287 of 1317 injuries) reported as undiagnosed [2]. In Japan, a study across 23 teams belonging to university basketball federations recorded 7.7% (37 of 480 injuries) of injuries as undiagnosed [15]. In the present study, only 14% (five of 36 participating teams) had support from athletic trainers, potentially contributing to the undiagnosed injuries observed. This underscores the urgent necessity for the establishment of a robust medical support system within the Japanese Ultimate community.

Characteristics of female ultimate athletes with lower limb injuries

Female Ultimate athletes had a significantly higher incidence of lower limb injuries, approximately 1.4 times higher than that of male Ultimate athletes, consistent with previous reports on Ultimate wherein female athletes had approximately 2.8 times higher knee- and ankle-joint injuries than did male athletes [7]. Lower extremity injuries in female athletes often presented as moderate to severe, heightening the risk of competition interruption for a week or more. Female athletes may be at greater risk for injuries due to biomechanical factors (knee valgus) [16], insufficient muscle strength [17], or hormonal influences that affect ligament laxity [18] during landing and cutting motions; however, these risk factors were not assessed during the current study. In addition, non-contact incidents were a predominant contributing factor,

Table 2 Comparison of sex differences in injury location, setting, onset pattern and injury severity

Injury Location	All ($n=116$)	Men ($n=70$)	Female ($n=46$)	p-value	Injury Rate Ratio (95%CI)	*phi(φ) coefficient*
Head/Face	0	0	0	N/A	N/A	*N/A*
Neck	0	0	0	N/A	N/A	*N/A*
Shoulder	2	2	0	N/A	N/A	*N/A*
Elbow	1	0	1	N/A	N/A	*N/A*
Wrist/Finger	8	6	2	0.38	0.79 (0.51–1.21)	*-0.08*
Trunk	1	1	0	0.42	0.60 (0.52–0.70)	*-0.08*
Hip	2	1	1	0.76	1.21 (0.30–4.88)	*0.03*
Thigh	10	6	4	0.98	1.01 (0.59–1.73)	*0.00*
Knee	8	3	6	0.17	1.65 (0.67–4.10)	*0.16*
Lower leg	1	0	1	N/A	N/A	*N/A*
Ankle	14	8	6	0.79	1.06 (0.66–1.72)	*0.02*
Foot/Toe	6	2	4	0.17	1.85 (0.59–5.81)	*0.12*
Other	4	3	1	N/A	N/A	*N/A*
All	*57*	*32*	*25*	*0.36*	*1.41(0.67–2.98)*	*0.08*
Upper / Lower						
Upper limb	11	8	3	0.38	0.81 (0.55–1.21)	*-0.08*
Lower limb	**42**	**20**	**22**	**0.05***	**1.37 (1.01–1.98)**	*0.18*
Setting						
Training	*38*	*22*	*16*	0.71	1.06 (0.39–1.89)	*0.05*
Competition	*19*	*10*	*9*	0.19	1.32 (0.82–2.13)	*0.07*
Onset pattern						
Contact	20	16	4	0.14	0.76 (0.56–1.03)	*-0.13*
Non-Contact	***37***	***16***	***21***	***0.03****	***1.46 (1.00–2.14)***	*0.20*
Injury severity						
Non time loss	10	6	4	0.98	1.01 (0.59–1.71)	*0.00*
Mild	12	8	4	0.64	0.89 (0.58–1.38)	*-0.04*
Moderate	21	11	11	0.31	1.25 (0.79–1.99)	*0.10*
Severe	12	6	6	0.38	0.79 (0.51–1.21)	*0.07*
Very severe	2	1	1	0.76	1.21 (0.30–4.87)	*0.02*

CI Confidence interval, *N/A* Not analysis

* $p<0.05$

Table 3 Characteristics of female athletes with lower limb injuries

	Lower limb injury (+)	Lower limb injury (-)	Mean difference (95%CI)	p-value	Cohen'd (95%CI)
Training day (day/week)	**3.8 ± 1.0**	**3.1 ± 0.6**	**0.62 (0.13–1.1)**	**0.01***	**0.76 (0.15–1.36)**

Results showed as mean and standard deviation

CI Confidence interval

* $p<0.05$

and more training days emerged as an independent factor associated with lower extremity injuries. In sports such as football, athletics, and volleyball, non-contact muscle and tendon injuries are prevalent, and studies have highlighted training volume [19], such as running distance [20] or the number of jumps [21–23], as a key factor in lower-extremity disorders. As Ultimate incorporates movements akin to these sports, the training volume emerged as a comparable factor for lower limb injuries. Comparison with other sports emphasizes the importance of regulating training volume in preventing lower limb injuries in Ultimate athletes. In the present study, fewer contact injuries were self-reported and there was less disruption to competition participation from contact-related injuries. Bodily contact with other athletes is discouraged in Ultimate due to the prohibition of

Table 4 Causes of lower limb injuries in female athletes

	N (%)	*p*-value	Injury Rate Ratio (95%CI)
Setting			
Training	16 (73%)	0.07	1.41 (0.88–2.28)
Competition	6 (27%)		
Mechanism			
Contact	**3 (14%)**	**$< 0.01^{*}$**	**10.0 (1.26–79.34)**
Non-Contact	**19 (86%)**		

CI Confidence interval

* $p < 0.05$

contact in the rules [1]. The main cause of contact injuries is contact with the ground during dives and catches (laying out) [2]. Compared to contact with other athletes, these injuries may not be serious enough to seriously interrupt competition. Female athletes typically face a higher likelihood of experiencing non-contact injuries of greater severity, such as anterior cruciate ligament injuries in sports such as football and basketball [24, 25]. For instance, in football, incorporating strength training, agility, and dynamic balance training into warm-up sessions may aid in injury prevention, as seen with the use of the Fédération Internationale de Football Association 11 + program [26, 27]. These approaches may be equally beneficial for Ultimate athletes.

Prospects for future injury prevention

Regarding injury prevention in Ultimate, this retrospective study indicates the need for further prospective cohort studies. For example, STROBE-SIIS should be conducted to further examine the factors that lead to injuries and diseases specific to Ultimate. This would help in identifying the season (pre-, in-, or post-season) in which injuries and illnesses are more prone to occur, as well as the amount of training (days or hours). The season and amount of practice can be adjusted for prevention. Furthermore, the Quality Appraisal for Sports Injury Video Analysis Studies (QA-SIVAS) can be used to analyze non-contact injury scenarios and indicate which scenarios and competition areas are likely to result in injury; it is a useful tool for preventive interventions.

Limitations

This study has several limitations that warrant consideration when interpreting the results. First, the questionnaires were sent to coaches of 128 universities who were then asked to disseminate the surveys to all their athletes, and therefore it is not known how many total athletes received the survey. In addition, only athletes currently participating in competitions were included in the survey. Thus, it is possible that those who were undergoing rehabilitation or who missed a season because of a serious injury were unable to respond. Second, the retrospective nature of the injury survey may introduce potential recall and cognitive biases, particularly with a prolonged time before the questionnaire was completed, which may affect the accuracy of reported data such as training day and severity. Third, to obtain an accurate injury rate, the number of injuries per 1000 athlete exposures or 1000 athlete hours needs to be calculated, which involves determining the ratio of athletes injured during competitions or training [28, 29]. Unfortunately, this calculation could not be conducted in this study due to the absence of recorded data on the exact amount of training, training times, and the number of games. Fourth, the athletes self-completed the questionnaire, which did not guarantee a specific diagnosis. In contrast, the NCAA survey methodology involves evaluations and documentation of injuries by medical doctors and certified athletic trainers [30]. Fifth, delineating the specific circumstances leading to injuries, particularly regarding the origin of lower limb injuries during Ultimate gameplay, proved challenging. Lower limb injuries often occur during running or jumping to catch a Frisbee in Ultimate [2]. Therefore, future research should aim to clarify the origin of the injury to effectively raise awareness and facilitate preventive measures.

Conclusion

Female Ultimate athletes experience a high frequency of severe lower extremity injuries, particularly those resulting from non-contact incidents. More training days were an independent factor associated with these outcomes, emphasizing the need for careful regulation of training intensity to prevent lower limb injuries in the Ultimate community.

Abbreviations

NCAA	National Collegiate Athletes Association
Ultimate	Ultimate Frisbee
UNIVAS	Japan Association for University Athletics and Sport

Acknowledgements

We would like to thank the MS&AD Insurance Group Holdings, Inc., for their support in conducting this study, as well as all the athletes who responded to the survey.

Authors' contributions

Y.M, T.K, and Y.K. wrote the manuscript. A. K., Y. Y., T. K., K. S., and Y. K. critically revised the manuscript for intellectual content and supervision. All authors have approved all aspects of our work and have read and approved the manuscript for publication.

Funding

This study was funded by the UNIVAS. UNIVAS was not involved in data analysis or manuscript writing.

Availability of data and materials
All data from this study are presented in this manuscript or are available from the corresponding author upon reasonable request. The source data are provided in this study.

Declarations

Ethics approval and consent to participate
This study was approved by the Ethics Committee of Keio University (approval number: 20211158) and was conducted in accordance with the principles of the Declaration of Helsinki. All participants provided written informed consent. There were no participants under the age of 16 years.

Consent for publication
We consent for publication.

Competing interests
The authors declare no competing interests.

Received: 15 January 2024 Accepted: 8 August 2024
Published online: 22 August 2024

References
1. World Flying Disc Federation. Disciplines. Colorado Springs: WFDF; 2020. http://www.wfdf.org/disciplines/. Accessed 1 Oct 2023 .
2. Swedler DI, Nuwer JM, Nazarov A, Huo SC, Malevanchik L. Incidence and descriptive epidemiology of injuries to college ultimate players. J Athl Train. 2015;50(4):419–25.
3. Flying Disc Association of Japan. Ultimate, 2023. 2023. https://www.jfda.or.jp/. Accessed 1 Oct 2023.
4. van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. Sports Med. 1992;14:82–99.
5. Hess MC, Swedler DI, Collins CS, Ponce BA, Brabston EW. Descriptive epidemiology of injuries in professional ultimate frisbee athletes. J Athl Train. 2020;55(2):195–204.
6. Fajardo Pulido D, Lystad RP. Epidemiology of injuries in ultimate (frisbee): a systematic review. Sports (Basel). 2020;8(12):168.
7. Akinbola M, Logerstedt D, Hunter-Giordano A, Snyder-Mackler L. Ultimate frisbee injuries in a collegiate setting. Int J Sports Phys Ther. 2015;10(1):75–84.
8. Brezinski T, Martin J, Ambegaonkar JP. Prospective injury epidemiology in competitive collegiate club sports, quidditch, and ultimate frisbee. Athl Train Sports Health Care. 2021;13(3):111–6.
9. Collings TJ, Bourne MN, Barrett RS, du Moulin W, Hickey JT, Diamond LE. Risk factors for lower limb injury in female team field and court sports: a systematic review, meta-analysis, and best evidence synthesis. Sports Med. 2021;51(4):759–76.
10. Halonen JI, Erhola M, Furman E, Haahtela T, Jousilahti P, Barouki R, et al. The Helsinki Declaration 2020: Europe that protects. Lancet Planet Health. 2020;4(11):e503-5.
11. Bahr R, Clarsen B, Derman W, Dvorak J, Emery CA, Finch CF, et al. International Olympic Committee consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sport 2020 (including STROBE Extension for Sport Injury and Illness Surveillance (STROBE-SIIS)). Br J Sports Med. 2020;54(7):372–89.
12. Sunagawa N. Recommended methods for sports injury and illness surveillance: Japanese Society of Clinical Sports Medicine and Japanese Society for Athletic Training Consensus. Doc J Jpn Clin Sports Med. 2022;30(2):155–71.
13. Kimura T, Mącznik AK, Kinoda A, Yamada Y, Muramoto Y, Katsumata Y, et al. Prevalence of and factors associated with sports injuries in 11,000 Japanese collegiate athletes. Sports. 2023;12(1):1–10.
14. Pang FO, Man GC, Ling SK, Yung PS. Injury epidemiology of ultimate frisbee in Hong Kong. Asia Pac J Sports Med Arthrosc Rehabil Technol. 2021;26:27–31.
15. Sekine Y, Kamada K, Koyama T, Hoshikawa S, Uchino S, Komatsu T. Descriptive epidemiology of injuries in Japanese collegiate men's basketball: 2013/2014 to 2019/2020. Inj Epidemiol. 2022;9(1):4.
16. Hewett TE, Torg JS, Boden BP. Video analysis of trunk and knee motion during non-contact anterior cruciate ligament injury in female athletes: lateral trunk and knee abduction motion are combined components of the injury mechanism. Br J Sports Med. 2009;43(6):417–22.
17. Lephart SM, Ferris CM, Riemann BL, Myers JB, Fu FH. Gender differences in strength and lower extremity kinematics during landing. Clin Orthop Relat Res. 2002;401:162–9.
18. Shultz SJ, Sander TC, Kirk SE, Perrin DH. Sex differences in knee joint laxity change across the female menstrual cycle. J Sports Med Phys Fitness. 2005;45(4):594–603.
19. Mohr PA, Matias TS, de Lucas RD. Association between internal training load and muscle injuries in Brazilian professional soccer players. Biol Sport. 2023;40(3):675–9.
20. Hreljac A. Impact and overuse injuries in runners. Med Sci Sports Exerc. 2004;36(5):845–9.
21. Lian ØB, Engebretsen L, Bahr R. Prevalence of jumper's knee among elite athletes from different sports: a cross-sectional study. Am J Sports Med. 2005;33(4):561–7.
22. Visnes H, Aandahl HÅ, Bahr R. Jumper's knee paradox—jumping ability is a risk factor for developing jumper's knee: a 5-year prospective study. Br J Sports Med. 2013;47(8):503–7.
23. Gouttebarge V, van Sluis M, Verhagen E, Zwerver J. The prevention of musculoskeletal injuries in volleyball: the systematic development of an intervention and its feasibility. Inj Epidemiol. 2017;4(1):25.
24. Noyes FR, Barber Westin SD. Anterior cruciate ligament injury prevention training in female athletes: a systematic review of injury reduction and results of athletic performance tests. Sports Health. 2012;4(1):36–46.
25. Parsons JL, Coen SE, Bekker S. Anterior cruciate ligament injury: towards a gendered environmental approach. Br J Sports Med. 2021;55(17):984–90.
26 Mattu AT, Ghali B, Linton V, Zheng A, Pike I. Prevention of non-contact anterior cruciate ligament injuries among youth female athletes: an umbrella review. Int J Environ Res Public Health. 2022;19(8):4648.
27. Vlachas T, Paraskevopoulos E. The effect of the FIFA 11+ on injury prevention and performance in football: a systematic review with meta-analysis. BioMed. 2022;2:328–40.
28. Brooks JHM, Fuller CW. The influence of methodological issues on the results and conclusions from epidemiological studies of sports injuries. Sports Med. 2006;36(6):459–72.
29. International Olympic Committee Injury and Illness Epidemiology Consensus Group, Bahr R, Clarsen B, Derman W, Dvorak J, Emery CA, Finch CF, et al. International Olympic Committee Consensus Statement: Methods for recording and reporting of epidemiological data on injury and illness in sports 2020 (Including the STROBE extension for sports injury and illness surveillance (STROBE-SIIS)). Orthop J Sports Med. 2020;8(2):2325967120902908.
30. Dick R, Agel J, Marshall SW. National Collegiate Athletic Association injury surveillance system commentaries: introduction and methods. J Athl Train. 2007;42(2):173–82.

Publisher's Note