



Original Article

Female athlete triad cross-sectional study of soccer players by level of competition

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Abstract. [Purpose] To determine the actual status of the Female Athlete Triad (low energy availability, menstrual dysfunction, and bone mineral density loss) in soccer players. [Participants and Methods] The survey was conducted between February 1 and March 1, 2022. It included 115 females between the ages of 12 and 28 registered with the Japan Football Association, from teams at different levels. [Results] Players in the top league did not differ in height and weight but were older and had a better understanding of caloric intake. There were no differences in amenorrhea or history of bone fractures based on league. [Conclusion] Of the female soccer players in the four different levels of competition, only the players in the top league had a better understanding of available energy and took preventive measures against the Female Athlete Triad.

Key words: Female soccer players, Female athlete triad, Menstrual dysfunction

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INTRODUCTION

Sports are defined in the Basic Act on Sports (Act No.78 of 2011) as athletic competitions and other physical activities performed by individuals or groups for the purpose of sound development of mind and body, retention and promotion of health and physical strength, acquisition of mental satisfaction, and cultivation of the spirit of self-sufficiency or other mentalities and are generally known to be good for daily life. Contrastingly, for female athletes, continuous sports activities can be detrimental to their health and have long-term negative effects¹⁾.

For female athletes, “low energy availability”, “menstrual dysfunction”, and “bone mineral density loss” are called the female athlete triad²⁾. It was first proposed by the American College of Sports Medicine in 1992 as a major problem that threatens not only women’s athletic performance but also their overall health. There have been many studies on the female athlete triad in rhythmic gymnastics and other competitions involving beauty standards, competitions that require being in a certain weight category, such as judo, or endurance sports, such as running, where weight and performance are closely related³⁾. In Japan, the Women’s Health Care Committee of the Japan Society of Obstetrics and Gynecology was established in 2013 to conduct a large-scale questionnaire survey of the three main characteristics of female athletes by competition levels, and other studies are underway⁴⁾. Sports coaches are still predominantly male, and male coaches have low awareness of menstruation and premenstrual symptoms⁴⁾. Female athletes do not consider amenorrhea to be a problem and do not report any issues related to abnormal menstruation because they prioritize sports performance⁵⁾. Women who were diagnosed with the female athlete triad around 1992 are now in their 30s and 40s, and long-term adverse effects such as low bone density have become apparent¹⁾. The fact that the female athlete triad is a problem that affects not only women’s athletic careers but also their overall lives is not well understood by either the athletes themselves or their coaches.

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When investigating the female athlete triad, athletes' lean body mass, energy expenditure, and menstrual status are determined. In addition, it is difficult to diagnose osteoporosis and bone density without specialized knowledge and equipment. It is unlikely that all women who exercise have access to body composition measurements using body composition analyzers daily. In particular, it is difficult for young athletes and athletes who are not at a highly competitive level to visit outpatient clinics for female athletes.

In 2011, Japan's women's national soccer team became the world's number one women's soccer team for the first time at the FIFA Women's World Cup, and in 2022, the first Japanese professional women's soccer league, the "WE League," was established. Establishing a professional league will create a higher-level category, resulting in more competition and increased medical issues surrounding female soccer players.

However, there are few studies on women's soccer overseas, and the number of studies conducted on Japanese women's soccer in particular is even smaller⁶⁾. Most of the research on women's soccer has focused on top-level athletes at the university level and above, and has been about disability and performance⁷⁾. Therefore, this study provides an opportunity to clarify medical problems in women's soccer by investigating the current status of women who play soccer across different age and competition levels in terms of factors related to the female athlete triad.

PARTICIPANTS AND METHODS

This study was a cross-sectional study and was approved by the International University of Health and Welfare (21-Io-18).

Between February and March 2022, the first author requested research cooperation from the women's soccer team via email, telephone, or verbally. The purpose of the study was explained to the team representatives. As an ethical consideration, an overview of the study was given at the beginning of the questionnaire, and the first question asked whether the participants gave their "consent to participate in this study". Informed consent was obtained from the minors, and consent to participate was obtained from parents. Participation in this study was voluntary. The purpose and objectives of the study were explained in writing and on video, and the URL of the Google form was distributed to the participants to answer the questions. Of the 137 respondents, 115 were included in the analysis. The exclusion criteria were as follows: (1) those who had not reached menarche, (2) those who were not registered with the Japan Football Association, and (3) those who were under 12 years old and over 29 years old.

There were four main sections of questions: basic information, nutrition (related to lack of available energy), menstrual dysfunction, and history of disabilities (For example, fatigue fractures related to osteoporosis). For the osteoporosis question, the participants were asked to indicate when and what type of injury they had suffered to determine if they had a fatigue fracture. The nutrition questions included "Do you eat three meals a day?" (yes/no), "Do you usually snack?" (yes/no), "What do you snack on?" (free response), "Do you know your daily calorie intake?" (yes/no), and "Do you want to lose or gain weight?" (yes/no).

Questions related to menstruation included "What was your age at menarche?", "Have you ever had amenorrhea?" (yes/no), "Have you ever visited a hospital for treatment?" (yes/no), "Have you ever found menstruation bothersome?" (yes/no), "Have you ever felt a change in performance due to menstruation?" (yes/no), "Have you taken painkillers at least once a month?" (yes/no), and "Do you take low-dose pills?" (yes/no).

According to the league classification to which they belonged, the participants were grouped into the Japan Women's League (hereafter referred to as "top league"), university leagues, regional leagues (eight regional leagues), and prefectural leagues, in descending order of competition level. In addition, to clarify the characteristics of players with amenorrhea, they were divided into two groups according to whether they had amenorrhea, and comparisons regarding menstruation were made.

Statistical analysis was conducted by tabulating each survey item and comparing them by league category. One-way analysis of variance and Bonferroni subtests were used for age, height, weight, and age at menarche, and χ^2 tests were used for the survey items. Differences due to amenorrhea were analyzed using an uncorrelated t-test and a χ^2 test.

RESULTS

Responses were received from 36 top leagues, 23 university leagues, 31 regional leagues, and 25 prefectural leagues. The basic information for each league classification is presented in Table 1. There was a significant difference in the mean age between the top league and the other league categories, with players in the top league being significantly older. Regarding injury history, 14 (12%) participants had a history of anterior cruciate ligament injury and 16 (14%) had a history of fatigue fracture. The χ^2 test results showed a significant difference in the history of anterior cruciate ligament injury between the league categories.

Regarding the nutrition question "Do you eat three meals a day?" the results of the χ^2 test showed no significant differences between the groups. For the question "Do you want to lose or gain weight?" there was a significant difference between the groups (Table 2).

Regarding the question about menstruation, the overall age of menarche was 13.1 ± 1.6 years (minimum age: 9 years, maximum age: 19 years), and six respondents did not respond. There were no significant differences according to the league

Table 1. Basic information and disability history of the participant

	ALL n=115	Top league n=36	University league n=23	Regional leagues n=31	Prefectural leagues n=25
Age (years)	20.0 ± 4.0	23.8 ± 2.0	19.7 ± 0.9*	18.4 ± 3.5*	16.7 ± 4.0*
Height (cm)	160.0 ± 5.9	161.0 ± 6.2	159.3 ± 6.5	159.6 ± 5.4	159.5 ± 5.6
Weight (kg)	53.5 ± 5.9	55.1 ± 5.3	53.5 ± 7.5	53.1 ± 4.7	51.5 ± 6.0
Anterior cruciate ligament injury (n (%))*	14 (12)	10 (28)	2 (9)	1 (3)	1 (4)
Fatigue fractures (n (%))	16 (14)	3 (8)	4 (17)	7 (23)	2 (8)

Values are presented as mean ± deviation.

*p<0.05: χ^2 test. *p<0.05: Bonferroni; vs. Top league.

Table 2. Responses to nutrition questions by league

	ALL n=115	Top league n=36	University league n=23	Regional leagues n=31	Prefectural leagues n=25
Eats three meals a day (n (%))	104 (90)	32 (89)	22 (96)	29 (94)	21 (84)
Knows calorie intake requirements (n (%))*	27 (23)	14 (39)	4 (17)	3 (10)	6 (24)
Wants to lose weight (n (%))*	72 (63)	14 (39)	14 (61)	23 (74)	21 (84)
BMI of 18.5 kg/m ² or less (n (%))	10 (9)	1 (3)	2 (9)	2 (7)	5 (20)

*p<0.05: χ^2 test.

category (Table 3). Table 4 shows the results of the analysis to identify the characteristics of those with and without a history of amenorrhea. There was a significant difference between the two groups in the age at menarche but no difference in other parameters, such as age, height, weight, and BMI.

The rate of low-dose pill use was very low, but the rate of habitual painkiller use was high. Many athletes felt depressed (95%) and experienced changes in performance (88%) related to menstruation.

DISCUSSION

The purpose of this study was to clarify medical problems in women's soccer by investigating the status of female athlete triad across different ages and competition levels in women who play soccer. The results of this study showed that different levels of competition resulted in differences in history of anterior cruciate ligament injury, nutritional literacy, and attitudes toward weight loss. Additionally, athletes with a history of amenorrhea were found to have a significantly later onset of menarche.

Regarding disability history, 14 (12%) athletes had a history of anterior cruciate ligament injury and 16 (14%) had a history of fatigue fracture. In this study, anterior cruciate ligament injuries and fatigue fractures were not associated with amenorrhea, and the higher the category level, the more likely the anterior cruciate ligament injury.

In Japan, young adolescent females are said to have a significantly stronger desire to be thin than males of the same age, including distorted body images⁸). Considering the questions related to nutrition and its association with the lack of available energy, 72 (63%) players answered that they wanted to be thin. In particular, many players outside the top league had a desire to lose weight; eating three meals a day is possible for most players, regardless of their level of competition. However, athletes outside the top league did not have a better understanding of their daily calorie intake.

Contrastingly, 10 athletes were classified as "skinny" with a BMI of 18.5 kg/m² or less, and four of them had a "desire to be thin". Currently, BMI is calculated as the difference between calorie intake and calorie consumption; however, this survey revealed the current status of women's desire to be thin and their literacy regarding necessary calorie intake and consumption. Particular attention should be paid to athletes who are not at a highly competitive level, and educating young athletes about energy deficiency may be important in the prevention of the female athlete triad.

Next, we considered the content related to menstruation: 83% of the Western athletes participating in the 2008 Beijing Olympics were taking low-dose estrogen/progestin pills ("low-dose pills"), but a 2012 Japan Sports Science Center survey of designated Japanese athletes and Olympic athletes found that only 3.4% were taking low-dose pills⁹). In the present survey, only five women (5%) were taking low-dose pills. Japanese people tend to lack knowledge about therapeutic interventions for menstrual complications and menstrual regulation with low-dose pills, and many women have a strong perception of low-dose pills as a contraceptive and a false perception that they are a doping violation or make them fat⁹). In the present survey, 92% of the athletes found menstruation to be depressing, and 86% reported that their performance was altered by menstruation.

Table 3. Responses to menstrual questions by league

	ALL n=115	Top league n=36	University league n=23	Regional leagues n=31	Prefectural leagues n=25
Age at menarche (years)	13.1 ± 1.6	13.4 ± 1.9	13.5 ± 1.5	12.8 ± 1.3	12.5 ± 1.6
Currently amenorrhea for more than 3 months or has had amenorrhea for more than 3 months (n (%))	26 (23)	7 (19)	10 (43)	4 (13)	5 (20)
Low-dose pills taken internally (n (%))	5 (4)	3 (8)	2 (9)	0 (0)	0 (0)
Amenorrhea was treated (n (%))	7 (6)	2 (6)	4 (17)	1 (3)	0 (0)
Feels menstruation is bothersome (n (%))	106 (92)	33 (92)	20 (87)	30 (97)	23 (92)
Menstruation causes changes in performance (n (%))	99 (86)	34 (94)	20 (87)	26 (84)	19 (76)

Values are presented as mean ± deviation.

*p<0.05: χ^2 test.

Table 4. Results of grouping responses by history of amenorrhea

	ALL n=109	Amenorrhea n=25	No amenorrhea n=84
Age (years)	20.0 ± 4.0	20.9 ± 3.1	19.7 ± 4.2
Height (cm)	159.9 ± 5.9	160.8 ± 7.1	159.7 ± 5.6
Weight (kg)	53.5 ± 5.9	53.4 ± 6.7	53.5 ± 5.7
BMI (kg/m ²)	20.9 ± 1.7	20.7 ± 2.3	21.0 ± 1.6
Age at menarche (years)*	13.1 ± 1.6	14.0 ± 1.6*	12.9 ± 1.6*
Amenorrhea was treated (n (%))	7 (6)	7 (28)	0 (0)
Low-dose pills taken internally (n (%))	5 (5)	3 (12)	2 (2)
Taking painkillers internally (n (%))	57 (52)	11 (44)	46 (55)
Feels depressed about menstruation (n (%))	104 (95)	23 (92)	81 (96)
Menstruation causes changes in performance (n (%))	96 (88)	19 (76)	77 (92)

Values are presented as mean ± deviation.

*p<0.05: Unpaired t-test.

In addition, 57 athletes (52%) reported taking painkillers at least once a month, suggesting that the hurdle to taking painkillers is not necessarily high. Despite the negative impact on athletes' lives due to performance changes that could be considered menstruation-related symptoms, gynecological examinations and menstrual adjustments have not been performed, indicating that easily available painkillers are widely used. Since the use of low-dose pills has advantages, such as improving premenstrual symptoms and reducing the risk of injury by up to 20%¹⁰, gynecological checkups and the use of low-dose pills should be actively promoted to improve the condition of not only female soccer players but also Japanese women in general.

In this study, there was no significant difference in age at menarche at the competitive level, but athletes with a history of amenorrhea tended to have a delayed onset of menarche. This result is similar to those of previous studies and is important for athletes and teams because all female athletes are at risk for amenorrhea⁴, regardless of the competition level. In addition, menarche requires a body fat percentage of approximately 17%, and a body fat percentage of at least 22% must be maintained to achieve a normal menstrual cycle¹¹. It has long been noted that the delayed onset of menarche and subsequent regular training can lead to amenorrhea, abnormal menstruation, and dysmenorrhea. Females with eating disorders and amenorrhea have been found to not regain bone density at some sites even after their eating disorders improve and menstrual function is restored⁸. We believe that early monitoring and intervention can reduce the risk of developing the female athlete triad in the future.

In the previous study, the percentage of amenorrhea by competition level was not significantly different, but a significant difference was found when comparing athletic and non-athletic females⁹. In addition, there is a significant difference in the percentage of amenorrhea among national and prefectural competition level competitors. The results of the analysis of the percentage of amenorrhea by league classification showed that the percentage of athletes with a history of amenorrhea was higher in the university league, although unlike in the previous study, there were no differences in the level of competition. The results suggest that athletes who aspire to the top level are more prone to amenorrhea.

The current study has several limitations. First, the study was a questionnaire survey using Google Forms, with participants self-reporting fatigue fractures and age at menarche without a formal diagnosis made by a medical or other institution. Second, reproducibility was not ensured because responses were anonymous and recorded only once. Third, height, weight,

and BMI were measured at the time of the survey, not at the time of amenorrhea. Thus, the relationship between BMI and amenorrhea could not be determined. Finally, we found that there is an age difference between players registered in the top league and those registered in other leagues; therefore, future studies should be conducted without age differences.

Funding and Conflict of interest

The authors declare no conflicts of interest.

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