Girls in Sport

The "Problem-Solving Practical Program for Girls in School-Based Sport Club Activities", a project to develop and support female athletes commissioned by the Japan Sports Agency in FY2023

Girls in School-Based Sport Club Activities Support Manual

For school nurses, school doctors, and family doctors

Japanese Center for Research on Women in Sport
JCRWS

When girls in school-based sport club activities with issues come to you … ?

Shortness of breath, dizziness

Menstruation has stopped

Legs hurt so much cannot even walk

Girls in School-Based Sport Club Activities

Are you menstruating?
Too much training?
Eat well?

School nurses

Stress fractures?
Amenorrhea?
Anemia?

Family doctors
Gynecologist/ Orthopedic surgeon/ Internist

School doctors

Are you not well?
Doesn’t seem to be concentrated and a lot of mistakes.

Club activity advisor

Could it be due to energy deficiency?

Signs of REDs/FAT vary.
Suspect energy deficiency and take action.

Introduction

Female athletes experience a variety of problems such as amenorrhea, stress fractures, and anemia, all of which can be caused by energy deficiency. This is true not only for top-level and professional athletes but also for girls who participate in junior high and high school athletic club activities (hereafter referred to as "girls in school-based sport club activities").

Especially in the case of growing girls in school-based sport club activities, they need to have sufficient energy in order to reach full growth and get the body (bones and muscles) that will serve as the foundation for a lifetime of good health.

This "Girls in School-Based Sport Club Activities Support Manual" is an updated version of the "Junior Female Athlete Health Support Manual" published by the Japanese Center for Research on Women in Sport (JCRWS) in 2018 to serve as a reference for school nurses, school doctors/family doctors, and instructors in supporting girls in school-based sport club activities, and to provide the additional necessary information. The manual includes easy-to-understand information on screening for Relative Energy Deficiency in Sport (REDs), causes of various physical ailments that girls in school-based sport club activities suffer from, how to deal with them, and when to refer them to specialist (sports physician).

We hope that this will help teachers and support staff who support the health of girls in school-based sport club activities to acquire correct knowledge and collaborate with medical professionals (school doctors and family doctors) so that all girls in school-based sport club activities in Japan can continue their athletic club activities in good health.

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1 Difference between girls in school-based sport club activities and girls who are not involved in junior high and high school athletic club activities (hereafter referred to as "general girl students")

Just as a larger engine requires more gasoline, more skeletal muscle requires more energy!

As height increases during growth, skeletal muscle mass increases accordingly. During adolescence, skeletal muscle mass increases due to increased sex hormones. This is evident by looking at Lean Body Mass. Lean Body Mass is, as the name implies, the body's weight minus fat, which is mainly muscle and bone mass.

*See p6 for details on Lean Body Mass.

In addition, skeletal muscle mass increases in girls in school-based sport club activities through training. Energy is required to maintain the body temperature of the increased skeletal muscle mass and also to move the increased skeletal muscle mass because of the additional physical activity that the general girl students do not have.
While height, weight, and body fat percentage are generally measured for general girl students, energy deficiency is more likely to occur during periods of increased skeletal muscle mass as the body size increases. This suggests that **girls in school-based sport club activities should be weighed for Lean Body Mass.**

Weight and body fat percentage alone can easily lead to the misconception that one must "lose fat" when weight increases. This often leads to the opposite, that they end up restricting their diet and dieting, even though they need to increase their skeletal muscle mass and increase their energy. Measuring "Lean Body Mass" helps us understand what has increased by our weight gain and confirms that it is muscle, not fat, that has increased.
If weight gain is due to increased muscle, energy intake should not be reduced!
We would like to remind the girls in school-based sport club activities to remember this. In particular, the first thing one thinks of when reducing energy intake is "sugar and fat are the enemy!" and then the talk turns to limiting carbohydrates and lipids. Even when energy intake is restricted, protein intake is often not reduced, so **energy deficiency from carbohydrates** is also pointed out in REDs (IOC, 2023).

In girls in school-based sport club activities, the problem is not with those who are thin. It is a problem in those with energy deficiency due to high skeletal muscle mass. Energy deficiency in these individuals can be solved by taking carbohydrates. One major difference from general girl students is that carbohydrate is the energy required for skeletal muscle to work, and therefore, **carbohydrates should not be restricted below the appropriate amount required.**

Column

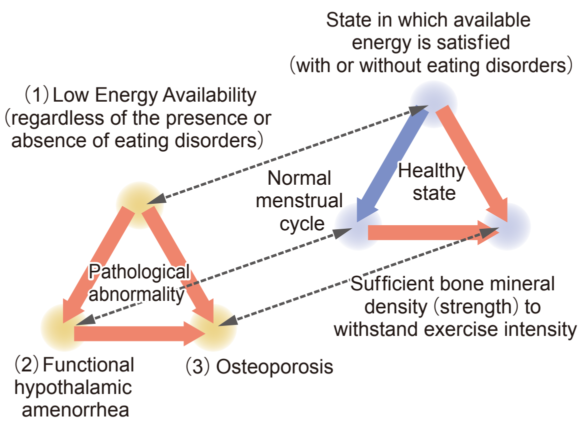
A Physician's Perspective : The "normal range" for the general public and athletes is different

Although "reference values" are listed on the test results form, for athletes, even if they are within the normal range of reference values, "normal=typical" may not necessarily mean normal for them. A deviation of 40 to 60 of ±1 standard deviation (SD) is considered typical, but most of the reference test values are generally ±2 SD. For example, if a test for anemia and hemoglobin level was near the lowest standard value, you should tell the patient, "You rank about 97th out of 100 people."
If they are junior high school students or older, they know that hemoglobin carries oxygen and that the ability to carry oxygen is important for exercise. You should tell athletes "If you can exercise better, that means you have a good ability to carry oxygen. Would you be okay with that being below average?"
Being "unable to concentrate" is a clear symptom of anemia. Before losing endurance, she will make more mistakes. We believe that having athletes examined with the recognition that having many mistakes due to a lack of iron or energy deficiency may be a shortcut to early detection of symptoms and diseases that can affect competition.

2 What is Relative Energy Deficiency

1. What is the Female Athlete Triad (FAT)?

When a female athlete competes, if her training and energy intake are in balance, her menstrual cycle is normal, and she can continue to exercise in a healthy state without injury. However, if, despite increased quantity and quality of training, the energy balance is not right and the athlete continues to compete in a state of (1) "Low Energy Availability," the menstrual cycle will be prolonged and bone stress disorders will occur. If left untreated, this condition will lead to (2) "functional hypothalamic amenorrhea" and (3) "osteoporosis," which the American College of Sports Medicine (ACSM) defined as the three main signs that a female athlete will have difficulty continuing to compete (**Figure 1**). When first proposed in 1992, (1) was an eating disorder, but in 2007 it was revised to "Low Energy Availability " and (1) was deemed to be the cause that triggers (2) and (3).



Source: Female Athlete Triad (ACSM position stand, 2007); figure revised by Koigawa, 2012

Figure 1. Three disorders that female athletes are prone to (the Female Athlete Triad)

What is Low Energy Availability (LEA)?

Low Energy Availability (LEA) refers to a state in which energy intake is less than energy consumption. When this condition persists, energy is distributed to the functions that require it, and the functions that are less essential are stopped. The most likely to be shut down are reproductive functions and maintenance of bone strength, which is involved in activity (**Table 1**).

In FAT, bone problems have taken center stage along with abnormalities in the menstrual cycle. Females have the highest annual rate of increase in bone mineral density between the ages of 11 and 14, with Peak Bone Mass around the age of 19. It is thought that the bones should continue to mature with sufficient loading after menarche.

Severe LEA and increased risk of amenorrhea and osteoporosis have been thought to be a problem of dietary restriction in thin athletes. However, sports-induced increases in skeletal muscle are thought to contribute to LEA, which also occurs in many athletes who are not of lean build. As skeletal muscle increases, basal metabolism increases. Despite the increased energy requirements to maintain this, a relatively low intake of carbohydrates in the diet, especially compared to protein may cause.

Table 1. FAT Risk Assessment

Risk Factor	Increased Risk		
	Low risk = 0 point each	Medium risk = 1 point each	High risk = 2 points each
Energy intake deficiency (with or without eating disorder)	☐ No dietary restriction	☐ Some dietary restriction*1	☐ With eating disorder *Present or past medical history meeting DSM-V criteria for eating disorder
Low BMI	☐ BMI ≧ 18.5 or > 90% of ideal weight*2 or stable weight	☐ 17.5 < BMI < 18.5 or less than 90% of ideal body weight or 5 to < 10% weight loss per month	☐ BMI ≦ 17.5 or less than 85% of ideal body weight or more than 10% weight loss per month
Delayed menarche	☐ Menarche: before the age of 15	☐ Menarche: the age of 15 or older but before the age of 16	☐ Menarche: over the age of 16
Oligomenorrhea or amenorrhea	☐ Menstruation: more than 9 times a year	☐ Menstruation : 6 to 9 times a year	☐ Menstruation : less than 6 times a year
Loss of bone mass	☐ Z-score ≧ -1.0	☐ Z-score -1.0 (for weight-bearing sports < -2.0)	☐ Z-score ≦ -2.0
Stress fractures	☐ No previous history	☐ One time	☐ 2 or more times, or high-risk cases such as trabecular bone rupture*3
Cumulative risk (subtotal and overall score by risk)	____ points +	____ points +	____ points = ____ overall score

The Accumulated Risk Assessment provides an objective method of determining an athlete's risk using risk stratification and evidence-based risk factors for FAT.
This assessment is used to determine whether or not an athlete's shall be allowed to participate in sport.
*1 Dietary restriction as evidenced by low/inadequate energy intake through self-report or dietary records.
*2 In adolescents, it is not absolutely necessary to use BMI cutoff.
*3 High risks associated with low bone mineral density and delayed return to competition in athletes with one or more components of FAT include stress fractures at the bony beam sites (femoral neck, sacrum, pelvis).

Source: Mary Jane De Souza et al. Br J Sports Med 2014; 48: 289 Translated by the Japanese Center for Research on Women in Sport

2. Relative Energy Deficiency in Sport (REDs)

In the midst of widespread FAT alerts, in 2014 the International Olympic Committee (IOC) advocated the dangers of Relative Energy Deficiency in Sport (formerly spelled as RED-S) for all athletes, regardless of gender[1]. "The 2007 Consensus Statement on the FAT" was updated to expand the concept of LEA to include men and to present multiple health issues and their impact on performance in addition to menstrual function and bone. In addition to menstrual function and bone health, multiple health issues include issues related to endocrinology, metabolism, hematology, growth and development, psychology, the cardiovascular system, the digestive system, and immunology. Examples of the impact on performance include increased risk of sports injuries, poor training response, impaired judgment, poor coordination, poor concentration, irritability, depression, reduced glycogen stores, reduced muscle strength, and reduced endurance performance. In addition, the report added new findings in 2023.

(1) Energy deficiency is mainly due to a lack of energy from carbohydrates (sugars), with protein intake often relatively preserved.

(2) Iron deficiency occurs when hepcidin secretion increases due to carbohydrate deficiency, blocking iron absorption.

(3) Energy deficiency causes a decrease in total testosterone (must be distinguished from overtraining).

(4) In an emergency, the body will respond by distributing both energy and iron to where they are needed in the body. LEA is a situation where this cannot be reversed.

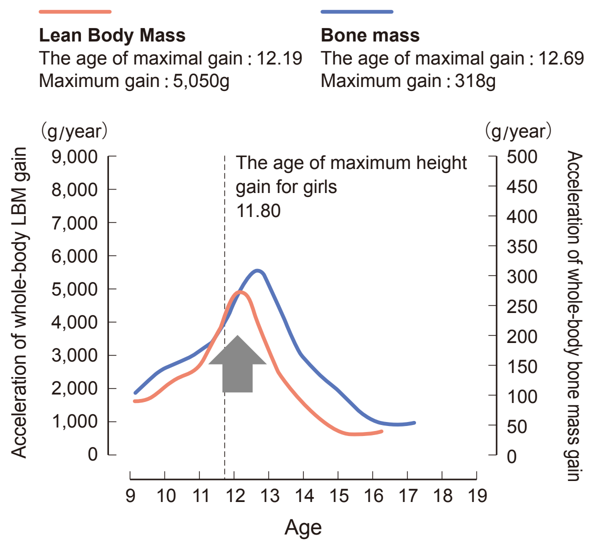
(5) The degree of energy deficiency can be determined by the degree of interval between menstrual cycles and other measurements.

*There are different views on total cholesterol (the problem is rather hypothyroidism and high cholesterol, but in our country, low cholesterol and protein catabolism are caused by carbohydrate deficiency).

3. Issues for girls in school-based sport club activities: decrease in bone and muscle mass and other symptoms due to energy deficiency during adolescence

Lack of muscle makes exercise impossible because then the bones will lose the ability to effectively support their own weight. It is natural for animals to lose the ability to exercise without energy

The growth peak, when the annual rate of height growth reaches its maximum, is said to occur at an average age of 11.8. Then, a little later, Lean Body Mass gain reaches a maximum. This gain can be as much as 5kg, which is estimated to be almost entirely skeletal muscle gain. Bone strength peaks a little later (1 to 1.3 years after the growth peak) due to the loading from this weight gain (see **Figure 2**), and menarche often occurs around this time. **Figure 3** shows the timing the growth peak and menarche. The onset of menarche can be **a sign that there is no energy deficit and that a growth peak has occurred.**



Source: Rauch et al., 2004

Figure 2. Changes in Lean Body Mass and Bone mass in adrescent growing girls

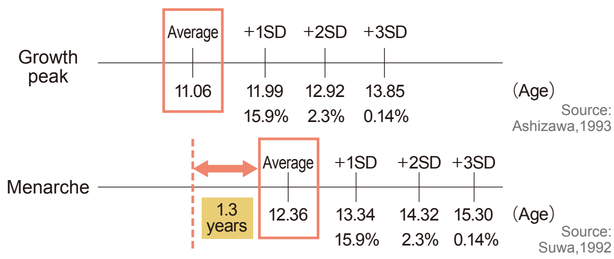
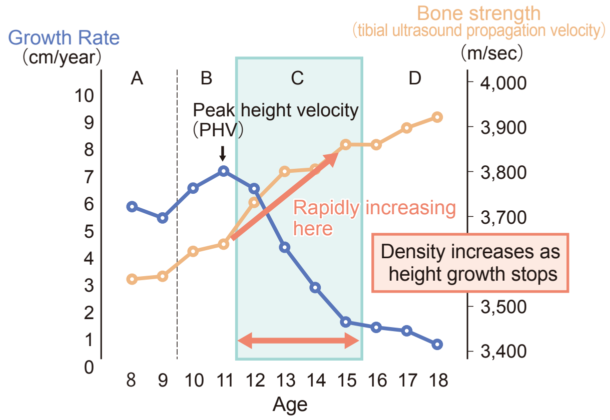


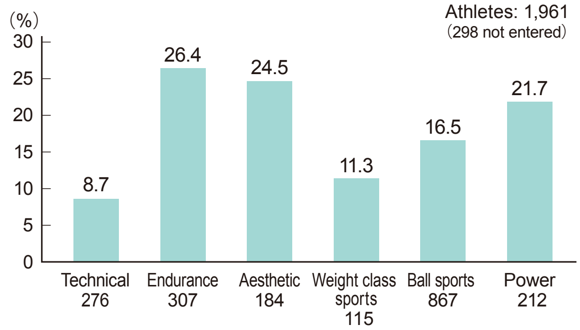
Figure 3. Relationship between growth peak and menarche

Menarche occurs at an average age of 12.4, and from then on, weight gain is often thought of as an increase in body fat due to slower height gain, which was easily linked to dietary restriction. However, even after the growth peak has passed, an increase in Lean Body Mass can be observed, and LEA status can easily be reached if energy intake should be increased but reduced in the opposite direction. During the 2 years between growth peaks, 26% of adult bone mass is acquired[2]. If LEA continues from this period, the growth peak is not clear and



Source: Kayo Takahashi from Takao Matsuda: 'Women and Exercise.' Bone development and health in children. Osteoporosis Japan 2002

Figure 4. Growth spurt and bone strength



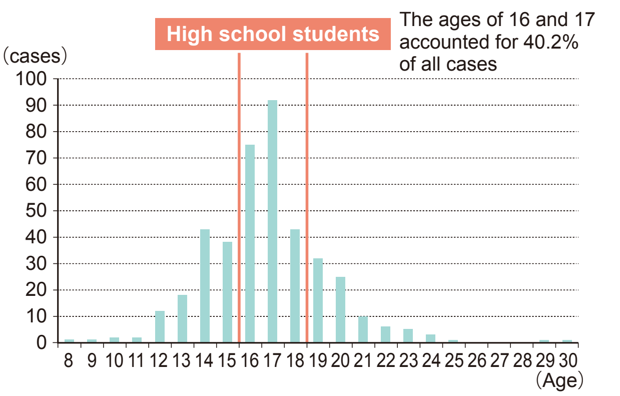
Source: Osuga et al. 2016

Figure 6. Percentage of previous fatigue fractures by sport

the increase in bone strength, which should increase rapidly between the ages of 12 and 15, is not seen (**Figure 4**)[3].

In high school, the quantity and quality of practice increases, and high performance is required to win games, but the increase in skeletal muscle, which is rarely seen in general girl students, may predispose them to LEA.

A national survey of 1,616 female athletes conducted by the Japan Society of Obstetrics and Gynecology (Subcommittee on Health Care of Female Athletes) in 2014 found that the frequency of stress fractures peaked at the age of 17 (**Figure 5**). It was reported to be significantly higher in female athletes with BMI of less than 18.54[4], and the Japan Institute of Sports Science (JISS) provided a history of stress fractures by sport, with a high percentage of thin athletes in endurance and aesthetic sports. However, they are also common in power sports, where skeletal muscle mass is relatively high, and the absolute number is highest in ball sports (**Figure 6**). Therefore, REDs are likely to occur not only in lean athletes but also in athletes with high muscle mass, and as a result, even if they are not on a restricted diet, they often do not receive enough energy to match their muscle mass.



Source: Japan Society of Obstetrics and Gynecology, Subcommittee on Health Care of Female Athletes Survey, 2015

Figure 5. Number of fatigue fractures by age

As skeletal muscle increases through growth and training, the basal metabolic rate necessary to sustain life and regulate body temperature increases, but on the other hand, blood glucose levels decrease due to increased insulin secretion, and blood calcium used for bone formation also decreases.

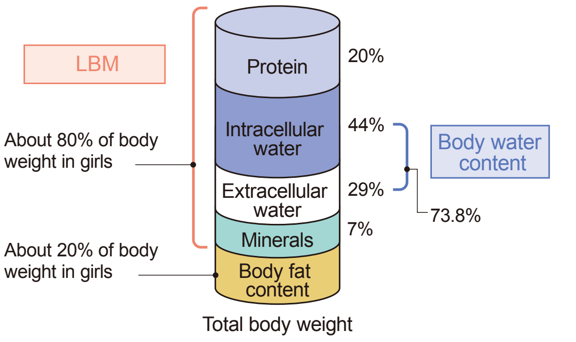
Total testosterone decreases in REDs in girls as well. Anabolism, which produces muscle in skeletal and other muscles, is reduced, resulting not only in muscle weakness but also in anemia, as red blood cell synthesis tends to stagnate. In addition to dilution of the blood due to increased circulating plasma volume due to increased skeletal muscle, iron deficiency is caused by changes in iron distribution due to increased myoglobin (intramuscular iron), which decreases blood iron and ferritin, the stored iron. In addition to this, iron deficiency is found to be caused by inadequate carbohydrate intake, which increases hepcidin, which inhibits iron absorption. The mechanism leading to iron deficiency was elucidated by LEA, indicating that carbohydrate deficiency is likely to underlie iron deficiency.

4. Lean Body Mass essential for assessing energy deficiency

Lean Body Mass (LBM) is important for assessing energy deficiency, and although it is commonly used overseas, it is rarely used in sports in Japan.

LBM represents body weight minus body fat mass (**Figure 7**). Body fat content is 20% of body weight, and 3/4 of LBM is body water content, which consists of muscles, bones, and internal organs.

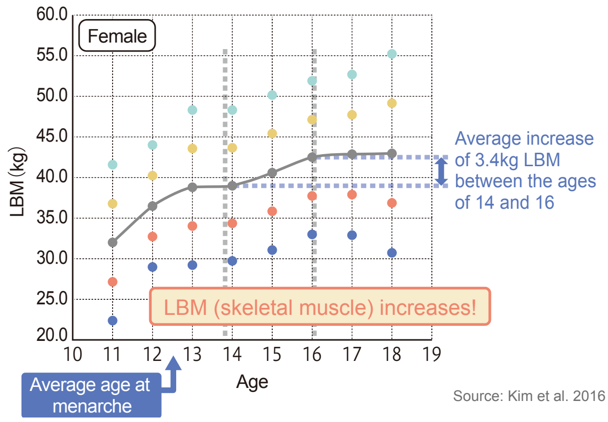
Figure 8 shows the change in LBM with age, with an average increase of 3.4kg of LBM between the ages of 14 and 16. Although skeletal muscle mass and body fat also



Source: Rie Tsutsumi et al. 2016

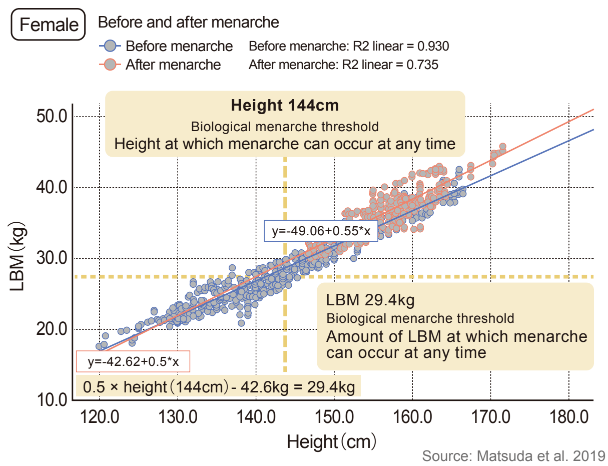
Figure 7. Weight Breakdown

increase with age-related increases in sex hormones, weight-conscious girls in school-based sport club activities often mistakenly believe they have gained weight and try to lose it. The amount of age-related increase in LBM tends to increase after menarche, and the amount of energy intake required also increases (**Figure 9**).



Source: Kim et al. 2016

Figure 8. Change in LBM with age



Source: Matsuda et al. 2019

Figure 9. Correlation between height and LBM before and after menarche

Energy Availability (EA) can be estimated by the formula in **Figure 10**, which is the difference between energy intake and energy consumption divided by LBM. Girls with high skeletal muscle mass have a low amount of Energy Availability and are likely to suffer from an energy deficiency.

The normal range of EA is considered to be 52.5 or higher, while less than 45 is defined as low energy and less than 30 as energy deficient. Therefore, it should be kept in mind that LEA is not only likely to occur in thin girls with low BMI and body fat percentage, but also in girls who are muscular and well-built or tall.

EA = 〈energy intake〉 - 〈energy consumed through exercise〉 (kcal) / **LBM** (=body weight - body fat mass) (kg)

EA (Energy Availability): The amount of energy required

Source: American College of Sports Medicine (ACSM), 2007

Basal metabolic rate = LBM (kg) × 28.5kcal/day

〈Japan Institute of Sports Sciences (JISS) formula〉

≒ LBM (kg) × 30kcal/day

≒ Body water content (kg) × 40kcal/day

Source: Dietary Reference Intakes for Japanese People, 2020

Figure 10. Lean Body Mass (LBM) and basal metabolism

Basal metabolic rate can also be calculated from LBM, but for simplicity, LBM multiplied by 30 approximates basal metabolic rate (**Figure 10**). Even so, it is troublesome for busy girls in school-based sport club activities to calculate EA and basal metabolic rate on a daily basis, so it is efficient to use tools that can automatically calculate LBM and EA provided by various institutions.

Using "Surari Muscle (see p10)," an application provided by the Japanese Center for Research on Women in Sport (JCRWS), one can display one's LBM and body water content simply by entering daily height, weight, and body fat percentage, and check the amount of energy required and basal metabolic rate according to one's physique. Furthermore, if you continue to record your height and weight, you can also learn about increases in LBM, growth peaks, and predicted maximum height. Regardless of body type, knowing one's own energy requirements with "Surari Muscle" and consuming the right amount of food for one's physique is essential for REDs prevention.

Screening for REDs/LEA

REDs are not characterized by not eating at all as is the case with starvation or anorexia. REDs are often a case of not getting the energy that one's body needs, especially when playing sport. Even if an athlete thinks that they are eating well, they often lack the energy required for sport, especially energy obtained through carbohydrates. Increased skeletal muscle mass may cause an increase in basal metabolism and REDs without being noticed, which may lead to iron deficiency and sport disorders. A certain amount of energy is required to repair body tissues damaged by sport activities on a daily basis. However, when REDs/LEA are present, the broken tissues are not repaired, and this can accumulate to become a sport injury. In order to prevent sport injuries, it is important to recognize and prevent REDs/LEA at an early stage.

REDs/LEA have a variety of risk factors, many signs, and symptoms, and are influenced by the environment. The newly revised 2023 IOC REDs Clinical Assessment Tool-V.2 (IOC REDs CAT2) is a three-step process.

(1) Screening for REDs
(2) Severity/risk assessment based on signs/symptoms (primary and secondary indicators) of REDs
(3) Clinical diagnosis and treatment by a physician

In addition, the severity/risk was graded using a four-level traffic light system (green, yellow, orange, and red). Primary and secondary indicators were used to allow objective scoring by the athletes themselves based on the presence or absence of each indicator (**Table 2**). The purpose of the IOC REDs CAT2 is to support early and accurate diagnosis of REDs through appropriate clinical severity and risk assessment in order to protect athletes' health and prevent long-term and irreversible consequences of REDs.

Table 2. IOC REDs CAT2 Assessment

	Primary Indicator	Secondary Indicator	Management and coping
Green: Healthy	None	0-1	
Yellow: Mild	1-2 None	Maximum 1 2+	
Orange: Moderate to High	3 2	0-1 2+	Month-to-month training management
Red: Very High/Extreme	4+ 3	2+	Hospitalization in some cases Almost daily checkups Prohibited from training

Source: Mountjoy et al. 2023

When it turns red, placed under the diagnosis and supervision of a physician, and positioned the same as a red card, it means removal from the competition.

1. Screening details

The following symptoms should be determined and noted if the patient is not in a healthy green state.

Regarding menstruation, the severity of menstruation will be divided according to the cycle (in boys, it cannot be determined without measuring testosterone, whereas in girls, the severity of menstruation can be determined by the menstrual cycle).

- Weight loss in case of no menarche until the age of 15 or no menstruation for 1 year.	**Equivalent to orange**
- When she has not menstruated for more than 3 cycles (90 days or more) **- Weight loss even with cycles of 35days or more**	**Equivalent to yellow**

The following are the primary and secondary indicators to stage the severity/risk of the four signal levels (green, yellow, orange, and red).

*The diagnosis of green also includes indicators that cannot be determined without a medical visit, so they are not immediately used clinically

< Reference >

IOC REDs CAT2 (PDF)
https://stillmed.olympics.com/media/Documents/Athletes/Medical-Scientific/Consensus-Statements/REDs/IOC-REDs-CAT-V2.pdf

Sports Nutrition Web*
(Sports Nutrition and Dietitian Japan website)
"2023 International Olympic Committee's Consensus Statement on Relative Energy Deficiency in Sport (REDs)"
https://sndj-web.jp/news/002498.php

*Japanese only

Severe Primary Indicators (equivalent to 2 primary indicators)

- Primary amenorrhea (females)

No onset of menarche until the age of 15 despite the presence of obvious secondary sexual characteristics

*In the U.S., menarche normally occurs at the age of 13 on average, and +2 SD is the age of 15 (note: in Japan, the average age is 12). Another indicator is if breast development (an obvious secondary sexual characteristic) is observed before the age of 10, but menarche does not occur within 5 years.

or

Prolonged secondary amenorrhea due to functional hypothalamic amenorrhea (FHA),

absence of 12 or more consecutive menstrual cycles (amenorrhea for more than 1 year)

- Clinically low free or total testosterone

Males: below reference range

Primary Indicators

- Secondary amenorrhea caused by FHA (females: absence of 3 to 11 consecutive menstrual cycles)
- Asymptomatically low total or free testosterone (males: the lowest 25% (quartile) of the reference range or less)
- Asymptomatic or clinically low, total, or free T3 (minimum 25% (quartile) of reference range or less)
- History of at least 1 bone stress injury (BSI) at a high-risk site (femoral neck, sacrum, pelvis) or 2 at low-risk sites (all other sites) within the past 2 years, or at least 6 months of breaks taken from training in the past 2 years
- Premenopausal females and males < the age of 50: BMD Z-score < -1 for total of lumbar spine, hip, or femoral neck, or decrease in BMD Z-score from previous testing; children/adolescents: BMD Z-score < -1 for lumbar spine or TBLH (total body less head), or decreased BMD Z-score from previous testing (can occur from bone loss or inadequate bone accrual)
- Negative deviation from the child or adolescent athlete's previous growth trajectory (height and/or weight) (note: this is the case if there is at least some weight loss)
- EDE-Q global (> 2.30 for females and > 1.68 for males) and/or clinically diagnosed DSM-5-TR-defined eating disorder (only 1 primary indicator for either or both outcomes)

Secondary Indicators

- Oligomenorrhea caused by FHA (> 35 days between periods for a maximum of 8 periods/year) (note: in Japan, this would be more than 39 days)
- History of 1 low-risk BSI within the previous 2 years and absence of less than 6 months from training due to BSI in the previous 2 years
- Elevated total cholesterol or LDL cholesterol (above the reference range)
- Clinically diagnosed depression and/or anxiety (only 1 secondary indicator for either or both outcomes)

Note: Although total cholesterol is included as a secondary indicator, this assumes hypercholesterolemia associated with hypothyroidism (including hypo T3 syndrome) when it leads to anorexia overseas, while in Japan, on the contrary, a low value is considered a risk as a carbohydrate deficiency, not a surplus, but a decrease.

Other symptoms and other signs that can be evaluated include the following. If any of these symptoms are present in the athlete's self-assessment, they should be considered as requiring attention.

Potential Indicators

(No scoring, newly identified as candidates)

- Asymptomatic or clinically low IGF-1 (within the lowest 25% (quartile) of the reference range)
- Clinically low blood glucose (below the reference range)
- Clinically low blood insulin (below the reference range)
- Chronically poor or sudden decline in iron-related tests (e.g., ferritin, iron, transferrin) and/or hemoglobin
- Lack of ovulation (via urinary ovulation detection)
- Elevated resting AM or 24-hour urinary cortisol (above the reference range or significant individual change)
- Urinary incontinence (females)
- Gastrointestinal or liver dysfunction at rest and during exercise/adverse gastrointestinal symptoms
- Reduced resting basal metabolic RMR (< 30kcal/kg FFM/day) or RMR ratio < 0.90
- Reduced or low libido/sex drive and decreased morning erections (especially in males)
- Symptomatic orthostatic hypotension
- Bradycardia (heart rate < 40beats/min in adult athletes; < 50 beats/min in adolescent athletes)
- Low systolic or diastolic blood pressure (< 90/60mm Hg)
- Sleep disturbances
- Psychological symptoms (increased stress, anxiety, mood changes, body dissatisfaction and/or body dysmorphia)
- Exercise dependence/addiction (inability to stop exercising)
- Low BMI

2. Screening with tools

In screening for REDs/LEA, it is important to use effective tools not only to interview students about their own health problems but also to make objective judgments from the viewpoint of prevention and avoiding missing signs and symptoms. The tools introduced below can determine the health status of students from various angles, so it is necessary to conduct regular screening by using the tools appropriate to the students' situations and objectives.
Since there is no screening sheet for IOC REDs CAT2 yet, the following should be used.

FAT Screening Sheet* (See Appendix, p35)

The FAT screening sheet is designed to extract (screen) FAT risks with a high degree of accuracy by simply answering simple questions.
*Downloadable from the following link

FAT Screening Sheet Link:
https://research-center.juntendo.ac.jp/jcrws/research-products/conditioning/fat/

PPE

Pre-participation physical evaluation (PPE) for female athletes is an online tool that allows athletes to answer 42 questions to assess athletes' risk for concussion, heart, general illness, bone, and current FAT status on a 3-point scale of low, medium, and high risk.

PPE Introduction link:
https://research-center.juntendo.ac.jp/jcrws/en/research-products/conditioning/ppe/

PPE link:
https://ppe4fa.jp/

Surari Muscle*

As previously mentioned, simply by entering daily height and weight, each individual can determine the amount of energy intake and basal metabolic rate required and check whether they are maintaining sufficient LBM to improve their competitive performance. (This is the tool that we want athletes to use the most, as this project recommends self-management by measuring LBM)

Surari Muscle Introduction link:
https://research-center.juntendo.ac.jp/jcrws/research-products/support/surari_muscle/

Link for PC:
https://surarimuscle.juntendo.ac.jp/

QR code for downloading the app version

iOS

EAT-26 (See Appendix, p35)

This is a questionnaire designed for symptom assessment and screening of patients with eating disorders. It consists of 26 items in three scales which are; "Eating Restriction," "Gluttony and Food Control," and "Fear of Obesity," and a high total score is considered suspicious for abnormal eating behavior.

Female Athlete Diary

The Female Athlete Diary was designed as a tool for all female athletes to manage their own physical condition so that they can lead a satisfying athletic life. By recording daily entries that are essential for female athletes to manage their physical condition, it is possible to objectively assess whether their physical and mental condition is good or bad.

Female Athlete Diary link:
https://research-center.juntendo.ac.jp/jcrws/en/research-products/conditioning/diary/

*Japanese only

3. Confirmation of growth and maturity

Measurement of body size is important in diagnosing energy deficiency in girls in school-based sport club activities. Since growth is a major factor, it goes without saying that height and weight measurements are necessary to ascertain the increase in skeletal muscle, including maturation, so **measurement of Lean Body Mass (LBM)** on a scale that can measure body fat percentage is considered essential for sport.

The main increase in body weight during height gain is **an increase in skeletal muscle mass**, which is directly related to energy status as it correlates with an increase in basal metabolism. Even if height growth has ceased, the body is still in the process of maturation, and skeletal muscle mass increases as menstruation begins, and sex hormones increase. If all this weight gain is mistaken for body fat, there will be an energy deficit. Since then, LBM has been measured, as there has been an increase in skeletal muscle that is not seen in the average general girl student due to the effects of exercise.

The growth rate curve plots the number of centimeters gained in one year, and a growth spurt (the period of greatest growth is called the peak) is observed, indicating a rapid increase in height as the amount of energy increases and there is more room to grow.

Check if there is a growth peak

⇒ If there is no peak, there is no increase in skeletal muscle and no increase in load, so beware of stress fracture.

Check if growing along the growth curve

⇒ If the height is increasing, is there any stagnation in weight gain? If weight has not increased by 550g per cm of height, energy deficiency is present.

1) Growth curve and growth rate curve preparation[1)]

Based on the growth records brought in, a growth rate curve (how many centimeters have grown in one year) is created using growth curve creation software. Although it is believed that the school setting was aware that physical measurements were taken once a year, a one-year measurement interval is not sufficient for growing athletes. Prefer to measure at least once every three months to check the growth. If height can be measured once a month and plotted on a height-weight curve, energy balance can be ascertained. Measure frequently during growth spurts on the growth rate curve.

"Surari-chan, Height!"*
(Japanese Center for Research on Women in Sport, Juntendo University)

https://research-center.juntendo.ac.jp/jcrws/research-products/support/surari_height/

"Health Mate"*
(Institute of Sport Medicine, NHO Nishibeppu National Hospital)

*There are two types of growth curves: longitudinal growth curves (reflecting individual growth) and cross-sectional growth curves (reflecting the population at that age), and use "longitudinal" when looking at individual growth.

https://nishibeppu.hosp.go.jp/section/cnt1_00103.html

2) LBM measurement

* correlates with skeletal muscle mass

Measure body fat on a scale that can measure body fat and produce LBM (kg).

LBM =

body weight− [body weight × body fat percentage (%) / 100]

"Surari Muscle" (See p10)
(Japanese Center for Research on Women in Sport, Juntendo University)

3) LBMI[2)]

LBMI is calculated by multiplying BMI (Body Mass Index; = weight(kg)/[height(m)^2]) by body fat percentage and subtracting it from BMI. It represents the percentage of body weight related to exercise, including skeletal muscle mass, as a proportion of BMI.

It includes skeletal muscle mass related to growth and maturation, which increases with training.

"Surari-chan's Growth and Muscle Graph"*
(Japanese Center for Research on Women in Sport, Juntendo University)

https://research-center.juntendo.ac.jp/jcrws/research-products/support/surari_nobi_muscle

*Japanese only

4. Assessment by a physician

1) Medical questionnaire

As much as possible, ask the patient to fill out and send in the questionnaire and FAT Screening Sheet to gather information in advance to see if there are any signs of FAT.

Create a growth rate curve from the height and weight records using "Health Mate" or other software, and draw a growth rate curve to check the phase of growth, etc. If the patient has already kept a physique record using "Surari-chan, Height!" or "Surari Muscle," instruct the patient to bring them.

During the interview in the examination room, it is important to ask the patient about his or her athletic activities and best results (individual and team results) and to remove any uneasiness about the medical treatment through conversation.

2) Examination

*Refer to [How to read examination data in sports medicine] on p15

Assessment from blood collection data - Determination of Relative Energy Deficiency in Sport (REDs) –

The results of general blood tests can predict energy status to some extent, although there are individual differences. Even without the assessment of a sports nutritionist, a family doctor who does not specialize in sports medicine can identify high-risk cases of REDs from the interview and blood draw data, and can refer the patient to a specialist when appropriate.

The following is a list of general biochemical tests that the family doctors can use as a guide.

(1) Creatinine (CRE)

Usually indicates kidney function, but it increases with skeletal muscle mass (usually about 1/100th of body weight). Athletes who play sports usually exceed this, and if the creatinine/body weight ratio (creatinine × 100/body weight) exceeds 1.0, it means that the skeletal muscles have a large amount of energy (a creatinine level for a person weighing 60kg is about 0.60. If it were 0.72, the skeletal muscle would be considered equivalent to a 72kg person). REDs tend to occur after adequate training and increased skeletal muscle mass. Don't forget to praise those athletes with high skeletal muscle mass by saying "You've been training hard lately, haven't you? You have very good muscles!" first (REDs occur when there is a lack of carbohydrates even though the muscles may look very good).

(2) Total testosterone

***This is not a general biochemical test, but one that family doctor should use to determine if possible**

It is a hormone that synthesizes proteins that synthesize the body (called anabolism) and thus has the role of increasing skeletal muscle mass.

It also works to repair a broken body, so if this is lowered, repairs will not be done adequately and can build up and cause sports injuries. This hormone is secreted by command from the brain, so when the brain determines that there is not enough energy, it issues an order not to build any more muscle and lowers it.

Boys Average 4.32ng/mL (10nM)
*Below average is not suitable for exercise
Below 2.88ng/mL (5nM) indicates REDs

Girls Average 0.3ng/mL
Below 0.2ng/mL indicates REDs
*Evaluation of the usefulness of active free testosterone has not yet been established in girls.

In addition to total testosterone, a test that should be used by your family doctor for determination, if possible, is **luteinizing hormone (LH)** (see p31).

LH is secreted by the pituitary gland at the command of the brain and is the hormone that orders a decrease in total testosterone to prevent further muscle building when the brain determines that there is a lack of energy from carbohydrates.

< 3.0 mU/mL suggests REDs
< 1.0 mU/mL indicates REDs

(3) Hemoglobin (Hgb)

It is an indicator of anemia, but can also be an indicator of energy deficiency. It has been shown in the literature that high total testosterone raises hemoglobin. Despite iron deficiency, anemia often does not improve with iron administration alone. If the anemia is not cured, REDs are likely to complicate the disease.

In junior high and high school boys, hemoglobin increases with total testosterone, averaging 15.1g/dL in high school boys (13.1g/dL in girls).

Boys with < 13.5g/dL are more likely to have REDs
Girls with < 11.5g/dL are likely to have REDs

(4) Total cholesterol
*Considered most useful as an indicator of carbohydrate deficiency

In junior high and high school students, low values are problematic and an indicator of REDs. Average 175mg/dL for both sexes from elementary through high school students, and values below 160mg/dL (generally less than -1 standard deviation) tend to be energy deficient. In athletes, carbohydrate deficiency is more often the cause than lipid deficiency.

< 160mg/dL requires attention
< 140mg/dL suggests REDs
(*If a high school student has more than 250mg/dL, there is a high possibility that they have a genetic predisposition to high cholesterol)

(5) Urea nitrogen (UN)

UN is the metabolite of ammonia and is produced in the preliminary stage of nitrogen disposal as urine. It is known to be influenced by dietary protein intake, and if it is 20mg/dL or higher in both men and women, it is expected to be high in catabolized (broken) protein.

> 20mg/dL: Suggests muscle damage or excessive protein or other protein intake
≥ 30mg/dL: Protein catabolic state

(6) Urea nitrogen (UN)/creatinine ratio
*The second most useful indicator of carbohydrate deficiency after (5)

Besides excessive protein intake, UN also rises when muscle fibers are damaged due to exercise. It also indicates that when nutritional disorders occur and energy from glucose (carbohydrate), the source of energy, is insufficient, glycogenesis (also called protein catabolism) occurs, in which glycogen stored in skeletal muscle is used or muscle itself is broken down and converted into energy. Normally, a UN/creatinine ratio of 15 or less is acceptable, > 20 indicates glycogenesis using muscle, and > 30 is considered REDs (the same level as starvation bone and skin only).

> 20 Protein catabolism and gluconeogenesis
> 30 REDs; the level at which skeletal muscle loss occurs

(7) Cholinesterase (ChE)

The proteins that make up the body are said to correlate with the amount of protein ingested, which indicates the degree of protein synthesized in the liver. Normally, this is around 300U/L for boys and 250U/L for girls. For athletes, 350U/L or more for boys and 300U/L or more for girls are required.

Boys < 250U/L suggests REDs
Girls < 200U/L suggests REDs

At the other indicators, address **general biochemical tests that affect REDs.**

(8) Creatinine kinase (CK)

Since lactate, which is released when muscle cells break down, has a very short half-life and is difficult to measure, CK is used instead and is an indicator of muscle fiber damage (more muscle fibers are released when the amount of skeletal muscle mass broken is higher). Immediately after exercise, CK may exceed 1,000U/L, but returns to the normal range in about 2 hours if appropriate hydration and carbohydrate replacement are provided and a cool down is performed (in fact, this may be consistent with the dynamics of lactate. Blood lactate levels have a short half-life (about 5 minutes) and must be measured during or immediately after exercise to be detected).
If it remains high for any length of time, muscle fatigue tends to accumulate, which is thought to influence the development of sports disorders. The inability to quickly decrease blood levels may be due to inadequate hydration or a decrease in metabolic water production itself due to decreased carbohydrate levels.

(after 2 hours of exercise)
The normal range is:
Boys < 250U/L
Girls < 200U/L
In both boys and girls, ≥ 400U/L may indicate poor recovery (exercise in this condition is said to increase the risk of heat stroke).

(9) Hematocrit (Ht)
*Similarly, dehydration due to lack of carbohydrates is inferred.

It is the percentage of liquid components of blood that are not solid components such as red blood cells. For high school students, the normal range is 45% for boys and 40% or less for girls. Anything higher than this indicates that the blood is concentrated due to dehydration, which, like CK, is caused by a lack of carbohydrates in addition to hydration.
If exercise is continued at or above 50% for boys and 45% for girls, the possibility of heat stroke is high.

- Urine-specific gravity is another indicator of dehydration. Urine-specific gravity is usually 1.010 (water is 1.000). A urine-specific gravity of 1.025 or higher suggests dehydration and a urine-specific gravity of 1.030 or higher indicates dehydration.
  High urine specific gravity in junior high and high school students is generally due to poor carbohydrate intake, although it can also be caused by inadequate water intake.

Athletes who are still growing - LEA is most likely to occur when height is increasing and skeletal muscle mass is at its highest! (In girls, the peak has passed, so the post-menarche period of skeletal muscle gain is the most likely time for this to occur, but if it is still growing, caution should be advised!)

(10) Alkaline phosphatase (ALP)

The maximum increase in skeletal muscle occurs about 6 months after the growth peak, when height growth is significant, averaging between the ages of 11 and 12 for girls. In many cases, junior high school students have already passed this period, but since the -2 standard deviation corresponds to the age of 13, this means that a small number of athletes continue to increase in height. They are especially susceptible to REDs during the period of height gain, as they require more energy.
ALP levels correlate with the amount of height gain (the difference between the previous year's height and this year's height), usually 120U/L for adult male and 90U/L for adult female, and if they are above that, they may be growing taller, so beware of REDs.

*If the value is very low, below 60 in girls, low metabolic turnover of bone is suspected.

Column

An Instructor's Perspective : "Take a break from training" is not allowed to say

A politician once asked, "Do you have to be the best?", however in conclusion, athletes are creatures who "have to be the best". Athletes live in the present to be the best. There is only one thing you should never say to such an athlete, "Take a break from training then you will recover".
The athletes know that it is obvious that they will recover if they take a break from training. But they come to the hospital using their precious training time with the earnest wish that God, Buddha, and physicians, please somehow be able to train.
College students and general athletes will have the ability to adjust their training volume appropriately. However, in the case of girls in school-based sport club activities, only the instructor (club activity advisor) has the authority to adjust the amount of training.
If an athlete reports to the instructor that "the physician has told them to take a break from training", unfortunately, there are still many unreasonable instructors who will say, "Don't go to such a hospital again" or "Who do you believe, the instructor or the physician!" in Japan. The urban legend that "if an athlete miss 1 day of training, it will take 3 days to recover" has taken root in the sports world. Surely, there are athletes who hide from their instructors that they have even been to the hospital.
So, there is a request to physicians. First of all, praise athletes for their courage to come to the hospital. That alone will make the girls in school-based sport club activities who are unsure of how much to honestly talk about their symptoms open up. Then tell them, "You can practice." However, don't forget to add "as long as it doesn't hurt", "as long as you can do it", and "as long as you eat properly".

Table 3. How to read examination data in sports medicine

Examination name (unit)	(Reference range)	Undesirable value for an athlete	Explanation
◆ Indicators of energy deficiency (carbohydrate deficiency)			
T-CHO (mg/dL)	(142-248)	< 140	One of the indicators of CONUT values for malnutrition. In case of carbohydrate deficiency, the value is lower than the average of 175mg/mL. (If extremely high values are shown and the patient is severely emaciated, an eating disorder may be present) *Athletes may be genetically predisposed to high cholesterol, so an above-average level does not necessarily mean a sufficient level. The level also increases with hypothyroidism.
Total testosterone (pg/mL)	(9-56)	< 20	This means there is no room for protein synthesis due to energy deficiency. Elevated levels of both LH and total testosterone are common in female power athletes. This correlates with IGF-1 levels, so if too low, skeletal muscle does not increase and height does not increase.
LH (mIU/mL)	(1.4-7.4)	< 3.0	A low value (< 3.0) is considered to be due to a lack of energy and the patient's inability to ovulate. *A low value < 1.0 may be due to taking low-dose oral contraceptives, along with FSH.
ChE (IU/L)	(201-421)	< 250	Normally indicates protein synthesis capacity in the liver. In athletes, a decrease is seen when food intake is low.
◆ Indicators of protein catabolism (Indicators of carbohydrate deficiency)			
UN (mg/dL)	(8-20) *Within 20 times of CRE	> 20	Increases when protein is catabolized into carbohydrates for the body to use as energy (A state in which protein is utilized as emergency and emergency energy due to carbohydrate deficiency) (Indicates the amount of protein that is excreted in urine as ammonia and can no longer be reused. It is the precursor of ammonia in the blood). Also elevated in case of excessive protein intake. If due to muscle breakdown, CRE is not elevated, only UN is elevated. *Not increased at the level of gastrointestinal bleeding produced by exercise (it has been reported that even bleeding of > 90mL did not cause an increase).
CRE (mg/dL)	(0.49-0.79) *×100 = kg body weight	CRE × 100 < body weight	In athletes, it reflects muscle mass. (Proportional to the amount of energy produced by skeletal muscle: thought to correlate with the amount of mitochondria in skeletal muscle) If CRE rises sharply, it indicates muscle gain (note LEA).
UN/CRE ratio	(< 15)	> 20	An index of protein catabolism, indicating carbohydrate deficiency. (The ratio increases with a high-protein diet, and a ratio above 20 indicates excessive intake of protein, etc. or lack of carbohydrate intake when consuming protein)
◆ Indicators of iron deficiency (Indicators of increased skeletal muscle mass) *Indicates change in iron distribution			
Ferritin (ng/mL)	(5.0-157.0)	< 30 < 20 Iron deficiency < 12 Anemia	Value decreases when iron stores are insufficient and decreases when skeletal muscle increases and myoglobin increases.
Hgb (g/dL)	(11.5-15.0)	< 13.0	Decreases as LEA progresses, because total testosterone, synthesis of heme, globin, and haptoglobin decrease.
TIBC (Tf)	(187-356)	> 360	> 360 indicates iron migration outside of bone marrow (where red blood cells are made; presumed to be skeletal muscle, mainly in athletes).
TSAT (%)	(20-30)	< 20	In the case of athletes, a decrease in TSAT may represent an increased demand for myoglobin iron in skeletal muscle. (Iron myoglobin taken up by skeletal muscle is excreted in urine when broken because of its low molecular weight and lack of binding proteins for re-collection) Once iron is taken up by skeletal muscle, it cannot be reused, resulting in iron deficiency. This should be used as a guide to start iron supplementation when it drops, and is considered an early indicator of LEA detection (it is an indicator of skeletal muscle gain and drops before ferritin drops).
Fe (μg/dL)	(40-188)	< 50	Used in combination with TIBC for determination.
◆ Indicators of poor recovery (Failure to return what can be reused to the liver: indicates dehydration and indirectly indicates carbohydrate deficiency)			
Urine specific gravity	(1.010-1.020)	> 1.020	> 1.020 indicates dehydration, > 1.030 indicates lack of metabolizable water and possible carbohydrate deficiency. *Urine ketone bodies: indicates beta-oxidation, in which lipids are converted to carbohydrates to supply energy, and may indicate carbohydrate deficiency. *Urinary protein: When protein is released even though kidney function is not impaired, it indicates that the urine cannot be reabsorbed due to the high specific gravity of the urine caused by dehydration. *Urinary occult blood: It can be positive for hemoglobin and myoglobin instead of red blood cells.
CK (IU/L)	(41-153)	> 250 at 6 hours after exercise	An indicator of muscle damage that is elevated with destruction of skeletal muscle. It is particularly high in athletes with high muscle mass, and high values until half a day after exercise indicate poor post-exercise recovery. Indicates the possibility of intramuscular chemical hemolysis due to lactic acid accumulation.
◆ Hormones (Criteria for determining amenorrhea: an indicators of indirect energy deficiency)			
FSH (mIU/mL)	(3-8)	< 3.0	Indicator of hypothalamic amenorrhea, which is decreased in LEA/REDs states. Below 3mIU/mL is considered to cause delayed ovulation due to lack of energy. *The time to ovulation can be approximated by this value. At 7mIU/mL, it is considered to be 14-15 days; at 5mIU/mL, 20 days; and at 3mIU/mL, 30 days or more. For 3mIU/mL or less, the cycle is 39 days or longer, so LEA can be presumed to be occurring. *If 14mIU/mL or more, the woman is presumed to be in a state of decreased ovarian function (40mIU/mL or more is a menopausal state).
Estradiol (pg/mL)	(around ovulation 200-300) (Other than that 50-100)	< 20	Values below 20pg/mL are presumed to be amenorrheic and are considered a state of LEA/REDs, which is considered a risk state for osteoporosis. *Ethynyl estradiol contained in low-dose oral contraceptives are not detected, so the value is < 20.

All values in the table are for female.

Reference values: Tanaka et al., 2008

4 Concept of Menstruation in LEA[1)]

1. Relationship between menstruation and LEA

"Menstruation" means that a woman has enough energy to give birth to a baby. In other words, it is a sign from the body that "there is enough energy to build up 2-3kg of muscle mass, which is equivalent to the weight of a baby".
A menstrual cycle that occurs approximately once a month (25 to 38 days) is an energy state that can afford to do that. If the menstrual cycle is not in this range (less than 25 days or more than 39 days), it indicates that the patient is becoming deficient in energy, which is a sign of LEA. If a person who used to menstruate every month without fail now has one every two months or twice a month, the first thing to check is to see if there has been a sudden increase in physical activity as well as a decrease in weight.
It is often thought that LEA occurs in athletes who do not consume a minimum amount of energy because they need to lose weight for competition, or in athletes who drastically reduce their diet because they think that being thin will give them an advantage in competition, but this is never the case.
On the contrary, when they train hard, they have more skeletal muscle to use for exercise. Comparing the increase in skeletal muscle to a car, it means that the engine has gotten bigger, which requires more gasoline. Despite this, athletes may start trying to lose weight by eating less just because they have gained weight. This is another cause of LEA.

Table 4. Risk assessment based on the menstrual cycle

Risk Level	Cycle	
Blue	25-38 days	Normal
Yellow	39-89 days	Oligomenorrhea
Orange	More than 90 days	Amenorrhea
Red	More than 1 year	Severe amenorrhea

Source: IOC Consensus Statement, 2023

2. Improvement of energy status first

Fortunately, girls have a good sign that indicates energy storage, "menstruation", which of energy stores that boys do not have.
First of all, it is important to keep track of how much Lean Body Mass they have on a daily basis.
If they gain weight, but it is an increase in Lean Body Mass, it means that their skeletal muscle mass has increased, which means that they have a bigger engine, and they can eat more food, which is like gasoline in this comparison. However, if they are concerned about weight gain and reducing the amount of food they eat, you should be careful because their menstrual cycle may become longer or shorter again.
At this point, if it is possible to reduce physical activity, it is recommended to decrease it a little and encourage them to increase the percentage of carbohydrates in their diet. At this stage, it is possible to quickly return to a normal monthly menstrual cycle.
However, if Lean Body Mass is decreasing at this stage, even though they intend to increase food intake, it means that they are still not eating enough. If left untreated, this will lead to "amenorrhea", in which menstruation does not occur for more than three months, resulting in the various symptoms described later.
Thus, menstruation is a very good sign that girls in school-based sport club activities can monitor their own energy status without having to have a dietitian check their food intake or wear wearable devices to measure how much energy they are expending in exercise.
For athletes, longer or shorter menstrual cycles are not a problem in and of themselves; the problem is LEA! Therefore, the first step is to eliminate LEA.

Column

Gender Issues in Athletes

The total testosterone concentration is used as a rule of entry for male to gender-changed athletes. In females, it is impossible to exceed 1.0ng/mL except for adrenal enzyme abnormalities, and the International Association of Athletics Federations has established a value of less than 5nM (1.44ng/mL), which is a qualification for the women's middle-distance event, as a value that is unlikely to be exceeded even in PCOS. The problem here is the possibility that sexual differentiation disorder may be included in delayed menarche, i.e., not having reached menarche at the age of 15. It has been a problem in many past cases that issues related to gender after becoming a top athlete can lead to scandals. The patient should be informed under adequate counseling by a specialist, and physicians need to take sufficient care in dealing with this issue at the junior high and high school stages.

1. Nutritional assessment

Assessment is conducted by a registered dietitian or a certified sports nutritionist and is carried out during nutritional guidance using the results of the assessment of nutrition, food environment, dietary habits, practice (training) situation, home environment, body composition data, dietary survey results, and the EAT-26 test (See p35). In addition to the assessment, the flow of nutritional guidance is described here.

1) Flow of assessment and nutritional guidance

(1) Preparation for initial nutritional guidance

a. Transcribe the necessary information onto the assessment sheet.

b. Prepare for body composition measurement.

(2) Implementation of initial nutritional guidance

a. Measure body composition before nutritional guidance.

b. Conduct assessment according to the assessment sheet.

c. Based on the results of body composition, the information obtained from b, and the problems the athlete is having, if there are things that need to be solved immediately, give priority to the guidance (things that cannot be solved in time for the next guidance: weight loss, anemia, etc.).

d. Explain how to fill out and submit the dietary survey form.

(3) Preparation for the second and subsequent nutritional guidance

a. Summarize additional assessment items.

b. Transcribe blood test results and other information from the initial visit onto the assessment sheet.

c. Prepare for body composition measurement.

d. Analyze the dietary survey.

e. Check the status of Energy Availability (EA).

f. Based on the results of the assessment, formulate personal goals and a draft nutritional supplementation plan.

(4) Implementation of the second nutritional guidance

a. Measure body composition before nutritional guidance.

b. Conduct assessment according to the assessment sheet.

c. Explain the results of the assessment and formulate a plan to improve dietary habits and personal goals.

d. Explain the nutritional supplementation plan associated with c, formulate a plan of action, and provide nutrition education.

<< Materials used >> * Japanese only

- Leaflet: "Nutritional Advice for Female Athletes" *
  https://research-center.juntendo.ac.jp/jcrws/research-products/education/advice/
- "Physical Characteristics of Female Athletes and Nutritional/Dietary Management" e-learning for Female Athletes, Chapter 5 *
  https://research-center.juntendo.ac.jp/jcrws/research-products/education/elearning/
- "Female Athlete Diary" (See p10)

※ Encourage them to record and have them bring it with them the next time you instruct.

(5) Implementation of the third and subsequent nutritional guidance

a. Measure body composition before nutritional guidance.

b. Conduct a reassessment including the achievement status of personal goals according to the assessment sheet.

c. Based on the reassessment results, formulate personal goals, nutritional supplementation plan, and action plan, and provide nutrition education.

<< Precautions during nutritional guidance >>

- Provide guidance that is suited to the athlete's dietary awareness, nutrition, and dietary knowledge.
- When the athlete proposes a weight loss plan, etc., carefully consider it, and if it is difficult, explain the reasons for the difficulty, and then formulate personal goals and action plans. In such cases, the process of physical changes that occur as a result of implementing the action plan should also be explained to the athlete, and their understanding should be encouraged before proceeding.
- Assessment is conducted from various angles, such as attitude toward competition, goals, and achievement points.
- Nutritional guidance often does not solve the problem by improving nutrition and diet alone. In order to achieve personal goals, nutrition education may also need to address the importance of menstruation and female hormones, correct body image, and improve sleep conditions.
- The certified sports nutritionist (registered dietitian) who provides guidance needs to have a wide range of knowledge, including laboratory values, which are frequently asked by athletes. It is also necessary to collaborate with information obtained from physicians in gynecology, orthopedics, psychiatry, and psychosomatic medicine.

- The important thing in nutrition guidance is to build a trusting relationship. Do not try to solve everything in one guidance session but try to solve the problem in regular guidance sessions.

2) EAT-26[1)]

(1) Conduct as an assessment for eating disorders.
(2) Give an EAT-26 test form with the dietary survey, have it filled out, and bring it to the next instruction.
(3) 3 points for "always", 2 points for "usually", and 1 point for "often", and calculate the total score. However, for No. 26 only, 3 points for "never", 2 points for "rarely", and 1 point for "sometimes".
(4) If the total score is 20 or more, they have an eating disorder tendency, and this should be indicated on the assessment sheet.

3) Energy Availability (EA)

EA was conventionally calculated as (energy intake - energy expenditure during exercise) / Lean Body Mass (kg), but the IOC's consensus statement on REDs[2)] published in 2023 indicates that there is a risk in setting a clinical threshold for EA because the level of EA involved in health and performance varies greatly depending on individual differences, gender differences, and body functions. Therefore, at this point, it is necessary to comprehensively assess whether energy intake is commensurate with energy expenditure.
Since EA declines as Lean Body Mass increases with growth, energy intake must be increased, or physical activity reduced to accommodate the increase in Lean Body Mass during the growth period. Energy expenditure during growth adds the amount of energy required to maintain the increased tissues and organs and the amount of energy associated with physical activity due to weight gain. Energy intake during growth must be added to the increased energy expenditure or EA will be reduced.

2. Improvement of nutritional status

1) Diagnosis (evaluation of nutritional status)

The assessment of decreased energy utilization (energy deficiency = Low Energy Availability; hereafter LEA) is made using EA.
When utilizing this assessment for girls in school-based sport club activities, a one-time assessment cannot simply be accepted as a daily assessment, since the amount of Lean

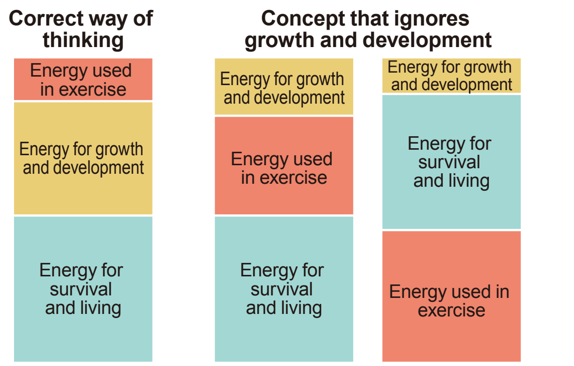


Figure 11. Way of thinking about energy intake for middle athletes

Body Mass is also increasing daily due to training. This is because as Lean Body Mass increases, the basal metabolic rate also increases, and furthermore, exercise with increased Lean Body Mass increases energy expenditure due to exercise.
Figure 11 shows the way of thinking about energy intake for middle athletes. The entire bar chart shows the maximum amount of energy that can be consumed from food in a day, including breakfast, lunch, and dinner, plus a supplementary meal. During the growth period, the energy intake is used for "energy for survival and living" and "energy for growth and development", and the remaining energy is used in the exercise. For example, a child who does not exercise or does not exercise much can become obese, as can an adult, if a child lives on the maximum amount of food that they can eat. Conversely, a child who does not exercise but eats less will not become obese. Considering the current situation of girls in school-based sport club activities, the central bar graph is shown. The priority in terms of energy use is "energy for survival and living", followed by "energy used in exercise", and the remaining energy is used for "growth and development". Furthermore, the bar graph on the right shows a situation that is often seen in athletes selected for elite programs. In order of priority, "do well in training", will be the first priority, and to reduce "energy for survival and living" they try to use as little energy as possible during the day (e.g., dozing off in class) to reduce "energy for living" and to leave energy for growth and development, but "energy for growth and development" will be lower. If the amount of energy used for growth and development is reduced by ignoring growth and development and exercising, short stature, delayed menarche (amenorrhea), anemia, and stress fractures will be caused, presenting with FAT. FAT during growth and development can only take place during a

limited period of growth and development, creating damage that can last a lifetime.

Thus, in assessing the nutritional status of girls in school-based sport club activities, it cannot be said that they are "well-nourished" simply because they eat a good breakfast, lunch, and dinner plus a supplementary meal[3].

It must also be combined with an evaluation of whether the amount of energy used for growth and development is adequate, not only in terms of energy used in exercise but also by utilizing "Surari-chan, Height!" and growth curves (see p11). If LEA is confirmed based on EA and "Surari-chan, Height!" status, nutritional improvement should be implemented, with a focus on energy.

2) Treatment strategy

Three major causes of LEA in girls in school-based sport club activities are presented.

Here, the focus is on the improvement of LEA, so if LEA is accompanied by a disease, nutritional management must also be added regarding its treatment.

A : When the amount of food eaten as a meal or supplement has reached the limit and the patient is unable to eat anymore.

In this case, the treatment strategy is to decrease the amount of energy consumption by decreasing the amount of physical activity to secure the amount of energy used for growth and development. At the same time, nutritional guidance should be provided to improve the way the child eats, cooking methods, and complementary foods to ensure efficient energy intake. As a contraindication, nutritional supplements or dietary supplements should not be used to maintain physical activity, as is the case with adult athletes.

B : When excessive physical activity (quality, quantity, intensity, and duration) or disruption of the rhythm of life results in a decreased appetite and eating less.

This is a condition in which LEA is caused by a decrease in appetite due to excessive physical activity due to a variety of factors such as quality, quantity, intensity, and time, or due to a disruption in the rhythm of life such as dinner and bedtime due to exercise that extends into the evening, or due to inability to eat a sufficient dinner due to drowsiness. In this case, as with A, it is necessary to decrease the amount of physical activity, adjust practice times, etc., and adjust the rhythm of daily life. After the physical activity and lifestyle rhythm have been improved, nutritional guidance should be provided from the dietary habits, focusing on the use of supplementary foods, to improve LEA.

C : When intentional (deliberate) reduction of energy intake

This is a condition in which energy intake is reduced by intentionally (deliberately) reducing food intake even though they can eat more, or by eating an unbalanced diet that is extremely low in fat and carbohydrate intake. In this condition, the body is adapting to a state of maintaining itself with less energy, not only because it uses less energy for growth and development, but also because it needs less energy for survival and living. If the body is suddenly given the amount of energy that is considered necessary from this condition, it will be recognized as excessive intake, and there is a high possibility that it will lead to a rapid increase in body weight (body fat). Therefore, energy intake is increased with the idea of changing the adaptation while maintaining the athlete's body shape as much as possible (in the case of the athlete who is lean, improvement of body shape is also considered). Specifically, energy intake will be increased gradually. For example, at first, one or two more mouthfuls of rice are added to each meal, and if there is no extreme increase in weight gain, the condition is continued for one or two weeks. At the next stage, increase another one or two bites, and continue for another one or two weeks, and so on, gradually increasing the intake.

3) Treatment process

For the aforementioned causes A and B, when LEA is improved, weight increases as well as height increases, confirming steady growth. For cause C, the process is a gradual transition to a situation where energy can be used (adaptation). If energy intake is increased rapidly in the initial stage of improvement, body fat mass will increase in a short period of time. Therefore, during the first month or two, adaptation should be carefully assessed by monitoring the growth situation and the increase in body fat mass.

4) Recovery process

If the patient recovers, the symptoms of FAT will improve, and the patient will be able to continue to grow and develop steadily and well. Furthermore, when growth and development are completed, the amount of energy that was needed for growth and development can be used in exercise, thus making it possible to increase physical activity without changing EA.

6 For School Nurses

This chapter summarizes the diseases 1) to 9) that are likely to occur in girls in school-based sport club activities who play sport, and what kind of awareness the school nurse, who is close to the students, should have in dealing with the students. Want you to be used as a guideline for managing the health of girls in school-based sport club activities and for supporting the implementation of healthy exercise when they complain of health problems.

1) Amenorrhea and abnormal menstrual cycles

The fact that the menstrual cycle is not nearly once a month is a sign of energy deficiency. First, it is necessary to check for a rapid increase in physical activity as well as a decrease in body weight. Training may have increased the amount of skeletal muscle used for exercise, which may have resulted in weight gain. Determine how much Lean Body Mass, excluding body fat, is present and advise to increase the proportion of carbohydrates in the diet that they consume.

2) Stress fractures

Stress fracture is one of the sports injuries caused by energy deficiency, which results in a continuous decrease in the ability of the body to repair the injured site of daily exercise. If menarche has not occurred, it means that the bone has not gained enough strength to support the weight of one's body.

3) Abnormality of the lower extremities

The legs, which support the body weight, are subjected to forces many times greater than the body weight when they are exercised. Even if the bones themselves have acquired a certain degree of strength, if the burden is placed on the same location, sports injuries will occur in that area. However, if they have enough energy, they will be repaired during one good night's sleep, so ask if there is a lack of energy or sleep.

4) Eating disorders

In the past, this was often seen in extremely thin athletes, and it was suspected that there was a problem with their eating (unbalanced or small amounts of food). If the students themselves say that they are eating properly, it should be understood and addressed that many cases are caused by relative energy deficiency due to excessive skeletal muscle growth.

5) Sports myopathy, iron deficiency, and anemia[1)2)]

Until now, it has been assumed that the symptoms of anemia are caused by iron deficiency in the blood. Symptoms caused by increased skeletal muscle mass due to sports are called sports myopathy, sports-induced iron deficiency is a condition in which iron (mainly ferritin) in the blood is reduced because iron that had been maintained in a certain amount in the body due to training is now distributed to skeletal muscle. In addition, if relative energy deficiency occurs due to an increase in skeletal muscle mass, the synthesis of the heme and globin proteins that constitute hemoglobin will decrease, resulting in sports-induced anemia.

6) Polycystic ovary syndrome (PCOS)

Polycystic ovary is a condition in which high levels of male hormones predispose to an increase in skeletal muscle due to training. Therefore, some athletes suffer from relative energy deficiency due to increased skeletal muscle mass. Therefore, Lean Body Mass, which increases in parallel with skeletal muscle mass, is a subject that should be measured.

7) Poor sleep

Deep sleep, which leads to physical recovery, appears more often in the early stages of sleep. In athletes with high skeletal muscle mass (especially in summer), deep sleep is often reduced due to the unfavorable decrease in deep body temperature. In particular, poor sleep is one symptom of energy deficiency, as it is believed to be affected by low carbohydrate intake at dinner.

8) Dysmenorrhea

Energy sufficiency may increase menstrual flow when the female hormone estradiol increases. There is no need to endure pain to confirm that menstruation is not a sign of energy deficiency. The response is to take low-dose oral contraceptives that suppress ovulation, which should encourage a prompt visit to a gynecologist.

9) PMS

Ovulation has occurred, progesterone is being produced, and the basal body temperature has been able to rise, which means that there is not an extreme energy deficiency. For this case too, low-dose oral contraceptives are the only treatment available for athletes who play sport, which should encourage a prompt visit to a gynecologist.

*Other commonly used herbal medicines and diuretics are included in doping-prohibited drugs, so athletes who play sport should be careful because they are equivalent to the kind of drugs that are not allowed under any conditions.

*For details on each item, please refer to the sections "Sport-caused Diseases and Treatment Process" on p24-34.

1) Treating girls in school-based sport club activities

Based on findings from overseas, knowledge about top athletes is increasing even among female athletes, and various measures are being taken. In Japan, most studies on female athletes have been conducted on university students, and many studies on problems in junior high and high school students have also investigated the history of problems in university students. Therefore, although studies have been conducted on athletes who were able to continue to compete through college age, they do not reflect information on athletes who had to give up athletics in junior high and high school. The medical problems of female athletes have been resolved mainly by obstetricians and gynecologists, but junior high and high school students rarely see them, and only menstruation-related problems have been resolved. Stress fractures are not directly treated, and anemia is often handled by internal medicine and pediatrics, so these problems have not been addressed.

For LEA/REDs, it has also been difficult at gynecology to measure individual physical activity and check nutritional intake. In addition, many municipalities in rural areas do not have obstetrics and gynecology clinics for junior high and high school students, and even if they do, many of them have only facilities that mainly handle childbirth.

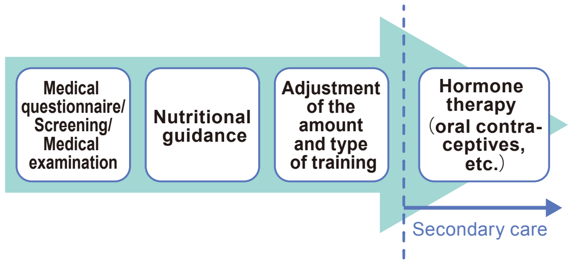
2) Medical treatment system

	Facilities	Roles
Primary care	Local family doctors	The first hospital to see patient and to provide primary care. A local hospital is readily accessible to junior high and high school girls, especially since gynecological consultations are difficult for girls in this age group, and orthopedics and internal medicine are also desirable.
Secondary care	Local or general hospitals with sports physicians	Hospitals to which patients are referred when the physician determines that the primary facility is unable to handle the problem, or when highly specialized treatment is required. Facilities that can perform more precise measurements such as bone metabolism markers.
Tertiary care	Hospitals with more advanced physicians such as university hospitals	Hospitals such as those affiliated with Juntendo University and the University of Tokyo have a female athlete clinic, where treatment can be provided in a three-way collaboration between gynecology, orthopedics, and a certified sports nutritionist.

Source: partially modified from Junior Female Athlete Health Support Manual, 2018, 2024

*This medical treatment system describes ideal medical treatment, but in Japan today, the opposite flow is used. This is because there are few facilities in easily accessible local hospitals that are able to treat FAT and disorders specific to female athletes, forcing athletes to consider going all the way to a secondary or tertiary care facility that is considered highly specialized, even if it is far away. In order to change the current situation which may lead to delay or even neglect of medical care, it is desirable to increase the number of hospitals in each region that can provide primary care for female athletes when they are seen.

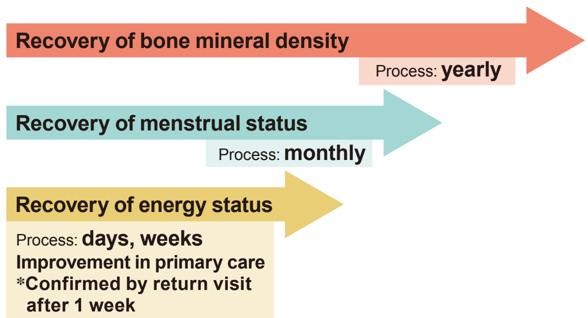
3) Approach and treatment flow



Source: Nattiv A, et al.: The female athlete triad. Med Sci Sports Exerc 39 :1867-1882, 2007, translated and modified for junior female athletes by the Japanese Center for Research on Women in Sport.

It is necessary that LEA/REDs be addressed at the primary family doctor stage as much as possible. At this stage, it is not necessary to be a gynecologist to deal with this stage. Iron deficiency and anemia also result from LEA/REDs, and should be addressed by internal medicine, pediatrics, and orthopedics, even if the menstrual cycle is prolonged.

4) Recovery process



Source: De Souza MJ, et al. Br J Sports Med 2014; 48: 48 289 2014 Female Athlete Triad Consensus Statement on Treatment and Return to Play of the Female Athlete Triad Koikawa Revised Figure, 2017

Each of FAT items recovers at different rates with appropriate treatment. First, recovery of energy status is observed, and the effect is observed after a few days or weeks. Recovery of menstrual status is observed after a few months, and female hormone levels improve.

The last to recover is bone mineral density, which takes days on a yearly basis. The period during which junior high and high school students can play sport is short, and yearly recovery often leads to withdrawal from competition. LEA/REDs should be addressed as much as possible at the level of the family doctor in primary care so that bone problems do not extend.

Gynecological consultation should be a last resort (limited to cases that can only be treated by a gynecologist), and LEA/REDs in girls in school-based sport club activities should be treated outside of the gynecology department.

1. What school doctors and family doctors need to understand

"Amenorrhea" itself is not the problem!
The problem is LEA!
When girls in school-based sport club activities visit you, focus on addressing LEA first, rather than immediately referring them to gynecology! Please consider referring them to a gynecologist only if their menstrual cycles do not normalize even after LEA has been resolved.

1) It is not a problem just for thin athletes

It has been thought to occur mainly in thin women, with LEA strongly suspected in adults with BMI < 17.5, and in adolescents with less than 85% of standard body weight[1], and in Japan, LEA is seen in a relatively large proportion of endurance and aesthetic athletes[2], however, it is by no means a problem just for thin athletes. Absolute numbers are also high in non-skinny athletes and in ball and power sports (see **Figure 6**, p6). The most common characteristic of athletes is PCOS with high LH and high total testosterone. The mechanism of an abnormal menstrual cycle is believed to be different from that of FAT[3], but the base is LEA. High total testosterone levels increase skeletal muscle mass and basal metabolic rate, and if they do not have a commensurate energy intake, they are prone to LEA. Please keep in mind that a prolonged menstrual cycle is a sign of LEA that is not present in boys.

2) Not a nutritional education issue, but a carbohydrate issue

When energy intake decreases, the higher center (hypothalamus) judges and suppresses the pituitary gland's rate-dependent secretion of LH. The ovulatory function is suppressed, thus presenting a prolonged menstrual cycle. When energy expenditure decreases due to interruption of competition, LEA may improve, and menstruation may resume spontaneously[4]. In junior high school students, athletic club activities are often completed by fall for entrance examinations, and menarche often occurs after that time, which is also due in part to excess energy consumption. However, the most important cause is **the decrease in the ratio of carbohydrate intake to energy intake.** Products claiming to be low in carbohydrates are everywhere, and the carbohydrate intake is decreasing even in families that are supposed to be eating an appropriate diet. In addition, the age of the parents of junior high and high school students is clearly older than in the past, due to the effect of an increase in the age of the mother's childbearing years. It must be recognized that this, in no small part, is spurring a state of too little carbohydrate intake for junior high and high school students.

3) What is the problem with amenorrhea for athletes who play sport?

It is that the suppression of sex hormones inhibits the increase in skeletal muscle needed for sport. In particular, if total testosterone, the male hormone, remains low, skeletal muscle will not increase no matter how hard the athlete trains. It should not be communicated as a problem that will affect future fertility, such as, "If you leave your amenorrhea untreated, you may not be able to have a baby in the future" (Unless severe anorexia is present, menstruation will recover once LEA is resolved). **Amenorrhea is a sign, not a target for treatment.**

2. What is expected from family doctors

The first choice of treatment is to improve LEA. However, there is no environment in which girls in school-based sport club activities can easily receive nutritional guidance from a certified sports nutritionist. In addition, although it has recently become possible to estimate the energy expended through exercise by recording heart rate using wearable devices, it is difficult to diagnose LEA because it is not possible to investigate backward in time.
Therefore, some sort of nutritional marker should be used to assist in the diagnosis of LEA. Protein nutritional indicators such as albumin and transthyretin are used in postoperative management, but since athletes in this age group are energy deficient, indicators that estimate carbohydrate sufficiency such as **total cholesterol** should be used. Objective medical indicators should be used to communicate energy deficiency to athletes with specific values. General biochemical tests such as the **UN/creatinine ratio**, which indicates protein catabolism (glycogenesis), can provide sufficient evaluation, and the athlete is likely to be convinced that subsequent treatment will improve the situation.
In addition, it is difficult to make continuous efforts without indicators that the athletes themselves can self-evaluate. It is recommended that body composition should be measured using a scale that can measure body fat percentage, and the increase or decrease in body composition be managed using the "Surari Muscle" app for creating Lean Body Mass increase curve. This will allow the change in Lean Body Mass to be monitored and lead to improvement of LEA.

3. Diagnosis when examined by a specialist physician

Gynecological LEA evaluation by a specialist in the treatment of amenorrhea should be made with LH. A mild decrease of < 3.0mIU/mL indicates the possibility of an abnormal cycle. Amenorrhea, the absence of menstruation for more than 90 days, is a severe LEA with a decrease to less than 1.0mIU/mL LH. The degree of decrease in FSH that accompanies the mild decrease in LH secretion prolongs the time to ovulation, resulting in a menstrual cycle of 39 to 90 days. Extension of the menstrual cycle to 38 days is within the normal range, and a mild LEA is suspected if the cycle is longer than 38 days. In athletes, attempts should be made to resolve LEA at this stage, but in general gynecology, the priority is to confirm the presence or absence of bleeding by administering hormonal agents.

For delayed menarche, in which menstruation has not occurred at the age of 15, if the administration of hormonal agents mentioned above does not result in bleeding, a more specialized obstetrician/gynecologist is required (primary amenorrhea is the absence of menarche at the age of 18). In this case, a close examination with chromosome analysis and MRI may be performed, if necessary, which may unexpectedly reveal chromosomal abnormalities (Turner's syndrome) or sex differentiation abnormalities. In athletes, measurement of total testosterone may also lead to the unexpected detection of sex differentiation abnormalities, and because of the sensitive nature of this issue, referral to a specialist is recommended in cases of suspected sex differentiation abnormalities. In addition, if significant leanness is observed or anorexia is suspected, even checking for bleeding is not done at the gynecology, as it is considered to be an energy consumption.

4. What to tell students for prevention

The significance of FAT treatment in the U.S. is secondary prevention to prevent recurrence of stress fractures, but in Japan, the purpose of FAT treatment is primary prevention to prevent stress fractures from occurring. Once a stress fracture occurs, it takes at least six months to return to competition. junior high and high school last for three years each, but each of these years is less than two and a half years the time available for competition. To spend six months of that time without being able to compete is a great loss. **Should make girls in school-based sport club activities well aware of the importance of not prolonging their menstrual cycle by themselves and maintaining their energy status to prevent LEA.** It is already too late to recognize stress fractures once they occur.

Because it takes time for LEA to improve while continuing to train, an objective recovery index is also needed to indicate if they recover. However, since it is not possible to go to the hospital for blood sampling every so often, body composition is used as an indicator for LEA improvement. The guideline for this is the measurement of Lean Body Mass. Lean Body Mass, which is calculated from the body fat percentage (measured on a scale that can measure body fat percentage) , can be used as a guide to manage increases and decreases in energy intake (see p6 and p7).

Recovery of LEA requires an increase of at least 52.5kcal per kg of Lean Body Mass. Even if one did not exercise at all, an energy deficit is calculated without an increase of at least 45kcal, and if it is 30kcal or less, it is considered LEA. In addition, Lean Body Mass increases in proportion to height. 10cm difference in height results in a 5.5kg difference in Lean Body Mass and a difference in basal metabolic rate of approximately 165kcal. Energy intake should not be assumed based on school grade or age but should be based on individual body size.

For example, if the body weight is 50kg and the body fat percentage is 20%, Lean Body Mass is 40kg. The basal metabolic rate is roughly 1,200kcal, and even without exercise, an energy intake of 2,100kcal is required. If all of this is supplemented with white rice, it is calculated to be a little over 5 "donburi" bowls of rice, and if 60% of the required energy is taken in with carbohydrates, have to eat a little over 3 "donburi" bowls of rice to meet the energy requirements. In other words, even if they think they eat enough, it is considered not enough, and that is the reason why LEA fails to recover.

It is also not uncommon for LEA in this age group to have anemia as a complication. It has been found that iron absorption is inhibited by 264% due to an increase in hepcidin when carbohydrate deficiency occurs[5)]. Even if iron tablets are administered, absorption is inhibited, and recovery is not expected. Without improving LEA due to carbohydrate deficiency, iron deficiency will not improve even if only iron is administered orally.

Stress fractures can occur even with various preventive measures. Even then, care must be taken, and while there is a decrease in appetite due to reduced exercise due to the injury, it is not uncommon for the amount of food intake to be intentionally adjusted and reduced, which also progresses to LEA and iron deficiency. Because this vicious cycle can greatly affect healing, for managing diet in the event of such a sports injury, it is important to be aware of one's energy needs then take.

For symptoms that cause difficulties with menstruation, such as dysmenorrhea or premenstrual syndrome (PMS), recommend them to advice that to visit gynecology and obtain a prescription for low-dose oral contraceptives.

1. Amenorrhea

1) Diagnosis

Growing girls in school-based sport club activities are prone to Low Energy Availability (LEA), a condition in which they do not take in enough energy to match the energy they consume, because they need energy for growth in addition to the energy they expend in exercise.

IOC advocated the dangers of Relative Energy Deficiency in Sport (REDs) in 2014[1], and in its 2018 revision, defined REDs as a syndrome of impaired health and athletic performance that can occur with prolonged exposure to LEA, alerted all athletes, regardless of gender[2].

If LEA continues before peak growth in girls in school-based sport club activities, the bone strength, which should increase rapidly at between the ages of 12 and 15, increases more slowly, reproductive function, which is a lower priority in life support, is impaired relatively early, and delayed onset of menarche or amenorrhea is not uncommon. Leptin, which is secreted from body fat, is necessary for menarche to occur, and athletes with reduced body fat are more likely to experience delayed menarche.

The diagnostic flow for secondary amenorrhea, a condition in which menstruation stops for more than 3 months for some reason even though menarche has occurred, is shown in **Figure 12**. In LEA with insufficient energy intake, the hypothalamus, the upper center, inhibits the pituitary gland's rhythmic secretion of LH, causing ovulation to cease, resulting in functional hypothalamic amenorrhea. This type is the most common type of secondary amenorrhea in girls in school-based sport club activities, and menstruation often resumes spontaneously when energy expenditure decreases due to an interruption of athletic activities.

As indicated by the U.S. FAT Risk Assessment (see **Table 1**, p4), a thin body type (BMI < 17.5 in adults and < 85% of standard body weight in adolescents) or rapid weight loss (> 10% per month) has been considered a risk factor for LEA for some time. However, there are reports that the absolute number of REDs is rather high in weight class and ball sports, as well as endurance and aesthetic sports, where thin body types are more common. This has become clear that athletes with high skeletal muscle mass are more likely to induce LEA because their energy requirements (basal metabolic rate) increase as their LBM increases.

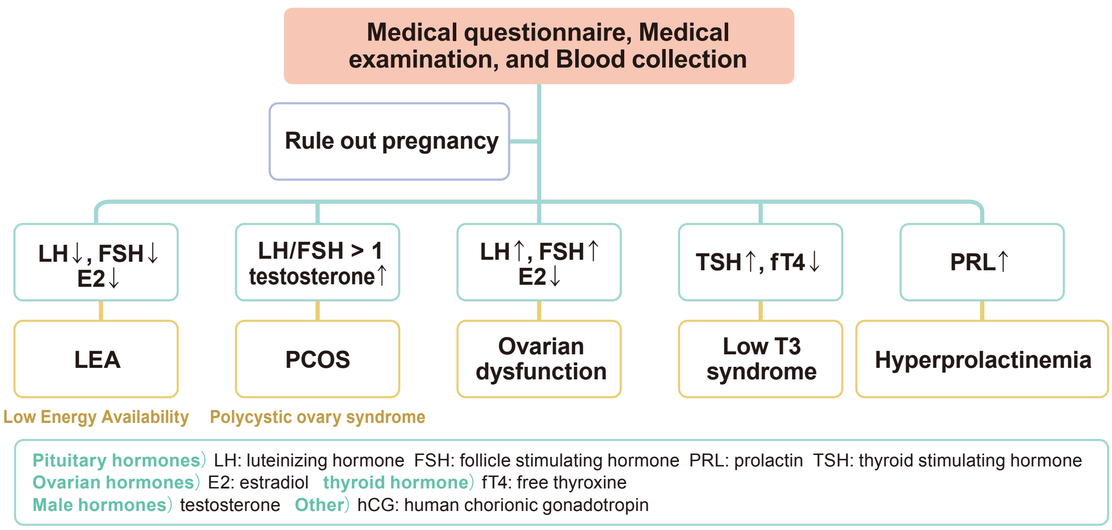
Polycystic ovary syndrome (PCOS) is the second most common cause of secondary amenorrhea after hypothalamic amenorrhea, but the mechanism is different from that of hypothalamic amenorrhea. PCOS is classified into two types: one with high LH and the other with high total testosterone, the latter is particularly common in girls who belong to athletic club activities and tend to have relatively high skeletal muscle mass. Such types are also prone to LEA, as mentioned above.

2) Treatment

Although amenorrhea may be a sign of LEA, the first choice of treatment is solely to improve LEA. However, if left untreated, amenorrhea has the disadvantage of stagnating bone mass and skeletal muscle growth due to suppression of sex hormones.

— Primary Care —

To evaluate for LEA, the first step is to check for a sudden increase in physical activity and weight loss; however, the



Source: Management Guidelines for Health Care of Female Athletes (partially revised)

Figure 12. Diagnostic flow chart for secondary amenorrhea

diagnosis of LEA is relatively difficult because weight gain occurs as skeletal muscle increases with training.

When functional hypothalamic amenorrhea is present, a useful indicator is the serum LH level, but when LH is < 3.0mIU/mL, the time to ovulation is prolonged, and amenorrhea is almost always present at LH is < 1.0mIU/mL. Another essential indicator is LBM which is calculated from body fat percentage and can be calculated using the formula {body weight - (body weight × body fat percentage)}. Since LBM can be converted from body fat percentage to evaluate excess or deficient energy amount, a corresponding amount of carbohydrate intake is recommended. The amount of Energy Availability per kg of LBM, which is expressed by the formula {(energy intake - energy consumption)/LBM}, if it is not 45kcal or more, they will be energy deficiency, and if it continues to be at 30kcal or less, the possibility of falling into LEA is increased. In addition, it is possible to predict the current energy balance to some extent by comprehensively determining biochemical tests. Useful objective indicators for diagnosing carbohydrate deficiency and LEA include such as TP, T-CHO, Hb, ferritin, and total testosterone (see **Table 3**, p15). The screening tool presented on P10 of this manual as a self-assessment index for athletes may also be of great help.

ー Treatment by a specialist physician ー

If LEA does not improve with diet and exercise amount adjustments, hormone replacement therapy for amenorrhea (obstetrics and gynecology) or osteoporosis treatment (orthopedics) may be necessary, depending on the situation. The most popular method of evaluating secondary amenorrhea is the progesterone stress test, which is diagnosed as grade I amenorrhea if there is withdrawal of blood after administration of a progesterone preparation, and grade II amenorrhea (considered a severe type) if there is no bleeding. Hormone replacement therapy in obstetrics and gynecology is shown in **Figure 13**, and most cases, Kaufmann therapy is used for primary amenorrhea and grade II amenorrhea, and cyclical progestin administration is used for grade I amenorrhea and PCOS.

Kaufmann therapy is used in combination with progesterone preparation once every 2 to 3 months to induce withdrawal bleeding and prevent irregular bleeding while on the regimen. In addition, transdermal estrogen preparation has been reported to improve bone mineral density at a higher rate compared to oral types[3], and transdermal estrogen preparation is recommended for growing girls in school-based sport club activities.

On the other hand, as a general treatment for amenorrhea, oral contraceptives/low-dose estrogen-progestin; OC/LEP may also be useful but are not recommended for athletes with LEA status. As mentioned above, in addition to the aforementioned benefits of transdermal estrogen preparation for bone mass gain, another reason is that low-dose oral contraceptives with LH-suppressing effects further exacerbate LH reduction caused by LEA, and their effectiveness in improving LEA is difficult to determine.

Treatment of amenorrhea by LEA should not be focused solely on hormone therapy but should always keep in mind the energy balance, however, considering the number of certified sports nutritionists nationwide and their uneven regional distribution, it is far from an environment where girls in school-based sport club activities can receive appropriate nutritional guidance from the start. From the above, the role of the family doctor up to the point of connecting them to a specialized facility is considered extremely important.

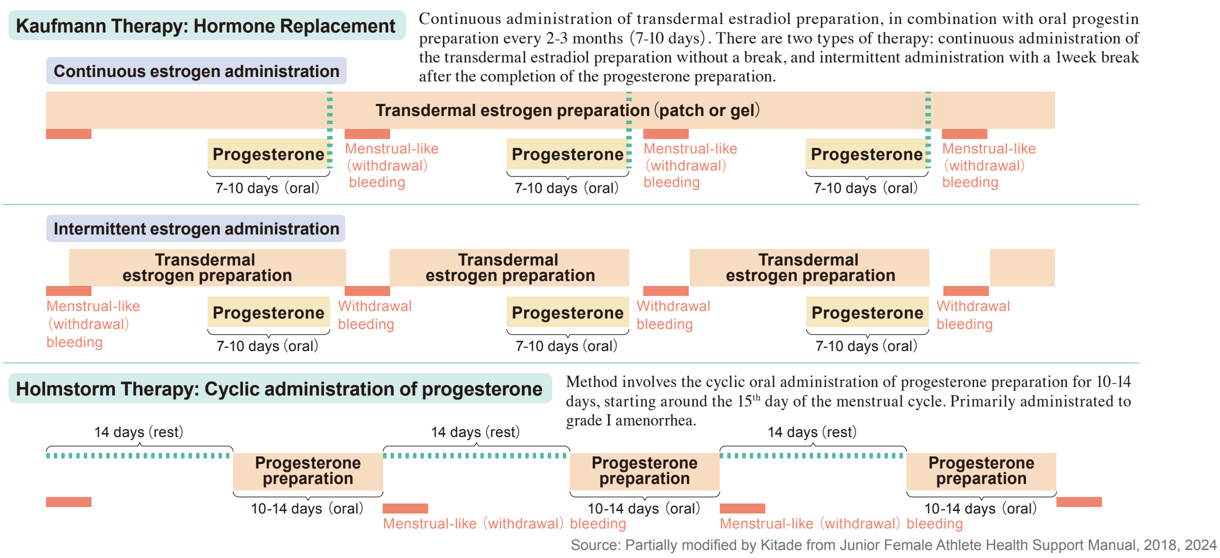


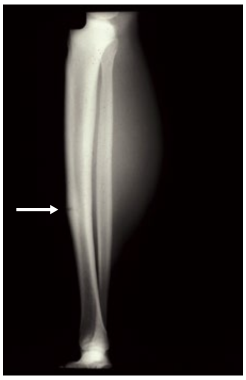
Figure 13. Hormone replacement therapy for amenorrhea

2. Stress fracture

1) Pathophysiology and epidemiology

Stress fracture is a disorder in which repeated small mechanical stresses such as running (so-called overuse) cause microfracture-like changes in the bone, eventually leading to an apparent fracture.

It tends to occur in the lower extremities, where the body weight is applied, but it can also occur in the upper extremities and lumbar spine. The tibia of the lower leg (**Figure 14**) and the metatarsals of the foot (**Figure 15**) are commonly affected, accounting for 70 to 80% of both when excluding the lumbar region.



Plain X-ray (XP) image; arrow: fracture site.

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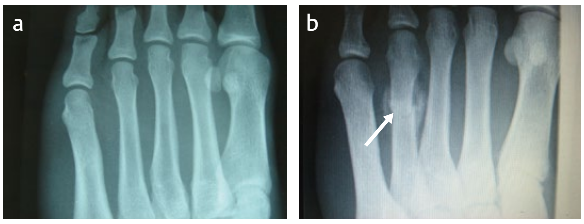
Figure 14. Tibia stress fracture (Jumping-type)



a: Initial, b: After 3 weeks, plain X-ray (XP) image; arrow: fracture site

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Figure 15. Left the forth metatarsal bone stress fracture

The incidence of this disorder has been reported to be approximately 10% of high school track and field athletes (at the national competition leve)[1], but the disorder may be latent more in athletes outside of the top level. There are sites where prone to stress fractures depending on the types of sport, and stress fractures of the proximal and distal tibia, distal fibula, and the second to the forth metatarsal bones are stress fractures strongly associated with running. The fifth metatarsal bone stress fracture (Jones fracture) is more common in soccer, rugby, and basketball, where sudden stopping and turning movements are common[2].

This disorder occurs in both males and females, with a peak incidence around the age of 16 in both cases[3]. When female athletes have amenorrhea, they have a higher history of stress fractures, known as FAT as mentioned in other sections. A study of female university relay runners found abnormal menstruation, including amenorrhea, in about half of the athletes, and abnormal menstruation were even more common in the group who had experienced stress fractures[4].

2) Diagnosis

It is important to obtain a medical history. The date of onset of pain is often unclear. Focus on localized pain and tenderness during sport such as running. Women should check FAT. It is more likely to occur in girls in high school and above, food intake status, abnormal menstruation, amenorrhea, and low bone mineral density from the junior years should be checked.

Caution should be exercised in the initial imaging diagnosis of stress fractures. Even if there is pain, the change in plain X-ray images of the bone may not be seen within the first 2 weeks. In nearly 30% of cases of early medical consultation, no bone changes were seen[3]. Even if the diagnosis is not made on the initial imaging, a stress fracture should not be easily ruled out, and a follow-up plain X-ray examination, such as after 2 weeks, should be conducted. If early diagnosis is necessary, MRI is useful. MRI can show changes in brightness within the periosteum, cortical bone, and bone marrow, high signals are clearly seen in cases with stress fractures (**Figure 16**).

The following is a flow chart for stress fracture diagnosis

a: The plain X-ray (XP) image does not clearly show a fracture, but MRI images in b and c show a fracture site (arrow).

©Juntendo

Figure 16. Right navicular fracture

and treatment (**Figure 17**).
Shin splints are used in the differential diagnosis of tibial stress fractures. Shin splints often occur on the distal medial tibia and cause localized pain with running, but the pain is milder than that of stress fractures.

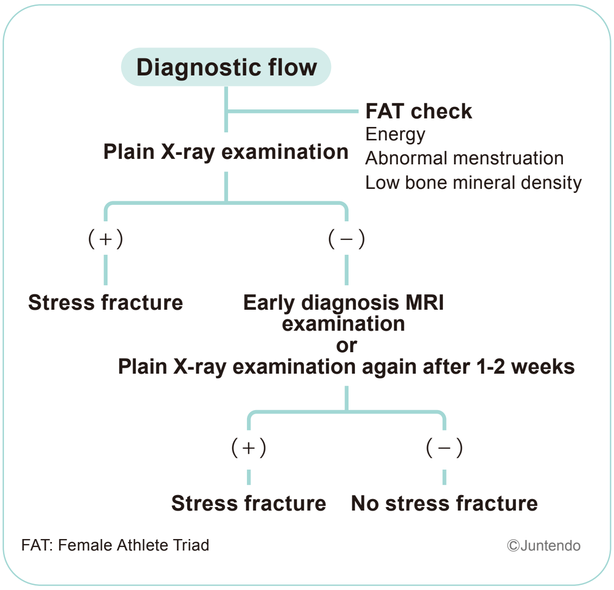


Figure 17. Flow chart for stress fracture diagnosis and treatment

3) Treatment

This disorder may require 2-3 months before running almost as usual, depending on the site. Although most cases of this disorder are suitable for conservative treatment, in cases of jumping stress fractures observed in the central part of the tibia, or the fifth metatarsal bone stress fractures commonly seen in basketball and soccer players, operations such as intramedullary nailing may be indicated.
For stress fractures, monitor with a plain x-ray image, and at first, be free to perform activities basically without pain, such as walking, when the periosteal reaction at the site of the stress fracture becomes firm, gradually start jogging, and if there is no worsening of pain and tenderness, specialized sport activities should be initiated. In addition, rather than simply resting when unable to participate in sport activities, should engage in rehabilitation aimed at an early return to sports, such as targeted localized stretching and muscle strengthening.
Although there are many causes of stress fractures, athletes with risk factors have been reported to develop recurrent and prolonged it. During the treatment period, it is extremely important not only to observe local progress, but also to make multifaceted judgments regarding improvements in nutrition, bone metabolism, menstruation, weight, muscle strength, sleep, and mental health, and to intervene including parents and instructors.
In addition, the Medical Affairs Committee of the Japan Association of Athletics Federations has developed the following 10 articles in consideration of stress fracture prevention.

Japan Association of Athletics Federations
10 Articles on Stress Fracture Prevention
- Watch out for stress fractures! Let's prevent! -

1. Pay close attention your fatigue and physical condition.
2. Occur if you run a lot, whether on the road, track, or field.
3. Be careful not to over-exercise.
4. Low bone mineral density increases the incidence.
5. Intense weight loss is the cause of stress fractures.
6. If you are not menstruating, you will lose bone mass.
7. Fatigued muscles cannot protect bones.
8. Get good nutrition.
9. Stress fractures occur in both boys and girls.
10. If you have persistent pain during training or running, go see a doctor immediately.

Source: Medical Affairs Committee of the Japan Association of Athletics Federations, 2014

3. Other traumas and disorders common in female athletes

1) Abnormality of the lower extremities alignment

Alignment briefly means the axis. This section outlines the alignment of the entire lower extremities such as the axis of the femur and lower leg, the femoropatellar joint, and leg heel alignment (LHA).

The alignment of the entire lower extremity is defined as the axis of the femur and lower leg (femoro tibial angle; FTA: **Figure 18**), when FTA is greater than normal, it is O-Bein, and when FTA is less than normal, it is X-Bein. A simple way to judge O-Bein is when the inside of the knees is 2 fingerbreadth when the lower extremities are viewed from the front, and on the other hand, X-Bein is when the inside of the medial malleoli is 2 fingerbreadth.

O-Bein is prone to iliotibial band syndrome, such as lateral knee pain, and also tends to put stress on the inside of the knee joint, which may lead to knee osteoarthritis in the future. When experiencing pain in the medial knee joint while engaging in sport activities, in addition to the usual quadriceps training, it is useful to insert insoles (such as lateral wedges) of the foot. X-Bein may also add patellofemoral joint rotation, resulting in peripatellar pain, patellar dislocation or subluxation, and lateral-type knee osteoarthritis.

LHA (**Figure 19**) is the lower leg to calcaneus axis when viewed from behind. When LHA is large, it is called a pronated foot. People with pronated foot are prone to Achilles tendonitis. The pronated foot is often accompanied by a pes planus, the arch lifting mechanism of the foot is weakened, and it is useful to strengthen the tibialis posterior related to such as dorsiflexion and inversion muscle strength of the foot.

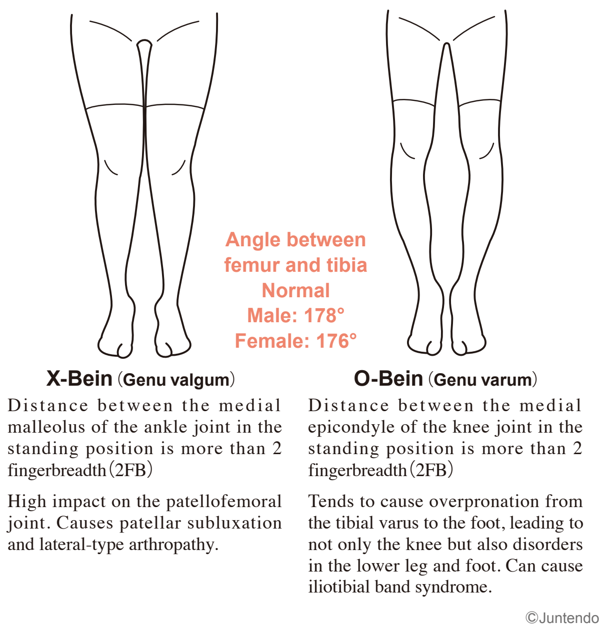


Figure 18. FTA (femoro tibial angle)

2) Patellar dislocation/subluxation

This is a sports injury in which the plate (patella) of the knee joint is dislocated. It often dislocates when the muscles of the entire thigh contract strongly during a jump landing, causing severe pain and swelling in the knee.

It is common among teenage females, especially those with X-Bein, and is said to repeat dislocate approximately 20-50% of them, causing damage to the ligaments that support the inside of the patella during dislocation. If there is damage to the bone or cartilage at the time of dislocation, or if dislocation repeats, bone and cartilage reduction and fixation or ligament reconstruction may be required.

Post-traumatic and post-operative rehabilitation is important for return to sports.

3) Anterior cruciate ligament injury

The anterior cruciate ligament plays a role in stabilizing the knee and is injured during sports such as when changes direction, stops suddenly, or fails to land a jump. Injury to the anterior cruciate ligament causes a sensation of the knee giving out during sport. The incidence and the risk of injury are reported to be higher in women due to a wider pelvis and joint laxity related to weaker muscle strength and female hormonal influences[1)]. Since the injured anterior cruciate ligament does not heal spontaneously, ligament reconstruction surgery is necessary to continue sport activities if leaving the injury untreated can lead to other traumas, such as articular cartilage or meniscus damage, in addition to decreased sport performance. Postoperative rehabilitation is also important.

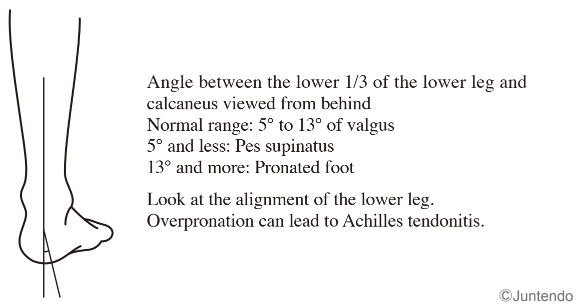


Figure 19. LHA (leg heel angle)

4. Eating disorders

Eating Disorders have been rapidly increasing among junior and high school students, especially girls, in recent years, against the backdrop of the public's glorification of thin girls. In athletic coaching situations, the risk of developing the disorder is even higher due to the combined stresses of seeking athletic performance. Athletic events with a high risk of developing eating disorders have been reported to be aesthetic (gymnastics, rhythmic gymnastics, ballet, figure skating, etc.), endurance (long-distance running, marathon, etc.), and weight class sports (judo, boxing, wrestling, etc.)[1].

According to the American Psychiatric Association Diagnostic and Statistical Manual of Mental Disorders (DSM-5)[2], eating disorders are classified into 4 categories. These include anorexia nervosa (restricting type and binge eating/purging type) referred to as anorexia, bulimia nervosa referred to as bulimia, and binge eating disorder. The pathology common to 3 categories excluding binge eating disorder, is the obsessive desire to lose weight, which is accompanied by various behavioral disorders and physical symptoms.

1) Diagnosis

The EAT-26 (Eating Attitudes Test)[3] is a screening tool for self-administered assessment of thinness desire (see **Appendix**, p35). The tool includes 3 subscales, eating restriction, gluttony and food control, and fear of obesity, with a cutoff score of 20/26, and a score of 20 or higher is considered positive (high risk for eating disorders). A limitation of this tool is that it is self-administered, so it is likely to be manipulated by students who do not want to admit their own desire to be thin. It may be worthwhile to consider asking students to take the survey together with other questionnaires or surveys.

Objectively assessing whether they have an appropriate body weight may be difficult, especially in the case of athletes, however, Body Mass Index (BMI) is generally used as an indicator. Described standard indicator in **Table 5**. When height is 160cm, weight will be 45kg and BMI will be 17.5 are the guideline.

$$\textbf{BMI} = \textbf{weight (kg) / height (m)}^2$$

In the field of athletic coaching, if behaviors and symptoms associated with the desire to lose weight are observed, considering the EAT-26 results and BMI index, a consultation with a specialized medical institution should be recommended.

Table 5. BMI indicators according to WHO classification and DSM-5

		BMI
WHO Classification	Obesity	30 or more
	Pre-obesity	25-29.9
	Normal weight	18.5-24.9
DSM-5 classification of emaciation	Mild	17-18.4
	Moderate	16-16.99
	Severe	15-15.99
	Extreme	< 15

Source: WHO criteria and DSM-5 diagnostic criteria

2) Treatment

(1) Anorexia nervosa

There are two types: the "restricting type", in which they do not eat or strictly adhere to an unbalanced diet, and the "binge eating/purging type", in which maintains a low body weight by compensating for binge eating with purging behaviors (self-induced vomiting, laxative abuse, diuretic abuse).

Often tends to have compulsive in personality, meticulous, serious, and inflexible.

Despite obvious emaciation, they are unaware of it and may act in an attempt to lose even more weight. In transient cases, rather hyperactivity may be observed. Physical symptoms such as muscle weakness, fatigue, amenorrhea, edema, and dry skin, and psychological symptoms such as depression, poor concentration, and emotional instability accompanied by weight loss are observed. In long-term cases, poor school performance is also observed.

Due to a distorted perception of their own body (body image), counseling and cognitive behavioral therapy are conducted to correct that.

(2) Bulimia

Bulimia nervosa is characterized by repeated binge eating accompanied by various inappropriate emissions behaviors to prevent weight gain, but unlike anorexia nervosa, it does not lead to weight loss. Binge eating disorder does not involve purging behavior described above, and is characterized by the consumption of a large amounts of food in a short period of time, also accompanied by a feeling of being unable to control eating by themselves.

Anorexia nervosa and bulimia nervosa share a common pathology of the desire to be thin and often transition. Stress plays a major role in the background of overeating followed by vomiting, and psychotherapy is based on approaching stressors such as family background, friendships, and academic and higher education. Comorbidities such as depression and alcohol abuse, and behavioral disorders such as food stealing and shoplifting are also common. Antidepressants (SSRI: selective serotonin reuptake inhibitor) is also used to control impulsive overeating behavior.

5. Sports myopathy, iron deficiency, anemia

1) Diagnosis

It is said that various organs are affected by REDs, and blood is also affected by LEA.

In general, the diagnosis of anemia is determined by a decrease in hemoglobin below the normal range, with anemia being defined as a decrease in hemoglobin at 13.0mg/dL which is -2 standard deviations in boys and below 11.0mg/dL in girls, but there is a positive correlation exists between average speed and hemoglobin concentration in female long-distance runners, and said to per 1mg/dL decrease in hemoglobin, oxygen uptake decreases by 3mL/kg/min. In the case of athletes, it had been proposed that a decrease of 0.5g/dL below the normal hemoglobin concentration would be considered anemia[1], but this has not been used because the normal value is unknown.

Hemoglobin levels are the same in boys as in girls during childhood, averaging 13.0mg/dL, but after the age of 11, when testosterone which has an anabolic effect increases, hemoglobin in boys increases to an average of 15.0mg/dL at the age of 18. In girls, 15.0mg/dL is +2 standard deviations, therefore, the gender differences in sport are strongly influenced by hemoglobin levels.

When testosterone decreases due to LEA, erythropoiesis decreases even in girls. It is now known that the greatest point of iron deficiency in sports is skeletal muscle. The greater the skeletal muscle mass, the more muscle disintegration occurs with exercise, but the myoglobin iron in muscle is excreted in urine and not reused because there are no recovery proteins, and the molecular weight is small. Haptoglobin is needed to transport the free heme produced by red blood cell breakdown to the spleen and liver when lactic acid accumulates in skeletal muscle and chemically hemolyses it, but its synthesis is delayed in girls compared to consumption, and the recovery of free heme hemolysed by exercise is reduced. Iron recycling is 24 times greater than iron ingested from food and other sources, which is thought to result in a decrease in iron in the closed system.

In addition to this, elevated lactate dehydrogenase (LDH), which indicates hemolysis effect, and urea nitrogen (UN), which indicates protein catabolism, are called sports myopathy. In sports myopathy, the increased demand for iron in myoglobin in the increased skeletal muscle causes a change in the distribution of iron in the body, which is maintained at a constant level, and is transferred to the skeletal muscle, resulting in an iron deficiency in the blood. In such cases, transferrin concentration increases, and the Japanese BioIron Society defines iron deficiency as a total iron binding capacity (TIBC) of 360μg/dL or higher, and serum ferritin of 12ng/mL or lower. When skeletal muscle mass increases, because the demand for iron increases and also energy intake must increase at the same time, LEA is likely to occur at the same time.

Ferritin, which is stored iron, has been shown to correlate with the amount of iron in skeletal muscle and other organs, including nerves, and there is a paper[2] that states that when ferritin is below 50ng/mL, the effects of high-altitude training are lost.

2) Treatment strategy

Although the increase in tissue iron with height increase is known, the increase in body weight after the cessation of height gain can easily lead to LEA and iron deficiency if not distinguish between increased body fat or lean body mass. It should be explained that these 2 conditions tend to occur simultaneously, are prone to anemia, and that anemia will not improve unless iron supplementation and the resolution of LEA are resolved. Iron supplemantation alone will result in repeated recurrences of anemia.

3) Treatment process

Needless to say, the key to treatment is not only iron supplementation but also the improvement of LEA. It is difficult to provide nutritional evaluation under insurance even at facilities where certified sports nutritionists and dietitians are on staff. It is also difficult to estimate the amount of energy being consumed. Since simply instructing patients to reduce physical activity does not lead to improved performance, lean body mass should be managed using the “Surari Muscle”.

4) Recovery process

If the hemoglobin level increases by even 0.5g/dL with iron supplementation, should continue oral administration as is. The goal for ferritin level recovery is at least 30ng/mL or higher and should continue administration. Inform them that they will need to take for approximately 3 to 6 months. The recovery status of LEA is determined by the measurement of Lean Body Mass. If Lean Body Mass has increased, it is acceptable. If it has decreased, inform the amount of energy that should be increased.

*The sports medicine term “athlete’s anemia” is not used in Japan. The athletic-induced, so-called “sports anemia (SA)” was originally defined as anemia caused by sudden exercise, mainly in people who had no habit of exercise. Anemia in sports is considered to be anemia caused by LEA via iron deficiency from sports myopathy caused by exercise.

6. Polycystic ovary syndrome (PCOS)

1) Symptoms and Diagnosis

Polycystic ovary syndrome (hereafter PCOS) is so common in athletes that one paper[1] states, "People with PCOS in adolescence participate in sport". Therefore, knowing PCOS in adolescents leads to knowing the condition of girls in school-based sport club activities who belong to athletic teams (this is a rather more important factor than dealing with athletes with low BMI).

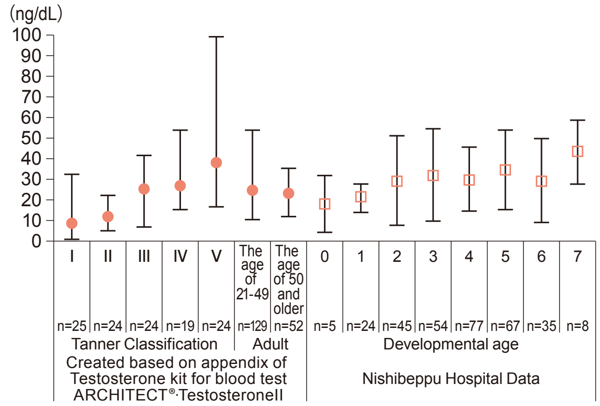
Not necessarily amenorrhea but is characterized by cycle abnormalities such as extended cycles of 39 to less than 90 days or there are 2 menstrual periods per month in less than 25 days and, with symptoms such as a tendency for acne, excessive body hair, and prone to gain weight, but with the advantage that skeletal muscle hypertrophy is easily obtained through training. Iron deficiency is a symptom that is associated with a characteristic in tendency for increased skeletal muscle, and a relatively common in athletes with PCOS.

Diagnosis is made by ultrasound tomography (transvaginal) or MRI showing numerous small follicles in both bilateral ovaries and multiple images of at least 10 small follicles, 2-9mm in diameter, in at least one ovary, although such imaging may be difficult in adolescent females[2].

Endocrine examination reveals that LH is usually around 4.0mIU/mL. In the case of LEA, it decreases to 3.0mIU/mL and less (< 1.0mIU/mL if amenorrhea persists), but in the case of PCOS, it is high and exceeds the normal FSH level of 7.0mIU/mL(+1 standard deviation of normal females). An LH/FSH ratio greater than 1.21 is suspected[3].

It is difficult to determine whether abnormal cycles in athletes with PCOS are due to LEA, and total testosterone should be used as a guide. Total testosterone is 20ng/dL and less (0.2ng/mL) before menarche but rises to the normal average of 30ng/dL after menarche. The upper limit level is set around +2 SD of 56ng/dL, but we believe that PCOS may be diagnosed in the adolescent ages if it exceeds +1 SD (generally 44ng/dL)[4]. **Figure 20** left shows total testosterone levels in the Tanner classification and the right shows the levels at the developmental age from the growth peak.

On average, menarche occurs 1 to 2 years after the growth peak, so the values for Tanner Classification III and developmental age of 2 are almost the same. If it decreases below average after this point, LEA is considered to have occurred, and -2SD of 10ng/dL and less are considered to be severe LEA because they correspond to the values indicated by the overtraining syndrome.



Source: Matsuda et al. 2019

Figure 20. Reference range of blood total testosterone in growth and adolescence by Tanner classification and developmental age

2) Treatment

In sports, PCOS itself does not cause any problems, so there is no specific treatment for it. It should be noted that it is prone to LEA and anemia. The details of anemia are discussed in another section (see p30), but increased skeletal muscle mass causes an iron deficiency state due to increased demand for myoglobin iron in muscle, and in addition, decreased protein synthesis in LEA results in decreased hemoglobin.

3) Treatment process

A characteristic of adolescent PCOS is that many individuals are considered for treatments such as low-dose oral contraceptives (OC/LEP) to manage minor issues like acne. Indications also include irregular menstruations, which are often used to control cycles.

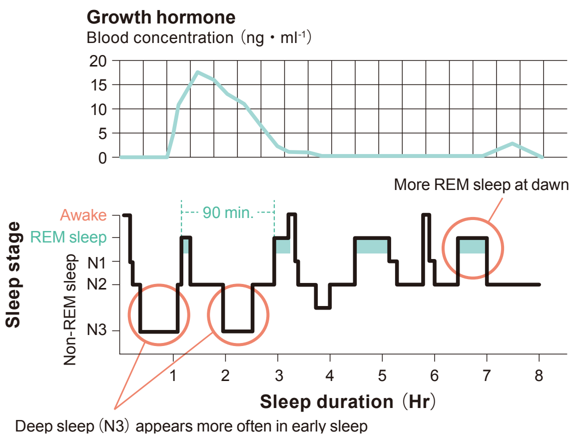
4) Recovery process

As LEA improves, prone to weight gain because of the tendency to gain skeletal muscle mass. If become concerned about this weight gain and reduce energy intake again or fail to increase energy intake sufficiently to match the increased skeletal muscle mass, they may fall back into LEA, therefore this condition requires the most management based on Lean Body Mass. For this reason, it is recommended to use Lean Body Mass management software "Surari Muscle" to manage whenever possible.

7. Poor sleep

1) Overview

Sleep is important in learning and memory, growth and recovery from fatigue, and stress and emotional control, and is recommended 9-12 hours of sleep for school-aged children (between the ages of 6 and 12) and 8-10 hours for adolescents (between the ages of 13 and 18)[1]. Sleep repeats in cycles of approximately 90 minutes, and since the first cycle has a high proportion of deep sleep and is involved in the secretion of growth hormones, maintenance of sleep during those times is important for physical development. On the other hand, REM sleep, which is involved in the consolidation of technical memory, increases in the latter half of sleep. It is important to keep in mind that sleep is an extremely important factor in the "growth and development" and "athletic performance" of girls in school-based sport club activities, but it is also easily susceptible to disability and cannot be overlooked in condition management.



Source: Pietrowsky R, et al., 1994
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Figure 21. Sleep cycle and growth hormone secretion

2) Sleep in athletes

Poor sleep in girls in school-based sport club activities mainly involves in shortened sleep duration, problems with sleep/wake rhythm, and sleep disorders that reduce sleep quality.

If it is shorter than 8 hours, it is considered that there is poor sleep due to shortened sleep duration. Girls in school-based sport club activities often sleep shorter hours compared to non-athletes of the same age because of the balance of training and academics[2].

Sleep duration reduction leads to delayed reaction time, increased errors, and decreased comprehension and execution[2], but in the growing junior generation, it can also hinder various brain developments as an athlete. Furthermore, shortened sleep (less than 8 hours) is said to be associated with an occurrence of injuries[3].

Sleep rhythms need to be adjusted for each individual due to the large differences among individuals[4] . At this point, understand that the sleep-wake rhythm matures earlier in girls than in boys, and that girls go to bed earlier and wake up earlier than boys[5]. Adolescents tend to have both bedtime and rise time later[6]. This is believed to be caused not only by the individual's own will and the impact of schedule but also by the effect of changes in hormone secretion during adolescence and light exposure in the evening and later, such as television.

Sleep disorders that lead to a decline in sleep quality include sleep apnea and sleep-related movement disorders (restless legs syndrome and periodic tetraplegia movement disorder), and sleep apnea is generally less common in girls, particularly after menarche, due to the protective effects of female hormones and the timing that natural regression of the tonsils, which play a role in airway obstruction, therefore, the prevalence of sleep apnea among girls in school-based sport club activities is assumed to be low. Sleep-related movement disorder is caused by anemia and abnormal iron metabolism and is also important in girls in school-based sport club activities who are prone to anemia, but the actual situation is unclear. Restless legs syndrome is characterized by an unpleasant urge to move the legs at rest, symptoms that lessen when the body is moved or standing up to walk, and symptoms that worsen at night.

In addition, a problem unique to women may be the effect of menstruation. Female hormones and sleep quality may be closely related. Female athletes tend to perceive sleep quality more strongly than male athletes, and this tendency is further enhanced when they have menstrual abnormalities[7]. Menstrual discomfort itself also causes poor sleep quality[8] . Many abnormal menstruation in female athletes are thought to be caused by energy imbalances. The decline in sleep quality affected by menstruation should also be noted.

3) Response

The most important guidance is sleep hygiene guidance. It is important to guide according to the sleep hygiene guidance items for girls in school-based sport club activities. If insomnia symptoms due to sleep disorders or high anxiety are suspected to be involved, encouraged to visit a specialized facility. If abnormal menstruation is present, or poor sleep worsens according to the menstrual cycle, should also encourage them to visit as related to abnormal menstruation. Athletes who complain of sleep problems should be interviewed about their menstrual status to determine if they have FAT, which is a problem specific to female athletes. Sleep hygiene guidance must be provided not only to the athlete but also to the parents and instructors.

> **Sleep hygiene guidance for girls in school-based sport club activities**
>
> 1. Keep bedtime and rise time as consistent as possible on weekdays and weekends
> 2. Reset the sleep-wake rhythm each morning with bright light upon awakening
> 3. Avoid light exposure (TV, smartphone, tablet) before bedtime as it interferes with sleep onset
> 4. Eat, bathe, and exercise at least 2 hours before bedtime as they affect sleep onset and after that
> 5. Spend at least 30 minutes in a quiet, relaxing environment before bedtime
> 6. Limit caffeinated beverages in the afternoon and evening
> 7. Napping up to 30 minutes in the afternoon (by around 3 pm) because it affects sleep onset and after that
> 8. Encourage outpatient consultation if abnormal menstruation (amenorrhea, premenstrual tension, heavy menstrual bleeding, etc.) is present
>
> ©Juntendo

8. Dysmenorrhea

1) Symptoms and diagnosis

Dysmenorrhea is defined as “pathological symptoms that accompany menstruation and interfere with daily life,” and is distinguished from so-called menstrual cramps. The main symptoms include lower abdominal pain, lower back pain, lower abdominal distention, headache, nausea, loss of appetite, fatigue, diarrhea, irritability, and depression, but the type and severity of symptoms vary widely among individuals.

Compared to women in general, the rate of dysmenorrhea in athletic club girls is relatively small but varies greatly depending on body type and competition. Since menstrual symptoms clearly reduce performance during competition, it is one of the problems that needs to be resolved as early as possible for girls in school-based sport club activities.

Table 6. Comparison of dysmenorrhea by classification

	Functional dysmenorrhea	Organic dysmenorrhea
Cause	Uterine contractions caused by prostaglandins, pelvic congestion, difficulty in expelling menstrual blood due to heavy menstrual bleeding, uterine growth retardation, stress, etc.	Endometriosis, adenomyosis of the uterus, uterine myoma, uterine malformations, genital inflammation, chlamydial infection, etc.
Time of onset	Around 1 or 2 years after menarche	Around 10 years after menarche
Prevalent age of onset	Late teens to early 20s	20s to 40s
Age-related changes	Gradually lighten	Gradually worsens
Timing of pain	Only before or after the onset of menstruation or during menstruation	When it gets worse, it also occurs outside of menstruation
Duration of pain	4 to 48 hours	1 to 5 days

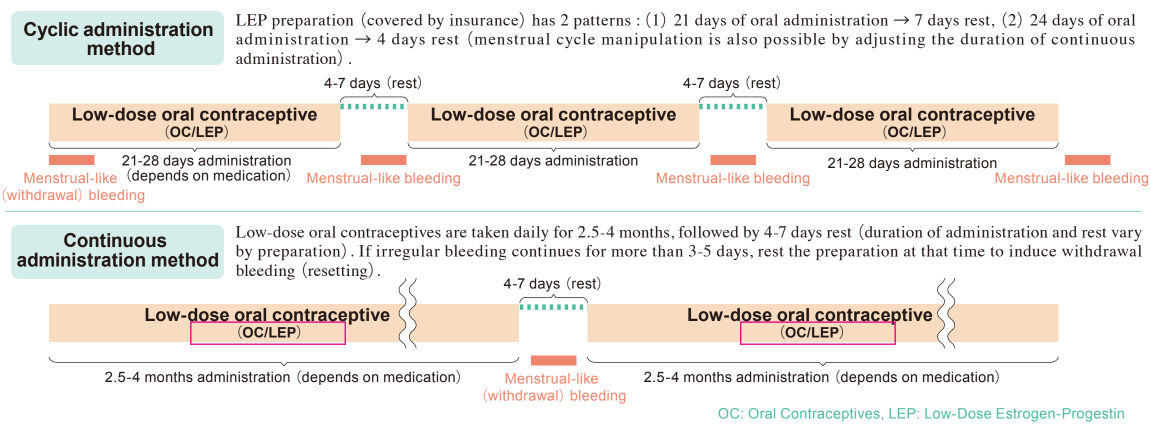
Source: Japan Enlightenment Committee In Endometriosis: Endometriosis Fact Note

Dysmenorrhea can be classified into organic dysmenorrhea with a causative disease and functional dysmenorrhea without a causative disease. **Table 6** shows the characteristics of each of those most of the cases seen in junior and high school girls are functional dysmenorrhea.

2) Treatment

If treated by a doctor other than an obstetrician/gynecologist, analgesics such as non-steroidal anti-inflammatory drugs (NSAIDs) should be administered initially for several days from the onset of pain, and if this is not effective, should refer to a specialist (in obstetrics/gynecology). The administration of Kampo medicines should be avoided for students competing in tournaments that mandate doping tests, as the medicinal herbs used in their formulations are often unknown.

As the 2nd step of treatment, at obstetrics/gynecology administer low-dose oral contraceptives (OC/LEP preparations) and progesterone preparations (Dienogest),



Source: Kitade, 2024

Figure 22. Administration of low-dose oral contraceptive (OC/LEP) for dysmenorrhea and PMS

which are not prohibited for doping (as of January 2024) and are expected to improve symptoms in most cases. In particular, the low-dose oral contraceptive allows for menstrual cycle manipulation, so even if symptoms do not improve sufficiently, be in the best possible condition for the competition by adjusting the timing of menstruation.

There are methods of administering low-dose oral contraceptives, cyclic administration and continuous administration (**Figure 22**), if there is no irregular bleeding or side effects, continuous administration tends to have a higher symptom-suppressing effect. However, low-dose oral contraceptives may cause side effects such as irregular bleeding, nausea, headache, weight gain, swelling, and blood clots, which should be explained to patients before starting administration.

9. PMS

1) Symptoms and diagnosis

Premenstrual syndrome (PMS) is as common as dysmenorrhea among disorders that affect the athletic performance of girls in school-based sport club activities, but it is also important to distinguish PMS from premenstrual dysphoric disorder (PMDD), a similar disorder. PMS is characterized by complaints such as lower abdominal pain, back pain, swelling, weight gain, breast tenderness, drowsiness, fatigue, and irritability that begin 7 to 10 days before the onset of menstruation and often disappear after menstruation begins.

On the other hand, PMDD mainly consists of psychiatric symptoms such as depressed mood, depression, and anxiety, although PMDD used to be considered a severe form of PMS, it has recently been treated as a type of psychiatric disorder based on the definition of the American Psychiatric Association. Although the causes of PMS and PMDD have not been fully elucidated, it has been reported that stress, menstrual pain, a history of stress fractures, and lifestyle factors (e.g., sleep onset disorder and increased web browsing time) may also influence, in addition to changes in female hormones and involvement of brain transmitters (serotonin and GABA)[1].

Table 7 shows data comparing premenstrual mental and physical symptoms between the female athlete group and the control group (general high school students), the female athlete group showed significantly higher severity of anxiety, tension, anger, irritability, overeating, and anorexia compared to the control group.

Table 7. Severity of premenstrual mental-physical symptoms

Symptom A	Athlete > High school student	Athlete < High school student	p-value
Depressive mood			0.054
Anxiety/Nervousness	○		< 0.0001
Tearfulness	○		0.04
Anger/Irritability	○		< 0.0001
Decreased interest in society and daily life	○		< 0.0001
Decreased ability to concentrate			0.2
Apathy			0.119
Overeating/Anorexia	○		< 0.0001
Insomnia/Hypersomnia	○		0.0286
Feeling overwhelmed			0.06
Physical symptoms	○		< 0.0001

Symptom B	Athlete > High school student	Athlete < High school student	p-value
Decreased efficiency in work, housework, and study			0.803
Impediments to participation in hobbies, social activities, and clubs			0.949
Impairment in inter-personal relationships	○		0.007

(Mann-Whitney's U test)
Source: Takeda et al. Obstetrics and Gynecology 2015 Special features: Examine Female Athletes - Obstetric and Gynecologic Issues and Their Countermeasures.

2) Treatment

As mentioned above, apart from the involvement of progesterone and serotonin, stress and poor conditioning are likely to be influential triggers of PMS and PMDD. On the other hand, the period during which girls in school-based sport club activities can concentrate on competition is never long enough, and if the condition does not improve with lifestyle modification and symptomatic treatment alone, it is advisable to refer to a specialist as soon as possible. As mentioned in the chapter on dysmenorrhea, symptomatic treatment with Kampo medicines or diuretics should be avoided for students who plan to participate in competitions that mandate doping tests.

The first choice of treatment by a specialist (in obstetrics/gynecology) is continuous administration of low-dose oral contraceptives (OC/LEP preparations), but depending on symptoms, Kampo medicine or selective serotonin reuptake inhibitor (SSRI) may be useful. SSRI is mainly prescribed for PMDD, but although it is not included in doping prohibited substances (as of January 2024), they may have stimulant effects when prescribed to those who are the age of 24 and younger, so caution should be exercised.

The most effective treatment is the low-dose oral contraceptive, which suppresses female hormone fluctuations (see **Figure 22**, p33) and is useful for performance improvement in terms of menstrual cycle manipulation.

FAT Screening Sheet

Sport & Position					
Date of birth (DD-MM-YYYY)		- -		(Age of)	
Height	cm	Body weight	kg	Age of menarche	
Today's date (DD-MM-YYYY)		- -		Age of	

This sheet is designed to help you recognize the risks of your FAT.
Let's check whether energy deficiency has affected your condition worse (poor health or anemia), your period change (irregular menstruation or amenorrhea), or your bone (decreased bone mineral density or stress fractures).

Let's check the boxes that apply to you!

Energy

- ☐ Do you have dissatisfaction with your weight or body shape?
- ☐ Is there anyone who recommends you to gain or lose weight?
- ☐ Do you think you currently need to lose weight?
- ☐ Do you think you would gain weight if you could not exercise?
- ☐ Do you think your performance will improve if you lose weight?
- ☐ Do you limit or carefully control what you eat?
- ☐ Do you avoid certain types of foods or food groups? (e.g., restricting rice, bread, noodles, etc.)
- ☐ Have you ever experienced an eating disorder?
- ☐ Do you feel guilty when you eat fried foods?
- ☐ Do you ever eat behind others' backs?

Condition

- ☐ Do you feel that it takes longer for you to recover from fatigue?
- ☐ Do you feel sleepy these days?
- ☐ Do you feel digestive issues (stomachache, heartburn, or indigestion) recently?
- ☐ Do you feel dizziness or lightheadedness frequently these days?
- ☐ Have you been diagnosed as "anemia" in the past year?
- ☐ Have you had any injuries that required you to miss training due to contact with other players during exercise in the past year?
- ☐ Have you had any injuries that required you to miss training due to overuse in the past year?

Period

- ☐ Was your first menstrual period (menarche) occurring after the age of 16?
- ☐ Is your menstrual cycle irregular? (including amenorrhea)
- ☐ Is your menstrual cycle (from the start of the previous menstruation to the next menstruation) longer than 35 days?
- ☐ Have you had 5 or less menstrual periods in the past year?
- ☐ Have you been without menstruation for more than 3 months in the past year?
- ☐ Are you currently experiencing a stopped menstrual period?

Bone

- ☐ Have you ever been told you have low bone density?
- ☐ Have you ever had a stress fracture?

To Medical Professionals
The person bringing this sheet is a female athlete. They may have the female athlete triad (FAT). We hope you will refer to the checklist on the sheet and listen to the concerns of the female athlete.

EAT-26

ID:

Name: Date entered (DD-MM-YYYY): - -

*Please put the circle each that apply to you.

EAT-26 Test (Attitude)

	Questions	Never	Once a month or less	2-3 times a month	Once a week	2-6 times a week	Once a day or more
A	Gone on eating binges where you feel that you may not be able to stop?						
B	Ever made yourself sick (vomited) to control your weight or shape?						
C	Ever used laxatives or diuretics to control your weight or shape?						
D	Exercised more than 60 minutes a day to lose or to control your weigh?						
E	Lost 9 kg or more in the past 6 months.		Yes			No	
F	Have you ever been treated for an eating disorder?		Yes			No	

	Statements	Never	Rarely	Some times	Often	Usually	Always
1	I am terrified about being overweight.						
2	I avoid eating when I am hungry.						
3	I find myself preoccupied with food.						
4	I have gone on eating binges where I feel that I may not be able to stop.						
5	I cut my food into small pieces.						
6	I aware of the calorie content of foods that I eat.						
7	I particularly avoid food with a high carbohydrate content (i.e. bread, rice, potatoes, etc.).						
8	I feel that others (family, friends, etc.) would prefer if I ate more.						
9	I vomit after I have eaten.						
10	I feel extremely guilty after eating.						
11	I am preoccupied with a desire to be thinner.						
12	I think about burning up calories when I exercise.						
13	Other people think that I am too thin.						
14	I am preoccupied with the thought of having fat on my body.						
15	I take longer than others to eat my meals.						
16	I avoid foods with sugar in them.						
17	I eat diet foods.						
18	I feel that food controls my life.						
19	I display self-control around food.						
20	I feel that others (family, friends, etc.) pressure me to eat.						
21	I give too much time and thought to food.						
22	I feel uncomfortable after eating sweets.						
23	I engage in dieting behavior.						
24	I like my stomach to be empty.						
25	I have the impulse to vomit after meals.						
26	I enjoy trying new rich foods.						

Source: Juntendo University Hospital and Juntendo University Urayasu Hospital, Women's Sports Medicine Clinic

Anti-Doping Compliance

Although it is unlikely that ordinary girls in school-based sport club activities are subject to doping, they may be subject to doping tests at the JAPAN GAMES (National Sports Festival), etc., therefore, they should use medications that do not result in doping violations.

The Prohibited List is updated regularly, and it is necessary to check the latest information, but is difficult to understand everything. On the other hand, there is also information on medications that are safe to use, so refer to that information before making a choice.

Many questions are asked about supplements, in the past, the foreign supplements that contain prohibited hormones were problems, but contamination due to adulteration in the production line has also occurred in Japan. Use at own risk, and if the prohibited substance is detected, will be punished, but it is important to be able to prove that it was not intentional. Especially in the case of contamination, the lot number is an important clue, and there have been cases where the punishment has been reduced (reduction of punishment, never cancellation of violation), so it is important to keep records of the manufacturer and the lot number. It is important to understand that everything you eat is related to doping, as there have been cases of doping violations that occurred due to the remaining muscle-enhancing drugs in meat.

The “World Anti-Doping Code” provides an understanding of the effects of various medications. Diuretics are considered a cover-up to dilute urine and are therefore prohibited substances. An exception, however, is the listing of “drospirenone”. Yaz flex is a low-dose oral contraceptive containing drospirenone and is the only permissible medication with a diuretic effect.

There are measures that allow the special use of prohibited drugs under certain conditions. In the case of Attention Deficit Hyperactivity Disorder (ADHD), anaphylaxis, bronchial asthma, diabetes, growth hormone deficiency, and inflammatory bowel disease, documentation of Therapeutic Use Exemption, generally named as TUE, can be submitted allows the use of the substance while undergoing treatment and possible to participate in competition.

Glucocorticoids, commonly referred to as steroids, were prohibited for local injection, but a washout period, in which the drug leaves the body, is allowed.

A relevant medication for girls in school-based sport club activities would be an anti-inflammatory analgesic for menstrual cramps. While many medications can be used basically, those containing tramadol (opioid), such as Tramcet, which is used for pain after tooth extraction, became prohibited substances in January 2024. The washout period of that is 24 hours.

Doping tests conducted at the time of a competition begin at 11:59 p.m. the day before midnight. Note that this does not start when the athlete enters the venue. The washout period is also based there. Recently, out-of-competition testing, or unannounced testing, has become more common, so if tested before the washout period has passed, may need to apply for a retroactive TUE.

< Reference >

Japan Anti-Doping Agency*
https://www.playtruejapan.org/

“Anti-Doping and Medical Care - 2023 Edition”
*Detailed information on TUE is available

“World Anti-Doping Code 2024 International Standard PROHIBITED LIST”

*The above documents are updated regularly, so please check for the latest information

The “Available Medications List 2024”*
(Japan Sports Association)
https://www.japan-sports.or.jp/Portals/0/data/supoken/doc/anti_doping/anti-doping-med-list_2024.pdf
*Please check for the latest version as it is updated every year in accordance with the International Standard PROHIBITED LIST

SPORTS NUTRITION AND DIETITIAN JAPAN website “Anti-Doping Information”*
*Information on supplements as well as medications is clearly presented
https://sndj-web.jp/anti-doping/

***Japanese only**

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Girls in School-Based Sport Club Activities Support Manual

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Girls in Sport

The “Problem-Solving Practical Program for Girls in School-Based Sport Club Activities”, a project to develop and support female athletes commissioned by the Japan Sports Agency in FY2023

Japanese Center for Research on Women in Sport
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