

Training Intensity, Nutritional Behaviors, and Menstrual Health Among High School Female Athletes in Singapore

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ABSTRACT

Amenorrhea and other menstrual irregularities are common but often overlooked in adolescent athletes. Adolescence is defined here as the transitional developmental stage between ages 10 and 19. Examining these issues in diverse populations is essential, as most existing research is based on Western cohorts.

Evaluating a Singaporean cohort allows us to examine how localized dietary habits, specific athletic training cultures, and unique academic-athletic balancing pressures impact the manifestation of these health issues. Focusing on high school athletes in Singapore provides a well-defined setting to evaluate menstrual health issues across diverse cultural, ethnic, and training environments. The research contributes context-specific evidence that advances understanding of menstrual health among female athletes in diverse populations.

Furthermore, there are gaps in education surrounding women's health, underscoring the need for increased education for parents, students, athletes, and coaches. Expanding professional research in non-Western countries is essential for developing more inclusive, culturally relevant, and effective approaches to supporting the long-term health and well-being of adolescent female athletes.

2. INTRODUCTION

The Female Athlete Triad is characterized by three interrelated components: low energy availability, menstrual dysfunction, and decreased bone mineral density. For instance, approximately 23.5% of female athletes in the United States experience menstrual irregularities, and between 16–60% exhibit at least one component of the triad. The broad range reflects differences in study populations, sport types, and assessment methods. (Thein-Nissenbaum & Hammer, 2017). If amenorrhea continues for long periods of time, it may cause the athlete to develop osteoporosis. During this stage, bone density deteriorates severely, leaving the skeletal structure fragile and susceptible to fractures.

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Current studies in the USA focus on disordered eating and energy deficiency, and the connection to menstrual regularity, primarily among Western high school athletes. This narrow focus limits the understanding of how cultural, socioeconomic, and regional factors may influence the development and presentation of amenorrhea. Therefore, evaluating and adapting existing international questionnaires provides greater insight into understanding menstrual irregularities, energy availability, and training intensity among high school athletes in Singapore.

3.1 Female Athlete Triad

The Female Athlete Triad exists on a spectrum, meaning athletes may experience one, two, or all three components simultaneously (Thein-Nissenbaum & Hammer, 2017). In addition, the condition can occur with or without a clinically diagnosed eating disorder (De Souza et al., 2025).

One component of the Female Athlete Triad is low energy availability, which occurs when an athlete does not consume enough energy to meet the demands of daily activity and training. As a result, the body begins to prioritize energy distribution, often compromising systems such as metabolic regulation, neurological function, and musculoskeletal development (Berz and McCambridge, 2016).

The second component of the triad is menstrual dysfunction, which occurs when metabolic disruption suppresses the hypothalamic-pituitary-ovarian (HPO axis), leading to irregular cycles or amenorrhea.

The third component of the Female Athlete Triad is low bone mineral density. Low bone mineral density is a result of a loss of proper hormonal functioning. Consequently, this increases the likelihood that an athlete will experience long-term health consequences, such as osteoporosis, which is characterized by reduced bone density and an increased risk of fractures.

3.2 Hormonal Regulation of the Menstrual Cycle

The female menstrual cycle is regulated by the hypothalamic-pituitary-ovarian (HPO) axis. This system connects the hypothalamus, pituitary gland, and the ovaries. The hypothalamus is a small, vital region of the brain located below the thalamus and directly above the pituitary gland. The hypothalamus controls the autonomic nervous system and manages hormone release *via* the pituitary gland (Ackerman & Misra, 2018).

The menstrual cycle is regulated by the hormonal signaling within the HPO axis, involving gonadotropin-releasing hormone (GnRH), luteinizing hormone (LH), follicle-stimulating hormone (FSH), estrogen, and progesterone. The hypothalamus initiates this process through the pulsatile release of GnRH, a pattern that is essential for proper reproductive function. This pulsatile signaling stimulates the pituitary gland to secrete LH and FSH, which act on the ovaries (Ackerman & Misra, 2018; De Souza et al., 2025).

FSH stimulates the ovaries to grow follicles (each follicle contains an egg) and helps follicles produce estrogen. LH triggers ovulation (release of a mature egg from the follicle). The ovaries produce estrogen. Following ovulation, the corpus luteum forms from the follicle left behind and secretes progesterone, a hormone that maintains the uterine lining in preparation for potential pregnancy. If fertilization does not occur, progesterone levels decline, leading to shedding of the uterine lining and the onset of menstruation (monthly bleeding) (Figure 1; Ackerman & Misra, 2018; De Souza et al., 2025).

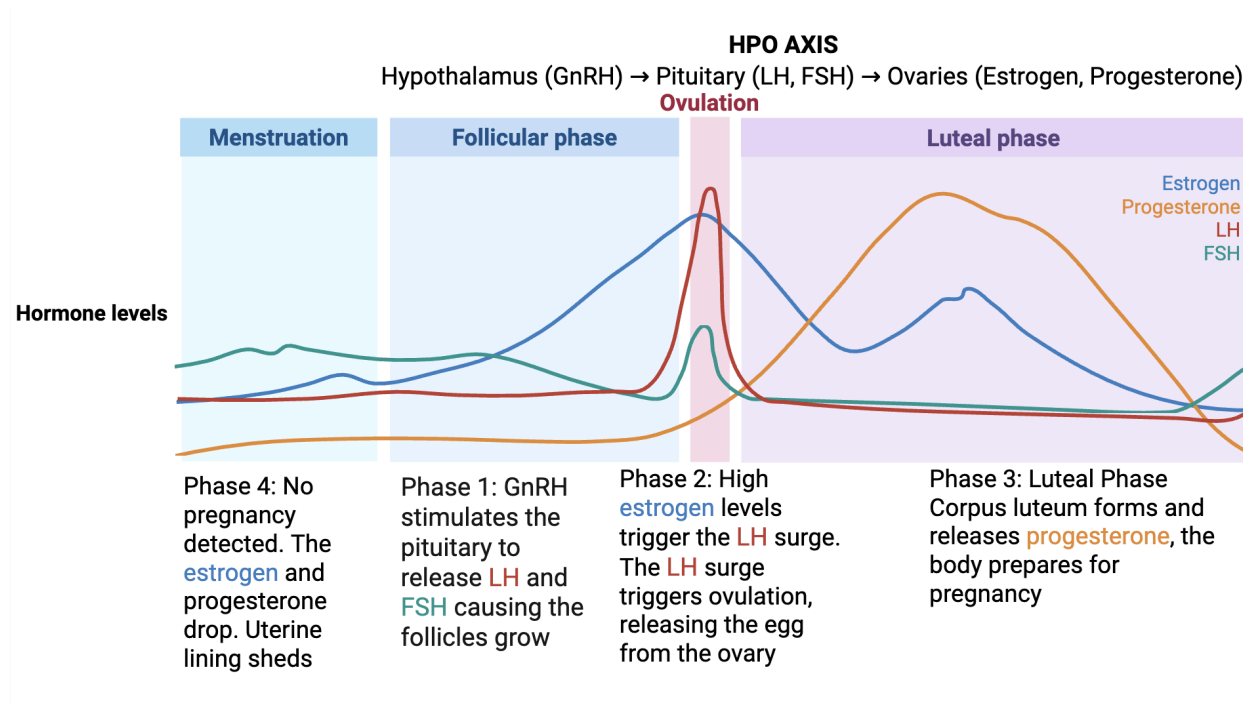


Figure 1. Hormones and the menstrual cycle.

This is an illustration of the phases of the menstrual cycle, including the menstrual, follicular, ovulatory, and luteal phases. The figure demonstrates the cyclical fluctuations in reproductive hormones, including gonadotropin-releasing hormone (GnRH), luteinizing hormone (LH), follicle-stimulating hormone (FSH), estrogen, and progesterone (source: created by the author).

3.3 Hormonal disruption of the Menstrual Cycle

To continue discussing the importance of the menstrual cycle, it is important to consider the consequences of a suppressed menstrual cycle. Potential causes of disruptions in hormone production include psychological stress, chronic illness, excessive physical activity, and significant changes in body weight or composition. Low energy availability impairs the pulsatile release of GnRH from the hypothalamus. (Ackerman & Misra, 2018; De Souza et al., 2025).

The disruption leads to decreased levels of LH and FSH released from the pituitary gland, which in turn

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reduces ovarian production of estrogen and progesterone. Without sufficient levels of estrogen, the positive feedback mechanism that triggers the LH surge is disrupted, preventing ovulation. As a result, the menstrual cycle may become irregular or absent, potentially leading to amenorrhea.

These changes illustrate the direct physiological link between low energy availability and menstrual dysfunction, a key component of the Female Athlete Triad (Figure 2; Ackerman & Misra, 2018; De Souza et al., 2025).

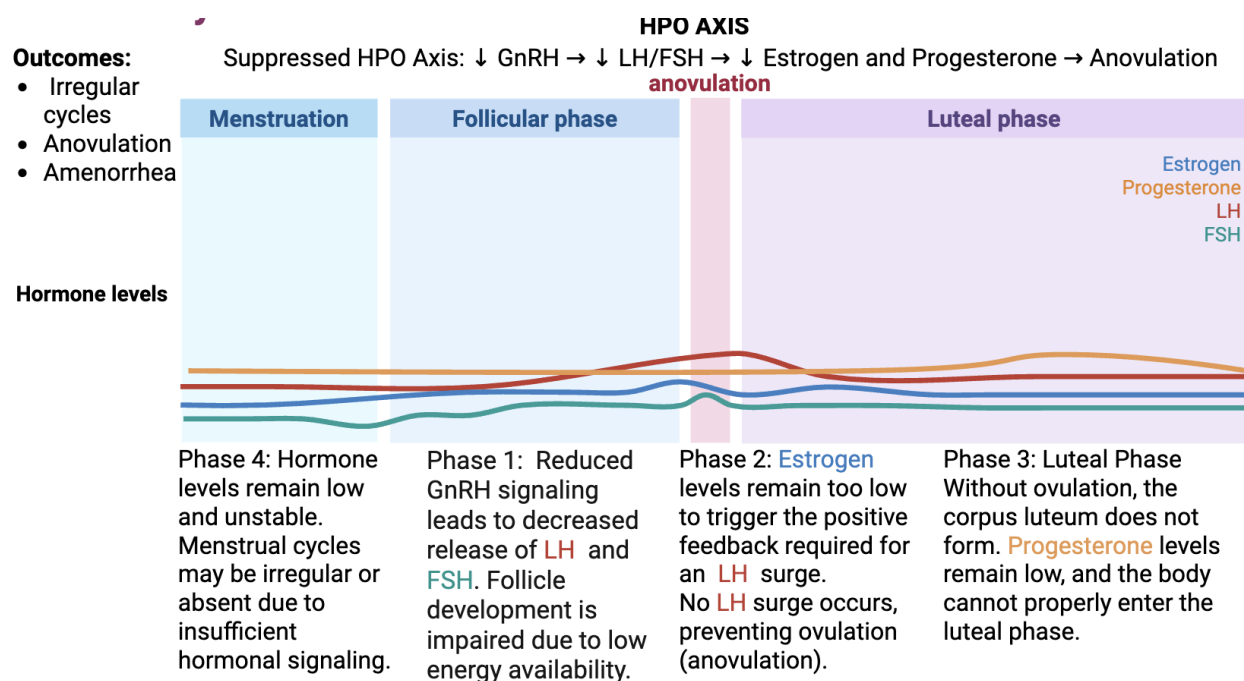


Figure 2. Hormone disruption of the menstrual cycle under low energy availability

Illustrates the hormonal cycle during low energy availability. The illustration includes estrogen, progesterone, luteinizing hormone (LH), and follicle-stimulating hormone (FSH) and shows how, without adequate energy availability, hormonal spikes and cyclical fluctuations are reduced.

3.4 Adolescents and Amenorrhea

As stated before, amenorrhea serves a critical pillar of the Female Athlete Triad. Amenorrhea is often overlooked by adolescent athletes because some perceive the absence of menstruation as beneficial during the season. However, amenorrhea may indicate underlying hormonal imbalances and unhealthy physiological functioning (Ackerman & Misra, 2018).

Adolescence is a critical period for hormonal changes and growth. Usually, during adolescence, the body is actively establishing normal menstrual function and building peak bone mass, both of which rely heavily on adequate energy availability and proper hormonal balance (Ackerman & Misra, 2018). Low

estrogen during adolescence can disrupt the normal menstrual cycle, which prevents proper bone development. As a result, adolescents who develop amenorrhea may not be able to reach optimal bone mass, which causes an increased risk of osteoporosis and stress fractures (Berz and McCambridge, 2016; Ackerman & Misra, 2018).

3.5 Disordered Eating in Female Athletes

Disordered eating is a significant factor contributing to menstrual dysfunction in adolescent female athletes. Unlike clinically diagnosed eating disorders, disordered eating does not meet formal diagnostic criteria. This is because the behaviors of disordered eating may be unhealthy or harmful but are not severe, consistent, or psychologically severe enough to meet the criteria of an eating disorder. Disordered eating includes a range of unhealthy eating behaviors, including restrictive eating, skipping meals, excessive focus on body weight, cycles of binge eating, and purging. These patterns are often driven by aesthetic pressure, performance expectations, body image, and training demands (Thein-Nissenbaum & Hammer, 2017).

This issue is not uncommon, and research shows disordered eating is widespread among adolescent athletes. For example, a study published reports that the prevalence of disordered eating and eating disorders in female athletes ranges from 6% to 60%. This broad range reflects differences in sport type, assessment methods, and definitions used across studies, but it nevertheless underscores the scale of the problem. Additionally, this highlights the limited data and understanding surrounding women's health (Ackerman & Misra, 2018).

Table 1. Different categories of sports and their associated risks. The table below outlines categories of sports in which athletes may experience increased pressure related to body weight, appearance, or performance demands. (Ackerman & Misra, 2018)

Sports category	Examples	Risk
Endurance sports	Cross-country, Nordic skiing, cycling, swimming, long-distance running	High energy expenditure, risk of low energy availability
Aesthetic sports	Gymnastics, ballet, cheerleading, and figure skating	Emphasis on appearance, low body fat, and low body weight can cause body image issues.
Weight class sports	Lightweight rowing, weightlifting, martial arts, wrestling	Pressure to meet weight categories

Anti-gravitational sports	Diving, ski jumping, acrobatics, synchronized swimming	Lower body mass is necessary, creating pressure to stay lean.
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These factors can contribute to a higher risk of disordered eating behaviors. For example, aesthetic sports often emphasize a lean physique, while weight-class sports require athletes to meet specific weight thresholds. Similarly, endurance and anti-gravitational sports may indirectly encourage lower body mass due to performance advantages (Ackerman & Misra, 2018; De Souza et al., 2025). It is important to note that these categories do not suggest that leanness is directly correlated with success in the specific sports shown above. Rather, they highlight environments in which external pressure may increase vulnerability to disordered eating. Research from external sources supports this, indicating that athletes in such sports may have a higher risk of developing disordered eating and consequent menstrual dysfunction compared to athletes in non-lean sports (Ackerman & Misra, 2018; De Souza et al., 2025).

If under-fueling continues, persistent oligomenorrhea may occur, causing menstrual periods to become increasingly infrequent. Oligomenorrhea is a condition where a person has infrequent menstrual periods. Meaning they may have a longer amount of time between their cycles compared to the regular length of 21-35 days. Then the final stage occurs when menstruation stops completely (Ackerman & Misra, 2018).

Research involving adolescent athletes in Singapore has shown similar results. This is especially evident in areas involving education on women's health and the relationship between under-fueling, training intensity, and menstrual irregularities.

4. METHODOLOGY FOR COLLECTING DATA FROM FEMALE ADOLESCENT ATHLETES IN SINGAPORE ABOUT TRAINING-RELATED AMENORRHEA

4.1 Literature review

A literature review was conducted using PubMed and Google Scholar with the keywords: Female Athlete Triad Syndrome, Amenorrhea, Menstrual Cycle, Adolescent Athlete, Track and Field. In addition, queries such as (((Female Athlete Triad Syndrome) AND (adolescent)) AND (female athletes)) AND (Track and Field), "Track and Field/physiology"[Mesh] AND (menstrual cycle), and "(amenorrhea) AND (adolescent) AND (menstrual dysfunction) were used to obtain the most accurate and relevant information. Five sources were selected based on their relevance to menstrual dysfunction, nutrition, hormonal imbalance, and female athlete health, with a focus on adolescents.

The questionnaires from these sources were analyzed by comparing information, data, questions asked, the environments in which they were conducted, and the samples. This was done to identify the commonly used measures of nutrition, training intensity, menstrual health, the tests administered, and the questions asked.

4.2 Questionnaire Development

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While questionnaires are widely used to assess patterns in nutrition, training intensity, and menstrual regularity, these studies were conducted in Western populations only. This creates limitations when applying them to different cultural contexts, including Singapore, where dietary habits, social norms, and athletic environments differ. As a result, the direct use of these questionnaires may reduce the accuracy and relevance of data collection to the Singapore population (Ackerman & Misra, 2018; De Souza et al., 2025).

To address this limitation, the questionnaires were adapted to examine the relationship between nutrition, training intensity, and menstrual health.

The questionnaire included three main components:

- training intensity, which assessed the frequency and level of physical activity
- nutritional behaviors, which focused on meal skipping and intentional food restriction related to body image or performance
- menstrual health, which examined cycle regularity and changes associated with increased training

This structure allowed the identification of patterns of low energy availability by analyzing the relationships among training intensity, nutritional intake, and menstrual irregularities.

The questionnaire was adapted to reflect the Singapore context better. Several changes were made to improve the clarity, cultural relevance, and accessibility for adolescent participants. Original questionnaires often relied on medical terminology, Western-specific activities, a Western diet, and assumptions about athletes' training (Thein-Nissenbaum & Hammer, 2017). Medical jargon was simplified to help adolescents aged 13 to 18 better understand the questions asked. For example, instead of using the term “amenorrhea”, the questionnaire asked the participants if they had “missed their period for three months or longer.” In addition, to assess energy availability, the questionnaire included questions regarding meal skipping and intentional food restriction. The simplified wording allowed participants to respond more accurately and with full understanding.

These adaptations improved data accuracy by reducing misinterpretation, increasing understanding, and encouraging honest responses. The results accurately captured patterns in nutrition, training, and menstrual health among high school athletes in Singapore.

4.3 Participants

Data were collected through an anonymous online questionnaire distributed using Google Forms. Participants were recruited through personal contact, school email distribution lists, group chats used by athletes, and word of mouth. As a result, most participants were from the same school, while approximately 20% attended a different school. The questionnaire did not collect any identifying information, such as participants' names, schools, or other personal identifiers. Only age was recorded.

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This ensured that all responses remained anonymous. Participation was voluntary, and all responses were self-reported. Individuals who reported using hormonal birth control were excluded from further menstrual-related analysis to ensure the accuracy of assessing natural menstrual patterns.

Responses were collected from 30 female high school athletes, aged 13-18, who were actively involved in sports such as volleyball, cross-country, soccer, touch rugby, basketball, track and field, swimming, gymnastics, tennis, going to the gym, and horseback riding.

4.4 Questionnaire Components

The questionnaire consisted of many different questions related to age, eating habits, training intensity, and menstruation patterns. The questionnaire included multiple-choice, checkbox, short-answer, and free-response questions, including:

1. How old are you?
 - a. 13
 - b. 14
 - c. 15
 - d. 16
 - e. 17
 - f. 18
 - g. 19
2. What sport/s do you play? (check all that apply)
 - a. Volleyball
 - b. Cross Country
 - c. Soccer
 - d. Touch rugby
 - e. Basketball
 - f. Track and field
 - g. Badminton
 - h. Softball
 - i. Swimming
 - j. Gymnastics
 - k. Other
3. If applicable, which events do you participate in for track and field and/or swimming?
 - a. Short answer response
4. How intense would you say your training sessions are?
 - a. Low
 - b. Moderate
 - c. High
 - d. Very high (elite level)
5. How many times a week do you train?

- a. 2-3
 - b. 4-5
 - c. 5-6
 - d. 7+
6. Have you ever intentionally restricted your food intake for performance or body image reasons?
- a. Yes
 - b. No
 - c. Other
7. How often do you skip meals?
- a. Never
 - b. Rarely
 - c. Sometimes
 - d. Often
8. Do you feel low energy (fatigue, dizziness, weakness) during the day?
- a. Never
 - b. Rarely
 - c. Sometimes
 - d. Often
9. Have you started menstruating?
- a. Yes
 - b. No
10. Do you take birth control pills? If yes, please do not continue with the survey.
- a. Yes
 - b. No
11. How regular is your menstrual cycle
- a. Regular (monthly)
 - b. Somewhat irregular
 - c. Very irregular
 - d. I do not get my period
12. Have you ever missed your period for 3 months or more (not due to pregnancy)
- a. Yes
 - b. No
 - c. Other
13. Is the length between your cycles between 21 to 35 days?
- a. Yes
 - b. No
 - c. Other
14. Have your periods changed since increasing training?
- a. No change
 - b. Less frequent

- c. Lost completely
- d. Other
- 15. Do you think missing periods are normal for high school athletes
 - a. Yes
 - b. No
 - c. Unsure
- 16. Is there anything else you would like to add?
 - a. Free response question

4.5 Limitations

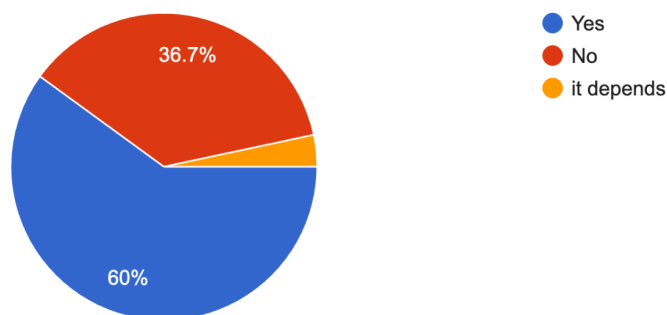
The study's sample size is small (n=30), which may limit the generalizability of the findings. Additionally, all data were self-reported, which may introduce self-reporting bias or recall inaccuracies.

5. RESULTS

A total of 30 participants completed the questionnaire. The majority reported high training intensity, with approximately 80% engaging in high or very high-intensity training.

Table 2. Participants who reported “yes” to food restriction and corresponding menstrual outcomes. *This table presents an analysis of adolescent female athletes in Singapore who reported intentionally restricting food intake for performance or body-image reasons.*

Have you ever intentionally restricted your food intake for performance or body image reasons?
30 responses



As shown in the graph above, 60% of participants reported “yes,” while 36.7% reported “no.” Among those who reported “yes” to restricting food intake, the following menstrual outcomes were observed:

Food restriction	Menstrual outcome	Percentage
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Yes	Less frequent cycles	50%
Yes	No change	44.4%
Yes	Amenorrhea	5.6%

Table 2 shows that the majority of participants (63.3%) who reported intentional food restriction; of these participants, 55.6% experienced menstrual irregularities. This pattern suggests a potential relationship between restricted nutritional intake and menstrual irregularities.

Table 3. Participants who reported menstrual irregularities and the sports they played. *The data also suggest a relationship between sport type and energy restriction. Participants who reported food restriction and decreased menstrual frequency (55.6%) were consistently involved in high-energy-demand sports.*

Participant	Sports played	Category of sport
1	Touch rugby, Track & Field, Gymnastics	Endurance and Aesthetic
2	Volleyball, Touch rugby, Track & Field	Team and Endurance
3	Cross Country	Endurance
4	Volleyball, Touch rugby, Track & Field	Team and Endurance
5	Track & Field	Endurance
6	Cross Country, Swimming	Endurance
7	Cross Country, Track & Field	Endurance
8	Touch rugby	Endurance

A common pattern observed among these athletes was involvement in high-endurance sports. All participants were involved in at least one endurance-related sport, suggesting a possible association between such sports and menstrual irregularities.

Additionally, awareness of menstrual health is limited. When asked whether missing periods are normal for high school athletes, 43.3% responded “no”, 23.3% were unsure, and 33.3% believed it was normal.

6. DISCUSSION

The findings of this questionnaire were consistent with previous research conducted in Western populations, which has similarly reported associations between restrictive eating behaviours, high training

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intensity, low energy availability, and menstrual irregularities. While the findings from this Singaporean cohort were similar, there is still a limited amount of research on Asian populations. Cultural differences in dietary habits, academic expectations, sporting environments, and parental pressure may influence an athlete's experiences. Adapting existing questionnaires helps improve the understanding of Asian populations. Future studies should involve a larger sample size to determine whether these findings are representative of the broader Singaporean population.

7. TREATMENT

Many strategies have been developed to treat amenorrhea, one of which is restoring adequate energy availability. This can be achieved by increasing daily caloric intake and reducing exercise intensity and volume. These strategies are commonly recommended for adolescent athletes.

To be more specific, to increase caloric intake, the athlete must consume at least 2,000 calories per day. This is the baseline advice. The advice varies depending on height, weight, and age; the minimum number of calories required will vary. This often involves reintroducing previously avoided food groups, most commonly healthy fats (e.g., oil, avocado) and carbohydrates (e.g., pasta, rice, potatoes). To do this, the athlete must address restrictive eating behaviors through discussions with trusted adults or counselors regarding difficulties they may be experiencing. This may help the athlete recognize unhealthy behaviours. A recommended strategy is to develop structured meal plans in collaboration with a sports dietitian/nutritionist (Berz & McCambridge, 2016).

Menstrual recovery is gradual and typically occurs only after energy balance is restored, so exercise modification is key to treating amenorrhea. There should be a reduction in training frequency and intensity. In more severe cases, there needs to be a temporary restriction on participation in sports.

Weight restoration and body composition are other useful indicators of treatment progress and of returning to a regular cycle. Gaining weight is the strongest indicator of the return of the menstrual cycle. Improvements from weight gain include higher estrogen levels, increased GnRH activity, and increased bone density. Since physiological improvements, such as body fat percentage, blood glucose, electrolyte levels, and BMI, are not always directly measurable, changes in body weight are often used as practical indicators of recovery and improved energy availability (Berz & McCambridge, 2016). BMI is a measurement used to estimate whether a person's body weight is appropriate for their height. BMI is used to classify individuals as underweight, normal weight, overweight, or obese.

Low energy availability caused by intentional restriction or disordered eating is often best treated through psychological intervention and nutritional rehabilitation. This can include cognitive behavioral therapy (CBT) or family-based therapy. CBT is a therapy that helps individuals change unhelpful thoughts and behaviors to improve emotional and physical well-being. In athletes, CBT can help promote a healthier relationship with food, body image, and exercise. Increased education, psychological support, and improved energy intake may help restore hormonal balance, improve ovarian function, and support overall recovery (Thein-Nissenbaum & Hammer, 2017).

Another possible treatment option is hormonal treatment. However, this approach is not recommended as a primary approach by medical professionals. Hormonal treatment should only be used if there is a severe estrogen deficiency. Taking supplemental hormones may bring back menstrual bleeding, but it does not fix the underlying issue, and it may give a false sense of recovery.

The recovery timeline for amenorrhea is very slow. Recovering from amenorrhea may take months or even years to return. An important point is that ovulation may return before visible menstrual periods. Recovery requires patience, consistency, and long-term behavioral change (Thein-Nissenbaum & Hammer, 2017).

8. CONCLUSION

The findings suggest a potential association between high training intensity, restrictive nutritional behaviours, and menstrual irregularities among adolescent athletes in Singapore. Although the study cannot establish causality because of its small sample size, the observed patterns are consistent with previous research on low energy availability and menstrual dysfunction throughout Western cohorts.

Furthermore, the results also reveal a clear lack of awareness surrounding menstrual health among adolescent athletes. These findings emphasize the importance of improving education surrounding menstrual health during adolescence and recognizing it as a key indicator of overall well-being. Missed or irregular periods should not be normalized in athletes. Instead, they should be viewed as warning signs of an underlying energy imbalance (Berz & McCambridge, 2016).

Expanding research beyond Western populations is essential for developing more localized and culturally relevant screening protocols. Future research should utilize longitudinal designs that follow Singaporean athletes over time and medical measurements, such as hormone fluctuations and bone density scans. Additionally, researchers should investigate the effects of sport type, training intensity, psychological factors, social media influence, and menstrual health education in adolescent female athletes.

Expanding professional research in non-Western countries is essential to developing a more effective approach to women's adolescent health.

REFERENCES

Nichols, J. F., Rauh, M. J., Lawson, M. J., Ji, M., & Barkai, H.-S. (2006). Prevalence of the Female Athlete Triad Syndrome Among High School Athletes. *Archives of Pediatrics & Adolescent Medicine*, 160(2), 137. <https://doi.org/10.1001/archpedi.160.2.137>

- Thein-Nissenbaum, J., & Hammer, E. (2017). Treatment strategies for the female athlete triad in the adolescent athlete: current perspectives. *Open Access Journal of Sports Medicine, Volume 8*(8), 85–95. <https://doi.org/10.2147/oajsm.s100026>
- De Souza, M. J., Williams, N. I., Misra, M., Nattiv, A., Joy, E., Barrack, M., Ricker, E. A., Gorrell, S., Koltun, K. J., O'Donnell, E., Mallinson, R. J., Salamunes, A. C. C., Woodruff, K., Fredericson, M., & Plessow, F. (2025). 2025 Update to the Female Athlete Triad Coalition Consensus Statement Part 1: State of the Science and Introduction of a New Adolescent Model. *Sports Medicine*. <https://doi.org/10.1007/s40279-025-02333-z>
- Ackerman, K. E., & Misra, M. (2018). Amenorrhoea in adolescent female athletes. *The Lancet Child & Adolescent Health, 2*(9), 677–688. [https://doi.org/10.1016/s2352-4642\(18\)30145-7](https://doi.org/10.1016/s2352-4642(18)30145-7)
- Berz, K., & McCambridge, T. (2016). Amenorrhea in the Female Athlete: What to Do and When to Worry. *Pediatric Annals, 45*(3). <https://doi.org/10.3928/00904481-20160210-03>
- World Health Organization (WHO). (n.d.). Retrieved July 1, 2026, from <https://www.who.int>