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REVIEW ARTICLE

MENSTRUAL CYCLE IN WOMEN'S FOOTBALL

CYKL MENSTRUACYJNY W PIŁCE NOŻNEJ KOBIET

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ABSTRACT
The menstrual cycle (MC) remains an underexplored yet potentially significant factor affecting the health, performance, and injury risk of female football players. This paper summarizes the physiological effects of hormonal fluctuations across the menstrual cycle and their possible impact on training adaptation, match performance, and recovery. Particular attention is given to the association between menstrual dysfunction, low energy availability (LEA), and Relative Energy Deficiency in Sport (REDs), a condition that increases the risk of stress fractures and impairs bone health. Despite growing interest in integrating MC monitoring into sports science and coaching practices, methodological challenges – such as inter-individual variability and the lack of standardized tracking protocols – limit its routine application. Nonetheless, there is increasing momentum toward personalized training and injury prevention strategies that consider menstrual cycle phases as part of a comprehensive approach to supporting female footballers. This paper underscores the need for continued research and practical integration of MC-related insights to promote athlete health and optimize performance in women's football.

Keywords: menstrual cycle, female football, low energy availability (LEA), relative energy deficiency in sport (REDs)

STRESZCZENIE
Cykl menstruacyjny (CM) pozostaje niedostatecznie zbadanym, choć potencjalnie istotnym czynnikiem wpływającym na zdrowie, wydolność i ryzyko urazów u piłkarek. Niniejsza praca podsumowuje fizjologiczne skutki wahań hormonalnych w różnych fazach cyklu menstruacyjnego oraz ich możliwy wpływ na adaptację treningową, wydajność meczową i regenerację. Szczególną uwagę poświęcono związkom między zaburzeniami miesiączkowania, niską dostępnością energii (LEA), a zespołem względnego niedoboru energii w sporcie (REDs), który zwiększa ryzyko złamań przeciążeniowych i pogarsza stan zdrowia kości. Pomimo rosnącego zainteresowania wdrażaniem monitorowania CM w naukach o sporcie i praktyce trenerskiej, trudności metodologiczne – takie jak indywidualna zmienność oraz brak ustandaryzowanych protokołów obserwacji – ograniczają jego rutynowe stosowanie. Niemniej jednak coraz większy nacisk kładzie się na personalizację treningu i profilaktyki uszkodzeń narządu ruchu z uwzględnieniem faz cyklu menstruacyjnego jako elementu

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kompleksowego podejścia do wsparcia piłkarek. Artykuł podkreśla potrzebę dalszych badań i praktycznego wdrażania wiedzy związanej z CM w celu wspierania zdrowia zawodniczek oraz optymalizacji ich wyników sportowych.

Słowa kluczowe: cykl menstruacyjny, piłka nożna kobiet, niska dostępność energii (LEA), względny niedobór energii w sporcie (REDs)

Women's sport in scientific research

Considering the role that the menstrual cycle (MC) plays in women's football, we would undoubtedly want to rely on as much available scientific research as possible. However, this is not so straightforward, as women's sports have often been overlooked by researchers. Costello *et al.* examined gender proportions in sports medicine journals from 2011 to 2013 (Costello *et al.,* 2014). They concluded that women were underrepresented in all major sports medicine and physiotherapy journals. Among all participants, women made up only 39%. Furthermore, only 4–13% of studies included exclusively female participants. Paul *et al.* arrived at similar conclusions (Paul *et al.,* 2023). Analyzing scientific publications from 2017 to 2021, they found that only 9% of the studies were conducted exclusively on women, while 71% focused solely on men. Research indicates that female athletes are often overlooked in scientific studies, particularly in areas related to sports medicine and health. For instance, Tsukahara *et al.* highlight that female sports medicine physicians frequently encounter gender bias in their professional interactions, which can lead to a lack of attention to female athletes' health issues in research contexts (Tsukahara *et al.,* 2022). This bias is compounded by a general trend of underrepresentation of women in sports-related academic fields, as noted by Forsyth *et al.,* who discuss the barriers that women face in pursuing careers in sports, including gender discrimination and a lack of self-confidence (Forsyth *et al.,* 2019). These barriers contribute to a cycle where female athletes' experiences and health concerns are not adequately addressed in the literature. A positive aspect of these findings is undoubtedly the fact that the number of studies conducted on women has been increasing year by year.

Sexual dimorphism in football

At first glance, it may appear justifiable to generalize findings from studies conducted on male athletes to women's football. The sport is governed by uniform regulations for both sexes, including identical field dimensions, goal sizes, ball characteristics (size and weight), and match duration. However, this approach overlooks fundamental anthropometric and physiological differences between sexes. On average, women exhibit lower stature, reduced body mass, and smaller foot dimensions compared to men. When these factors are considered, it becomes evident that female players may be subjected to relatively greater biomechanical and physiological loads under standardized playing conditions.

Consequently, female footballers exhibit specific adaptive responses to the demands of the sport. One such adaptation pertains to aerobic capacity. Notably, the disparity in endurance performance between elite male and female players is narrower than that observed in the general population, suggesting a sex-specific convergence in relative endurance capacity within the elite athletic context. Another observed adaptation involves ball-striking velocity. While female athletes typically possess lower absolute lower-limb strength than males, the difference in ball-striking speed is proportionally smaller. This indicates a potential compensatory reliance on technical proficiency rather than maximal force production (Pedersen *et al.,* 2019). Such a trend

may underscore the increasing importance of refined kicking mechanics in female football.

These sex-specific adaptations exert a discernible influence on match dynamics and performance indicators in the women's game. Empirical analyses indicate a higher frequency of set pieces (e.g., free kicks), physical contests (e.g., duels), and ball interactions (e.g., clearances, touches) in women's football compared to men's. Furthermore, female players demonstrate lower passing accuracy, with passes tending to be shorter in length and slower in velocity (Pappalardo *et al.,* 2021). These cumulative differences contribute to a distinct performance profile for women's football, reinforcing the notion that direct comparisons between the male and female formats of the game may be methodologically and conceptually inappropriate.

Menstrual cycle and REDs disorders in sports

A key physiological distinction between females and males is the presence of the menstrual cycle (MC) in females. A typical menstrual cycle ranges from 21 to 35 days in duration, with the menstruation phase (bleeding) lasting approximately 3 to 8 days (Fehring *et al.,* 2006). Female athletes are particularly vulnerable to menstrual disturbances, including amenorrhea and oligomenorrhea, often as a result of inadequate energy availability relative to the demands of training and competition. This state, known as Low Energy Availability (LEA), initiates a cascade of physiological disruptions. LEA – whether or not it coexists with disordered eating – can result in the suppression of endogenous estrogen and other key hormones, contributing to reduced bone mineral density. This interrelationship among LEA, menstrual dysfunction, and impaired bone health forms the foundation of what has been termed the Female Athlete Triad (Sangenis *et al.,* n.d.). However, this triadic model was later deemed too narrow, as it did not capture the broader multisystemic health and performance consequences observed in athletes experiencing LEA. In response, the International Olympic Committee introduced the concept of Relative Energy Deficiency in Sport (REDs) in 2014 (Mountjoy *et al.,* 2014). REDs encompasses a wider array of physiological and psychological impairments beyond those identified in the Triad. REDs negatively affects numerous body systems, including the cardiovascular, gastrointestinal, endocrine, reproductive, skeletal, renal, and central nervous systems. It can result in micronutrient deficiencies (e.g., iron deficiency anemia), chronic fatigue, increased susceptibility to infections, and impaired recovery. From a psychological standpoint, REDs is associated with heightened stress, anxiety, and depressive symptoms. In terms of performance, REDs can reduce reaction time, coordination, concentration, muscular strength, endurance, and glycogen availability. Additionally, it increases the risk of musculoskeletal injuries, impairs decision-making capacity, and may contribute to mood disturbances and irritability (Mountjoy *et al.,* 2014).

REDs management in sports

Given the potentially severe health and performance consequences associated with REDs, it is imperative to implement an evidence-based, individualized treatment strategy. The initial step involves the accurate identification of the specific clinical manifestations of REDs in the affected athlete. In cases where LEA is present, the primary therapeutic focus should be on restoring energy balance – achieved either by increasing energy intake, reducing energy expenditure, or a combination of both. Nutritional interventions may include the incorporation of energy-dense foods, liquid meal replacements, or structured meal plans designed by a qualified sports dietitian. Concurrently, training loads may need to be adjusted by reducing intensity, volume, or frequency – such as adding additional rest days to promote physiological recovery. Collaboration among the athlete, sports nutritionist, and coaching staff is essential to ensure adherence and long-term success (Heikura *et al.,* 2018).

When LEA results in menstrual dysfunction (e.g., functional hypothalamic amenorrhea), weight restoration remains a cornerstone

of treatment. Although oral contraceptive pills are sometimes considered for hormonal regulation, it is important to counsel athletes that these agents do not restore endogenous hormone production nor improve bone mineral density; they primarily mask the symptom of menstrual irregularity. Moreover, any pharmacological intervention must be evaluated for compliance with the World Anti-Doping Agency (WADA) Prohibited List (WADA 2024).

If REDs has progressed to involve compromised bone health (e.g., decreased bone mineral density or stress fractures), treatment must include not only nutritional and training adjustments but also the implementation of resistance training (2–3 sessions per week), and supplementation with calcium and vitamin D, as per clinical guidelines (Tenforde *et al.,* 2017).

Psychological symptoms – such as disordered eating behaviors, depression, anxiety, or obsessive training attitudes – should be addressed by a mental health professional experienced in sport psychology. Cognitive-behavioral therapy (CBT) is commonly used, and pharmacological treatment with antidepressants may be considered when clinically indicated (Curie, 2010).

As REDs is a multifactorial and multisystemic condition, optimal management requires an interdisciplinary approach involving sports medicine physicians, registered dietitians, physiologists, psychologists, and coaching staff. Interventions must be individualized to align with the specific physiological, psychological, and performance needs of each athlete.

Individuality of the menstrual cycle

Monitoring the impact of the menstrual cycle (MC) on physical performance presents significant challenges from a scientific standpoint. This complexity arises from the considerable interindividual variability in cycle characteristics – each woman's hormonal profile, symptom severity, and response to cycle phases may differ (Bell *et al.,* 2014). Research by Bell and colleagues highlighted that some women are more sensitive to hormonal fluctuations than others, underscoring the need for personalized approaches to monitoring and management.

As a result, it is increasingly recommended that female athletes individually track their menstrual cycles and observe any corresponding changes in physical performance, training capacity, or recovery. Despite this, many athletes remain hesitant to discuss the MC openly, fearing it may be perceived as a sign of weakness (Bergström *et al.,* 2023). This stigma can limit effective communication and management within sports environments.

Surveys indicate that more than 40% of physically active women believe the menstrual cycle negatively affects their training and performance (Julian *et al.,* 2021; Statham, 2020). However, emerging evidence suggests that these perceptions may be shaped more by societal stereotypes and cultural narratives than by consistent physiological experiences. For instance, Statham (2020) noted that many women expect to feel worse premenstrually, but this expectation does not always align with actual symptom severity or performance outcomes.

Risk of injury in women's football

It is essential to acknowledge that the injury profile in women's football differs significantly from that observed in men's football. Research has shown that female players experience a higher proportion of serious injuries, resulting in approximately 21% more days lost to injury compared to their male counterparts (Larruskain *et al.,* 2018). Among the most common injuries sustained by female footballers are quadriceps strains and ankle sprains, reflecting the biomechanical and neuromuscular demands of the sport (López-Valenciano *et al.,* 2021).

Female athletes are also at a greater risk for stress fractures, which are often linked to low energy availability and undernutrition, as seen in conditions such as Relative

Energy Deficiency in Sport (REDs). Stress fractures are clinically categorized into high-risk types – which are prone to complete fractures, delayed union, or nonunion – and low-risk types, which typically respond well to conservative treatment and allow for weight-bearing during recovery (Chen *et al.,* 2013).

A particularly concerning injury in women's football is the anterior cruciate ligament (ACL) tear, which occurs at a rate nearly five times higher in female athletes than in males (Larruskain *et al.,* 2018). ACL injuries are more frequently sustained during match play compared to training sessions, possibly due to higher-intensity movements and unpredictable game scenarios (Waldén *et al.,* 2011). One of the contributing factors receiving increased attention is the playing surface. The prevalence of artificial turf in competitive settings may elevate ACL injury risk due to increased shoe-surface traction and elevated ground reaction forces, both of which place greater mechanical load on the knee joint (Alentorn-Geli *et al.,* 2009a; 2009b).

In recent years, head injuries and concussions have also emerged as a major health concern in the women's game. Evidence indicates that female footballers sustain concussions at more than twice the rate of male players, raising concerns about sex-specific vulnerability and the need for tailored prevention and management strategies (Dvorak *et al.,* 2007).

Summarizing, the menstrual cycle is an important but often overlooked factor in women's football, with potential implications for performance, injury risk, and overall health. Menstrual disturbances are frequently linked to low energy availability, a key driver of Relative Energy Deficiency in Sport (REDs), which can impair bone health and increase susceptibility to injuries such as stress fractures. Although monitoring the menstrual cycle is methodologically challenging due to individual variability and inconsistent tracking methods, there is growing recognition of its relevance. Increasingly, researchers and practitioners are moving toward individualized strategies in performance planning and injury prevention that account for the athlete's menstrual cycle as part of a holistic approach to female athlete care.

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