Kontagora International Journal of Educational Research (KIJER) **Volume 1, Issue 1 May 2024**
https://fuekjournals.org/index.php/kijer

Menstrual Cycle and Female Athletics Performance: A Literature Review of Empirical Studies

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DOI: https://doi.org/10.5281/zenodo.11653682

Abstract

The menstrual cycle is a complex process influenced by hormonal changes and various physiological pathways. This study provides an overview of recent research on the relationship between menstrual cycle, exercise, and sports performance. The reviewed literature indicates that the menstrual cycle impacts physical performance, mood, and sleep quality, with hormonal changes affecting muscle strength, endurance, metabolism, and thermoregulation. Awareness of the menstrual cycle's phases and their effects varies among athletes, many of whom reported fatigue and mood disturbances during menstruation. While physical activity helps mitigate menstrual symptoms and enhance well-being, its effects on performance metrics like VO_2 max and power output are inconsistent due to individual variations and small sample sizes. From the reviewed studies, the paper concludes that a more personalized approach to training and performance strategies, considering the menstrual cycle's potential impact is required. Among others, the paper recommends that coaches and trainers should develop training schedules that account for individual athletes' menstrual cycles, potentially modifying the intensity and type of training based on the phase of the cycle.

Keywords: Menstrual cycle, Exercise, Sports, Performance

Introduction

Despite the continuous marginalization of women in sports science and the significant anatomical, physiological, and endocrine differences between male and female athletes, most training methodologies are derived from studies utilizing men. One of the most fundamental differences between females and males is the menstrual cycle (MC). Developing a female-specific evidence based sports science is crucial to understanding how the menstrual cycle impacts athletes and informing the design of training, recovery, and athlete monitoring programs that consider the MC phase.

The availability of information on the menstrual cycle is increasingly important, given the growing media attention and interest among athletes. This knowledge enables female athletes to make informed decisions about their health and performance. Disruptions in the balance of steroid hormones can influence various parameters, from fatigue and sleep disturbances to mood disorders such as excitement and depression (Ojezele, et al. 2022). These variables can, in turn, alter training responses, adaptability, and overall performance.

The need to study the impact of the menstrual cycle on female athletic performance is crucial due to the significant physiological differences between male and female athletes, which are neglected in most training methodologies derived from male-based studies (Pitchers and Elliott-Sale, 2019). This gap leaves female athletes without personalized guidance, but investigating the impact of the menstrual cycle will provide valuable insights into physiological and psychological changes, enabling tailored training programs and athlete monitoring strategies. This study aims to address the gender gap in sports science, enhancing female athletes' performance, health, and well-being.

Menstrual Cycle

The menstrual cycle, also known as menses or period, is a natural process that occurs approximately every 28 days in sexually mature females who are not pregnant. It is characterized by bleeding from the vagina, which usually lasts for 3-7 days. The menstrual cycle consists of four phases: menstruation (days 1-5), follicular phase (days 6-14), ovulation (day 14), and the luteal phase (days 15-28) (Thiyagarajan, Basit and Jeanmonod, 2022). The cycle length can vary among individuals, typically ranging from 21 to 35 days. In the early follicular phase, progesterone (P4) and oestrogen (E2) levels are low. Halfway through the follicular phase, E2 concentrations rises, peak in the late follicular phase, and then drop sharply before ovulation (Oosthuyse and Bosch, 2010). Ovulation is defined as the day after a luteinizing hormone (LH) surge occurs. During ovulation, a mature follicle releases an egg, stimulated by a sudden increase in LH and a rise in body temperature of about 0.5°C (Larsen, et al. 2020). After the ovulation phase, the cycle

progresses into the luteal phase, characterized by the formation of the corpus luteum from the ruptured follicle, leading to a significant rise in P4 and E2 levels (Kolic, et al. 2021). These hormones plateau during the mid-luteal phase and then decrease during the late luteal phase, eventually leading to the shedding of the endometrial lining and the beginning of a new cycle (Berglund, 2020).

The menstrual cycle is regulated by a complex interplay of hormones produced by the hypothalamus, pituitary gland, and ovaries, known as the hypothalamic-pituitary-ovarian (HPO) axis (Tremback-Ball, et al. 2020). The key hormones involved include oestrogen which stimulates the growth and thickening of the uterine lining, progesterone which maintains the uterine lining for potential implantation of a fertilized egg, follicle-stimulating hormone (FSH) which stimulates the growth and maturation of ovarian follicles, and luteinizing hormone (LH) which triggers ovulation. Although women perform and compete in various sporting events across different MC phases, the impact of these hormonal fluctuations on athletic performance has generated significant debate in the literature (Janse and Thomson, 2019).

These physiological changes across the two broad phases of menstrual cycles; the follicular and the luteal phases, particularly variations in oestrogen and progesterone levels, impact muscle strength, endurance, cardiovascular response, metabolism, and thermoregulation (Kneller and Zelinka, 2020). Understanding the menstrual cycle and its phases is essential for optimizing the performance and health of female athletes.

Impact of Menstrual Cycle on Physical Performance

Ranchoux, Dubois and Guillot (2022) investigated the connection between the menstrual cycle and its effects on physical performance, mood and sleep quality in female athletes using a cross sectional study design, online survey distribution and questionnaire based data collection. 164 female recreational athletes participated in the study, inclusion criteria was regularly menstruating female between the ages 18-40 who engaged in recreational sports or physical activity. The result indicated that 29.9% aware of the menstrual cycle phases and only 11.2% knowledgeable about the four (4) primary hormones involved. 37.8% of the participants believed their performance was occasionally affected by menstruation with physical fatigue being the most common symptom. Sleeping disturbances were reported by 19.5% of females and 20.4% experienced changes in sleep quality during menstruation.

Eliakim, et al. (2022), probe the relationship between the menstrual cycle and exercise performance in elite adolescent athletes was conducted with 14 elite female athletes (16-18 years old). VO2 max, power output and 20-meter sprint exercise was performed during the follicular (days 1-14) and luteal (days 15-28) phases of their menstrual cycle. The result indicted that VO_2 max and power outputs were significantly higher

during the follicular phase compared to the luteal phase. The sprint performance was faster during the follicular phase while perceived exertion was higher during the luteal phase. The study concluded that menstrual cycle phase affects exercise performance in athletes, with better performance during the follicular phase.

Křížová (2022) explored how the menstrual cycle influences various physiological and performance-related factors in female athletes. Twenty (20) female athletes participated in the study, undergoing physiological and performance tests, including VO_2 max, muscle strength, power, and flexibility assessments, during the follicular and luteal phases of their menstrual cycle. The results indicated no significant differences in VO_2 max and muscle strength between the phases; however, there were notable decreases in muscle power and flexibility during the luteal phase. These findings found a correlation between hormonal fluctuations and changes in physiological and performance metrics. The study highlighted the necessity of incorporating menstrual cycle considerations into sports training and performance strategies and called for further research to gain a comprehensive understanding of the menstrual cycle's effects on exercise performance.

Berglund (2020), sort to find the effect of menstrual cycle on physical performance in elite female soccer players. Fourteen players were tested for physical performance parameters (speed, agility, strength, endurance) during three menstrual cycle phases (menstruation, follicular and luteal). The result indicted no significant differences in physical performance parameter between menstrual cycle phases. However, individual variations and small sample size may have influenced the results. Carmichael, et al. (2021), conducted a pilot study on the impact of menstrual cycle phase on elite Australian football athletes. Fourteen elite football athletes participated during their menstrual cycle phase which was assessed using a self-reported menstrual cycle diary. Physiological and perceptual measures were collected during the follicular and luteal phases. The result indicated no significant differences in physical performance measures (e.g., sprint speed, endurance) between menstrual cycle phases and small to moderate effects suggesting improved performance in the luteal phase for some measures (e.g., agility, power). Furthermore, self-reported fatigue and wellbeing varied across the menstrual cycle, with increased fatigue and decreased wellbeing in the luteal phase. The study suggests that menstrual cycle phase may have a small impact on physical performance in elite Australian football athletes.

Hayashida, et al. (2016), explored the effects of menstrual cycle phase on exercise-induced muscle damage, inflammation, and repair in women. Twelve participants completed a 60-minute cycling exercise at moderate intensity during the follicular and luteal phases. Blood samples were collected before, immediately after, and 24-48 hours after exercise to measure muscle damage and inflammation markers.

The results indicated that exercise-induced muscle damage and inflammation were lower during the luteal phase compared to the follicular phase.

Menstrual cycle plays a role in the physical performance, exercise-induced muscle damage and inflammation response in women. By studying the menstrual cycle's impact, coaches and sports scientists can create individualized training regimens, maximizing performance, reducing injury and burnout risk, and ensuring female athletes receive the support they need to achieve their full potential.

Perceptual Responses and Menstrual Cycle

Paludo, et al. (2022), explores the relationship between the menstrual cycle and athletes' perceptual responses, including motivation, competitiveness, sleep quality, stress, muscle soreness, fatigue, perceived effort, mood, menstrual symptoms, perceived endurance, and readiness. The review includes fourteen studies, with eight eligible for meta-analysis, and reveals that some perceptual responses are affected by different menstrual cycle phases. The study finds that motivation and competitiveness increase during the ovulation phase, while mood disturbance and fatigue increase in the pre-menstrual phase. The meta-analysis reveals no significant difference in perceived exertion between days 1-5 and 19-24 of the menstrual cycle.

Meignie, et al. (2021), inquired on effects of menstrual cycle phase on elite athlete performance. The researchers collated seventeen (17) studies involving three hundred and fourteen (314) elite athletes across various sports. The review found that different sports performance-related parameters are affected during the menstrual cycle among elite athletes. The effects of the menstrual cycle on performance vary widely across studies, with some showing improvement and others decrements. The study concluded that majority of studies relied on self-reported menstrual cycle data, which may be subjected to bias.

Hicks, et al. (2023) reviewed related studies on menstrual cycle influences women's physical performance. The review included twenty-five (25) studies, revealing that muscle strength and endurance decrease during the luteal phase due to hormonal changes, whereas the follicular phase shows improved physical performance metrics.

Impact of Physical Activity on Menstrual and Premenstrual Symptoms

Lima-Trostdorf, et al. (2021), investigated the effects of physical activity on menstrual and premenstrual symptoms in sedentary, active, and athlete women. The study found that female athletes experience fewer physical and mental symptoms than non-athletic women, with dysmenorrhea, bad mood, discouragement, and anxiety being the most intense symptoms during the menstrual period. The study highlights the importance of physical activity in managing menstrual and premenstrual symptoms, with 62.1% of

participants using medication to relieve menstrual period symptoms. The findings suggest that physical activity can be a valuable tool in reducing the severity of menstrual and premenstrual symptoms, leading to improved physical and mental well-being for women. The study's results can inform strategies for mitigating the impact of menstrual and premenstrual symptoms on daily life and athletic performance.

Joshi, Pendse, and Vaidya (2018) examined the effect of moderate aerobic exercise on perceived stress during luteal phase of menstrual cycle in students pursuing professional course. The study consisted of 60 female students (aged 18-25) pursuing a professional course, divided into an exercise group (n=30) and a control group (n=30). The exercise group performed moderate aerobic exercise for 30 minutes, three times a week, during the luteal phase, resulting in a significant reduction in perceived stress scores (mean ± SD: 15.23 ± 3.45 to 10.13 ± 2.56, $p < 0.001$). In contrast, the control group did not show any significant change in perceived stress scores (mean ± SD: 15.50 ± 3.51 to 15.23 ± 3.45, $p > 0.05$). The exercise group had significantly lower perceived stress scores compared to the control group at the end of the luteal phase ($p < 0.001$). The study concluded that moderate aerobic exercise during the luteal phase of the menstrual cycle significantly reduces perceived stress in female students pursuing a professional course.

Omidvar, et al. (2019), explore the relationship between physical activity, menstrual cycle characteristics, and body weight in a cohort of young South Indian females. A total of one thousand (1000) healthy female students aged 11-28 participated in the study. Physical activity levels were assessed, and menstrual cycle characteristics and body weight were evaluated. Results showed that the majority of participants (87.9%) engaged in low levels of physical activity. However, those who were physically active exhibited more favourable menstrual cycle characteristics, including longer cycle length, increased regularity, and reduced severity of dysmenorrhea. Additionally, physically active participants had lower body mass indexes (BMIs) compared to their inactive counterparts. The findings revealed a positive association between physical activity and menstrual health, as well as a beneficial impact on body weight. These results highlight the importance of promoting regular physical activity among young females to reduce the risk of menstrual cycle disturbances and promote overall health and well-being.

Kolic, et al. (2021), explored the impact of the menstrual cycle on physical activity in women, using a mixed-methods approach. The online questionnaire and semi-structured interviews revealed that nearly a third of participants (44) avoided physical activity due to menstrual events. These individuals reported longer periods, heavier flow, and higher levels of fatigue and pain, highlighting the physical and emotional challenges associated with menstruation. The findings emphasize the importance of considering individual perspectives and societal norms when promoting physical activity among women. By normalizing and

supporting physical activity during menstruation, we can encourage women to prioritize their overall health and well-being. The study's insights can inform physical activity recommendations and agendas, helping to create a more inclusive and supportive environment for women to engage in physical activity throughout their menstrual cycle.

Yang et al (2024) conducted a systematic review and meta-analysis of observational studies that investigated the relationship between physical activity and premenstrual syndrome (PMS) in female college students. The study had a total of 1,316 participants, sourced from three (3) databases for relevant studies published up to October 7, 2023 and included five (5) cross-sectional studies conducted in Asia. The result revealed a significant negative association between physical activity levels and PMS risk, indicating that high physical activity levels are associated with a reduced risk of PMS in female college students. The findings suggest that physical activity may be a useful strategy for preventing or alleviating PMS symptoms in this population.

Summary and Conclusion

The collected body of research underscores the nuanced and multifaceted relationship between the menstrual cycle and various aspects of physical performance, mood, and sleep quality in female athletes. Studies by Ranchoux, Dubois & Guillot (2022) and Paludo et al. (2022) highlight a general awareness among athletes about the menstrual cycle's phases and its perceived impact on performance, mood disturbances, and sleep disruptions, albeit with variations in knowledge and symptom severity. Lima-Trostdorf et al. (2021) and Joshi et al. (2018) illustrate the positive influence of physical activity in mitigating menstrual and premenstrual symptoms, indicating that consistent exercise can reduce perceived stress and improve overall well-being.

In contrast, research by Eliakim et al. (2022), Berglund (2020), and Meignie et al. (2021) reveals the complex and sometimes inconsistent effects of menstrual phases on performance metrics such as VO2 max, power output, and sprint performance, with individual variations and small sample sizes possibly influencing outcomes. Křížová (2022) and Hicks et al. (2023) further elaborate on these findings, suggesting that hormonal fluctuations during the menstrual cycle can lead to variations in muscle strength, endurance, and other physiological factors. Additionally, studies like those by Omidvar et al. (2019) and Kolic et al. (2021) emphasize the importance of promoting physical activity among young females to enhance menstrual health and overall well-being, while Hayashida et al. (2016) and Carmichael et al. (2021) explore the differential impacts of menstrual phases on exercise-induced muscle damage, inflammation, and recovery.

In conclusion, these studies collectively advocate for a more personalized approach to training and performance strategies, considering the menstrual cycle's potential impact. They also highlight the need for further research to develop comprehensive guidelines that support female athletes in optimizing their performance and health across all phases of their menstrual cycle.

Recommendations

Based on the findings of the studies discussed, the following recommendations are advanced

1. Coaches/trainers should develop training schedules that account for individual athletes' menstrual cycles, potentially modifying intensity and type of training based on the phase of the cycle.
2. Coaches/trainers should educate athletes about the menstrual cycle, its phases, and the physiological and psychological changes that may occur. Emphasize the importance of understanding their bodies to optimize performance.
3. Athletes should maintain a personal diary or use apps to track menstrual cycles, symptoms, and performance. This can help in recognizing patterns and planning training and competition schedules accordingly.
4. Athletes should communicate openly with coaches and medical professionals about menstrual health and any symptoms that impact training and performance.
5. Athletes should prioritize rest and recovery, especially during phases of the menstrual cycle that may increase fatigue or muscle soreness. They should also follow a balanced diet and stay well-hydrated, with special attention to nutritional needs that may vary throughout the menstrual cycle.
6. Regular check-ups should be conducted to monitor menstrual health and identify any potential issue that could impact athletic performance. A holistic approach to athlete care should be implored with consideration on menstrual health as an integral part of overall health and performance.
7. Further studies should be conducted with more extensive and varied studies to understand better the relationship between menstrual cycles and athletic performance across different sports and levels of athleticism. Also, include a diverse range of participants in terms of age, sport type, and level of competition to develop more generalized and applicable findings.
8. Researchers should use objective measures and standardized protocols to assess the impact of menstrual cycles on performance and reduce reliance on self-reported data which can be subjective and prone to bias.

9. Government should put in place policies and guidelines that recognize and support the unique needs of female athletes regarding menstrual health and allocate resources for education, research, and support services focused on menstrual health and its impact on athletic performance.

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