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Review Article

The effect of the menstrual cycle on physical characteristics (speed, strength, and endurance) in women in Saudi Arabia

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ABSTRACT

The increasing participation of women in sports has raised interest in understanding how the menstrual cycle, specifically estrogen, progesterone, follicle-stimulating hormone (FSH), and luteinizing hormone (LH), affects athletic performance. These hormones fluctuate throughout the menstrual cycle, which is divided into the early follicular phase, ovulatory period, and mid-luteal phase, each with distinct hormonal profiles. While estrogen is believed to have an anabolic effect on skeletal muscle and influence substrate metabolism, progesterone may have an antiestrogenic effect, potentially affecting physical performance. However, research on the impact of these hormone fluctuations on performance yields contradictory results. Some studies report improved performance during various menstrual cycle phases, while others find no significant differences. Additionally, the effects of oral contraceptives (OCPs) on muscle strength and function remain unclear. Menopause, characterized by a decline in skeletal muscle mass and bone density, is associated with reduced physical performance in women. More research is needed to understand the effects of estrogen and progesterone fluctuations on physical performance in women, emphasizing the importance of gender-specific research and guidelines for optimizing athletic performance.

Keywords: Menstrual cycle, Estrogen, Progesterone, FSH, LH, Athletic performance, Women, Physiology

INTRODUCTION

The rising number of women in sports has sharpened the focus on the physiological and metabolic reactions of women to physical activity. Over the past ten years, researchers have done studies to explore the correlation between physical activity and the menstrual cycle, with a particular emphasis on understanding the hormonal mechanisms that regulate it.[1]

These hormones primarily control the reproductive cycle but also affect various physiological systems, which can result in changes to athletic performance.[2]

Estrogen secretion in young women naturally fluctuates, with levels increasing by a factor of 10 to 100 over the menstrual cycle. In addition to estrogen, the menstrual cycle is marked by notable fluctuations in other crucial plasma hormones, including follicle-stimulating hormone (FSH), luteinizing hormone (LH), and progesterone. This evidence suggests that there are cyclical changes in steroid hormones, specifically estrogen and progesterone, throughout an ovulatory menstrual cycle (MC).[3] Although there are theoretical implications for physical performance, the existing research on the impact of hormone fluctuations associated with the MC on physical performance is contradictory.[4]

The menstrual cycle consists of three distinct phases: the early follicular phase characterized by low levels of estrogen and progesterone, the ovulatory period marked by high levels of estrogen and low levels of progesterone, and the mid-luteal phase characterized by high levels of both estrogen and progesterone.[2]

Figure 1 illustrates the variations in female sex hormones, specifically estrogen, progesterone, FSH, and LH, which define the different stages of a normal menstrual cycle.[5]

The menstrual cycle comprises a sequence of events that prime the uterus for the possibility of pregnancy. Eumenorrheic refers to a menstrual cycle that happens regularly and lasts for a period ranging from 21 to 35 days. A regular menstrual cycle is divided into two distinct phases: the follicular phase and the luteal phase. These phases are determined by the occurrence of menstruation, the maturity of follicles, ovulation, and the creation of the corpus luteum.[5]

There is a limited amount of research undertaken on the menstrual cycle specifically about athletes, and the existing studies need to take into account all the physical and physiological factors. The relationship between menstruation and physical activity is closely connected, and remarkable athletic achievements have been observed during every stage of a woman's menstrual cycle.[6]

Given the varied impacts of estrogen and progesterone, it is reasonable to expect that the timing of the MC could affect the physical fitness of females. The hormonal variations linked with the menstrual cycle could affect various aspects of the body, including cardiorespiratory ability, high-speed strength, hand grip strength, and flexibility.[7]

REVIEW LITERATURE

Considering the benefits of endurance and strength training for women's body composition and physical fitness is crucial, despite the perceived impact of the menstrual cycle on performance. Research indicates that engaging in physical activity can decrease body fat, increase muscle mass, and enhance overall fitness.[8] Additionally, the specific effects of menstrual cycle phases on performance outcomes have not been consistently recorded in studies examining objective measures of physical performance, including anaerobic, aerobic, and strength evaluations. Prioritizing training and fitness may help reduce the negative impact of menstrual cycle symptoms on sports performance.

This indicates that an athlete's overall sports performance can be affected by different perceived and physical factors, rather than solely the menstrual cycle. It is important to carefully weigh the possible psychological advantages that women might receive by working out during their menstrual cycle. Scientific studies indicate that physical activity can alleviate PMS symptoms, boost mood, and enhance overall well-being. Women can potentially mitigate the negative impact of the menstrual cycle on sports performance by focusing on training and fitness.

It is important to remember that symptoms related to the menstrual cycle and their impact on performance can vary from person to person. The way each woman goes through her menstrual periods is unique, and the impact may not be the same for everyone. Each woman experiences her menstrual periods differently, and not all women may be affected by them in the same way. Some athletes may experience no impact or even a boost in performance during specific menstrual cycle phases. Therefore, when creating training plans and resolving any potential issues related to the menstrual cycle, it is crucial to take into account the particular demands and experiences of each athlete.[5]

Moreover, research on specific physiological variables during high-intensity interval exercise, endurance-trained athletes experience changes in oxygen consumption, carbon dioxide production, respiratory exchange ratio, breathing frequency, energy expenditure, relative perceived exertion, and perceived readiness has demonstrated that menstrual cycle phase has no significant effect on these variables. It doesn't appear that the changes in sex hormones that occur during the menstrual cycle have a significant enough effect to stop the tissues from responding to intense exercise.[9]

Additionally, it has been observed that variations in the menstrual cycle phases or in the active vs placebo phases of oral contraceptives do not significantly affect exercise performance or the hypertrophy of muscles in response to resistance training. Research indicates that the menstrual cycle and oral contraceptives have negligible effects on the development of muscle, oxidation of substrates, and exercise capacity.[10]

Though the menstrual cycle may not have a significant effect on psychological reactions in particular, it is crucial to keep in mind that psychological well-being can decline, particularly during high-intensity exercise. This implies that while the menstrual cycle may not directly affect an athlete's physical performance, it may affect their psychological performance, which in turn may affect how much they enjoy their entire athletic experience.[11]

Likewise, it was discovered that there were no statistically significant variations in the speed of sports women during the menstrual cycle, indicating that it had no discernible effect, notwithstanding the influence of menstrual phases and the biological alterations that take place within a woman's body.[12]

SPEED

Running is an excellent way to enhance physical fitness and improve mental, respiratory, cardiac, and muscular health. Additionally, it improves endurance, fitness, and

aids in weight loss. Additionally, when women run, they should consider the menstrual period, a crucial factor linked to hormonal and physiological changes in the body. Women experience different effects and symptoms during their menstrual period, including pain, mood swings, and fatigue. Consequently, this can affect running performance and endurance. Women's menstrual period can impact their energy and endurance levels, leading to physiological changes and movement. Women may have varying symptoms. During the menstrual period, some experience decreased energy levels, increased fatigue, and pain during exercise, resulting in reduced speed and intensity.[13]

A study on eleven sports players found that the menstrual cycle does not greatly affect body composition or physiological changes at rest, but it does impact running economy (RE). Different units were employed to measure RE, including oxygen consumption per kilogram of body weight per minute ml kg^{-1} min^{-1}), oxygen consumption per kilogram of body weight per kilometre (ml kg^{-1} km^{-1}), and the cost of a unit of calories per kilogram of body weight per kilometre (kcal kg^{-1} min^{-1}), as depicted in Table 1.

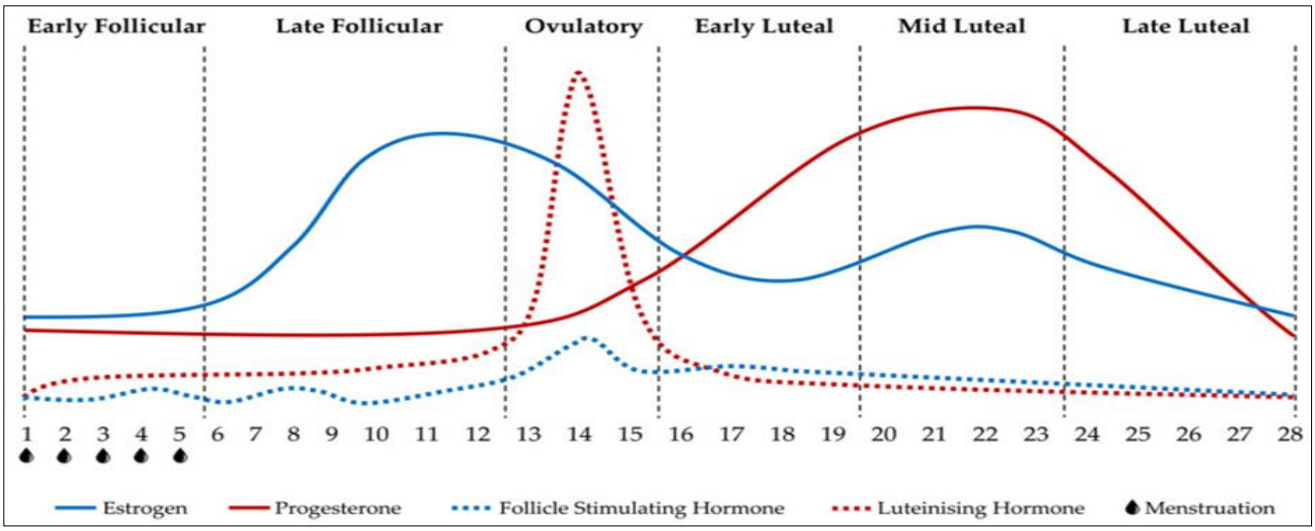

Figure 1: Hormonal events and phases in a eumenorrheic 28-day menstrual cycle.

Table 1: Depicts the variation in running economy across different speeds during the follicular and luteal phases.

Parameters	75% LT	85% LT	95% LT	Main effect of menstrual cycle phase	Main effect of speed	Menstrual cycle phase × speed interaction
ml kg^{-1} min^{-1}						
FP	33.1±5.5	36.5±6.7	41.5±7.4	P<0.05	P<0.01	P>0.05
LP	31.3±5.8	34.6±6.7	38.7±7.5			
ml kg^{-1} km^{-1}						
FP	218.2±35.6	212.5±33.8	215.7±29.5	P<0.05	P>0.05	P>0.05
LP	205.7±27.7	200.4±23.3	201.4±21.7			
kcal kg^{-1} min^{-1}						
FP	1.08±0.17	1.06±0.16	1.08±0.14	P<0.05	P>0.05	P>0.05
LP	1.03±0.14	1.00±0.11	1.01±0.11			

The study revealed that athletes performed better during the luteal phase (LP) than the follicular phase (FP), indicating heightened energy and oxygen efficiency. As the speed of exercise increased, the study found a significant increase in RE measured by oxygen consumption per minute. Additionally, there were no major distinctions in RE and different exercise velocities when evaluated based on oxygen consumption per meter and caloric unit cost. Based on the findings, it can be concluded that the menstrual cycle did not have a significant effect on exercise speeds for RE, but it did influence efficiency during LP.[14]

ENDURANCE

Endurance is crucial in sports performance, particularly in activities like cycling, swimming, jogging, and other endurance-based sports, as it determines a person's ability to sustain physical activity over a long period. The list now includes endurance-based sports, with a specific focus on understanding the relationship between women and their

menstrual cycle. The endurance ability can be affected by these changes and fluctuations in various ways, like cardiovascular function, body temperature, and muscle strength.[9]

Understanding the connection between the menstrual cycle and endurance is crucial for girls and trainers to comprehend the potential variations in performance and training adaptations during this period, despite hormonal and physiological changes. A study involved twenty individuals aged 20 to 30. It contained information about the three stages of the menstrual cycle. Measurements were taken of hormonal changes, such as FSH and LH, as well as muscle strength in anaerobic force and muscular endurance.

Even with hormonal and physiological changes during the menstrual cycle, there were no notable variations in muscle capacity for anaerobic force and muscular endurance. This also implies that the menstrual cycle does not restrict girls' physical abilities and there is no need to be concerned about decreased performance during menstruation.[1]

STRENGTH

In the realm of strength, women typically exhibit less muscle strength on average than their male counterparts. Strength training serves not only as a proactive measure for maintaining health but also as a means to alleviate musculoskeletal symptoms. The journey of muscular adaptations to exercise involves a myriad of intricately connected cellular and physiological mechanisms, with some influenced by an individual's biological sex.

When it comes to resistance exercise training (RET), both men and women experience gains in muscle size and strength. However, an intriguing hypothesis emerges, suggesting that sex might bestow divergent hypertrophic potential, influenced by hormonal disparities. Unlike men, whose sex hormone levels remain relatively stable day to day, women experience fluctuations throughout their menstrual cycle. This adds a layer of complexity when considering the impact of hormonal variations on women's responses to exercise.

Navigating the potential intricacies associated with accounting for hormonal fluctuations in women becomes pivotal, acknowledging the unique interplay between biological sex, hormonal dynamics, and the multifaceted journey of muscular adaptation to strength training.[15]

In three out of five reviews, it was concluded that the menstrual cycle phase does not significantly impact strength performance. Although McNulty and colleagues reported trivial effects on endurance and strength during different stages, only 35 out of 73 studies specifically investigated the relationship between the menstrual cycle and strength outcomes. Interestingly, 63% of these studies found no significant difference in strength outcomes between menstrual cycle phases, with notable trends observed when considering study quality. Notably, 90% of studies found no difference in strength performance between menstrual cycle phases.[16]

Moreover, some authors suggest greater gains in fat-free mass (FFM) and strength when training aligns with the post-menstrual phase coinciding with the FP. However, conflicting observations exist regarding neuromuscular differences across menstrual phases. Studies have reported a higher workload during the FP compared to the LP, along with various metabolic differences, including increased pulmonary ventilation and oxygen absorption at rest, reduced rates of gluconeogenesis and glycolysis, increased lipid production, and greater utilization of free fatty acids as an energy source.[16] Addressing the timing of training frequency, previous research indicated improved muscle hypertrophy and strength when resistance training (RT) is more frequent in the FP. However, in our study, the frequency of training by muscle group remained consistent across all menstrual phases, with no significant differences observed between groups. Undulating training, as explored in various studies, demonstrated positive effects on both performance and muscle hypertrophy.[17]

Additionally, it is noteworthy that the late follicular phase is considered optimal for peak performance in isometric maximal strength, while the late luteal phase, likely due to low estrogen levels, is less suitable. In contrast, dynamic maximal strength is most conducive during the late follicular phase, possibly due to elevated estrogen levels. The mid-luteal phase is considered the least suitable time for optimal muscle function, attributed to decreased estrogen levels and increased progesterone.[17]

ORAL CONTRACEPTIVE

Oral contraceptive pills (OCPs) are dual-action medications that reduce endogenous oestradiol and progesterone levels while also providing daily exogenous estrogen and progesterone supplementation throughout OCP use.[18] Hormonal contraceptives can be given to both nonathletes and athletes for a variety of reasons, including contraception, cycle regulation, amenorrhea treatment, painful menstruation, and bone density maintenance.[19]

This altered hormonal milieu is markedly different from that of eumenorrheic women and may have an impact on exercise performance due to changes in ovarian hormone-mediated physiological processes.[18]

The effects of female sex hormones on muscle strength and function and adaptation to resistance training are not well understood. Studies of hormone replacement therapy in postmenopausal women have confirmed the role of estrogen in maintaining muscle strength.[20] Sex hormones play an important role in adaptation to physical activity. Changes in their concentration in the blood caused by OCs may reduce the extent of this adaptation and thus worsen strength results.[21] However, studies on the influence of

natural MC on acute performance when assessing muscle strength and function have provided conflicting results. Several studies have reported significant differences in strength performance and muscle function during MC, while others observed no difference. Limited research on the potential effects of OC on muscle strength and function generally reports no differences in performance during the OC cycle.[20]

AGE AND MENOPAUSAL

Menopause, defined as the irreversible cessation of menstrual periods as a result of ovarian aging, can happen naturally, frequently between the ages of 42 and 58, or it can be caused by medical treatments. Menopause is divided into three stages: premenopausal, perimenopausal, and postmenopausal.[22,23] Menopause is linked with a reduction in skeletal muscle mass. Between perimenopause and the early stages of postmenopause, lean mass decreases.[24] Begins the year premenopause and lasts for an additional three years, after that, it somewhat slows down. The next four to eight years show a mild rate of bone loss. Half of the women are losing bone even more quickly during menopause, with a 20% loss in the 5 to 7 years surrounding menopause. The average decline in bone mineral density (BMD) during this time is approximately 10 percent. Bone loss rates and markers of bone resorption also indicate that approximately 25% of postmenopausal women are fast bone losers.[25] Reduced bone density, muscle mass, and strength, as well as a drop in estradiol levels, are all linked to the menopausal transition.[26]

Female athletes who put in a lot of physical effort during puberty run the risk of developing the female athlete triad (FAT), an adverse syndrome. It includes hormonal imbalances, the development of osteopenia or osteoporosis, and eating disorders accompanied by low energy. Several research endeavors have endeavored to assess the impact of exercise on the onset and progression of menopause. It has been observed that women who are involved in physical activity may experience delayed menopause.[27]

According to the study, there were 334 female participants between the ages of 45 and 65. They were purposely placed in a control group as well as a study group. The study group consisted of 148 women who were former elite athletes based on presumptive inclusion criteria: age range 45–65, female gender, consent to participate in the study, completion of the survey, and meeting the requirements of previous sports activity (no less than five years of training experience, championship-level participation in national or international competition, affiliation with a sports club as a competitor, and completion of sports training at least ten years before the study date). Aimed to determine whether participating in elite sports at a young age was correlated with one's current level of physical activity, a few selected sociometric characteristics, and the degree of menopausal symptoms in women going through perimenopause. This information will aid in understanding the benefits of participating in sports.

Sports participation alters the menstrual cycle and pubertal maturation, a phenomenon supported by numerous publications. Delays in puberty and later menarche are associated with a low proportion of adipose tissue, an inappropriate diet, and malnutrition. The age at the onset of the first menstrual cycle in the current study was 13.3 years, and there was no statistically significant difference in this regard between the study and control groups. This age corresponds to the menarche average for the European population. The level of physical activity that is present today is influenced by sports training in the past; female athletes who trained at a higher level now do so. Previous sports training did not distinguish between menopausal symptom severity.[27]

CONCLUSION

The menstrual cycle does not appear to have a significant impact on physical characteristics such as speed, strength, and endurance in women in Saudi Arabia. Understanding the hormonal fluctuations that occur throughout the menstrual cycle is important for athletes and trainers to optimize training adaptations and performance. Further research is needed to explore the relationship between the menstrual cycle and physical performance in women in Saudi Arabia.

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