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Review

Menstrual cycle and Exercise

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Abstract. Menstruation is the biological rhythm that women experience every 28±7 days. Menstruation is defined as an endometrial rash and continues from menarche to menopause. There are increasing and decreasing hormonal changes during this cycle. Ovarian follicles and hormones (estrogen and progesterone) secreted from the corpus luteum cause some cyclic changes in the endometrium. Changes in the wall of the uterus constitute the endometrial cycle, which is called the menstrual cycle or menstrual period.Exercise is a physical activity that affects many systems such as the heart and musculoskeletal system and the health and fitness of the individual. As it affects many systems, this cyclical event, which is performed regularly by women, is also effective on menstruation. Menstruation phases, exercise type, exercise duration and continuity, and exercise intensity affect this cycle. This review will evaluate how different exercises and intensity affect the menstrual cycle.

Key words: menstruation, exercise type, exercise intensity, exercise duration, sexual cycle

Introduction

What is biological rhythm?

Biological rhythm is the cyclical, biochemical, physiological and behavioral responses of many living things, from cyanobacteria to humans, against physical factors (1). Biological rhythms are divided into subgroups such as ultradian, circadian, infradian and circannual, considering cycle times. An example of an infradian rhythm that includes cycles over time periods of weeks or months is menstruation, which includes cyclic changes or monthly cycles seen in women (2). The menstrual cycle is one of the most important biological rhythm which is regulated by the hypothalamic-pituitary-ovarian axis and mainly influenced by follicle–stimulating hormone (FSH), luteinizing hormone (LH), progesterone and estrogen hormones (3).

Menstrual cycle

The menstrual cycle is characterized by the shedding of the functional layer of the endometrium during sexual maturity, which begins with menarche and ends with menopause. Regular periodic changes characterized by endometrial bleeding are called menstrual cycles (3). Menstruation is the reproductive process in which the upper two-thirds of the endometrium is discarded and rebuilt on a repetitive basis. The endometrium is ultimately a site of recurrent physiological damage and repair (4). Although periodic changes during the cycle affect many systems of the body, significant changes are seen in the genital system. The changes in the ovaries and endometrium are the most striking ones (4).

Each cycle, by definition, starts on the first day of menstrual bleeding and lasts until the beginning of the next bleed (5). The average menstrual bleeding time is 2–6 days and total blood loss is 20-60 cc (5). However,

as a result of the examination of many women with normal menstruation, it was reported that the average cycle time of adult women ranges between 21-35 days, although 28 days is accepted as average (6, 7).

Hormonal System in Women

The female hormonal system, like the male system, consists of three hormones in hierarchical order. These are:

1. Gonadotropin-releasing hormone (GnRH), a hypothalamic-releasing hormone
2. The anterior pituitary sex hormones, follicle-stimulating hormone (FSH) and luteinizing hormone (LH), are both secreted from the hypothalamus in response to GnRH release.
3. Ovarian hormones, estrogen and progesterone, are secreted from the ovaries in response to the two sex hormones from the anterior pituitary gland (8).

The secretion of these hormones varies sharply at different times in a woman's monthly sexual cycle. During the monthly sexual cycle, the amount of GnRH secreted from the hypothalamus also increases and decreases. However, these changes are not as abrupt as for the anterior pituitary sex hormones and ovarian hormones. The release of GnRH is pulsatile in women as well as in men and occurs in short releases every 90 minutes on average (8).

Menstruation phases

Follicular phase (Proliferation): Starts after menstrual bleeding and ends with the onset of the LH curve. This period is called the follicular phase due to changes in the ovary, and proliferation phase due to changes in the endometrium (9).

The follicular phase in humans lasts for an average of 10–14 days, and often the variability of the follicular phase duration is the factor that changes the total cycle duration (9).

Periovulatory phase: This is the period when LH rises and ovulation occurs (9).

Luteal phase (Secretion): This begins with the transformation of the follicle into the corpus luteum after ovulation, and ends with the onset of menstrual bleeding (9).

This period is called the luteal phase due to changes in the ovary and the secretion phase due to changes in the endometrium. The period from ovulation to the beginning of menstruation is 14 days on average (9).

Menstrual Phase: This is the endometrial bleeding period. After preparing for pregnancy during the menstrual cycle, the endometrium is discarded in the form of menstrual bleeding if pregnancy does not occur. Menstruation is a time of reorganization for future ovulation and possible pregnancy (6). Menstruation occurs at the end of the monthly ovarian cycle due to a decrease in estrogen and progesterone, especially progesterone.

During normal menstruation, 40 ml of blood plus 35 ml of serous fluid is lost. From 4-7 days after the start of menstruation, blood loss stops because the endometrium is re-epithelialized during this process (5).

Each menstrual cycle represents complex interactions between the hypothalamus, pituitary gland, ovaries, and endometrium. Cyclical changes in gonadotropin and steroid hormones cause functional as well as morphological changes in the ovaries, such as follicular maturation, ovulation, and corpus luteum formation. Similar changes at the endometrial level allow implantation of the developing embryo (8).

What is exercise?

Exercise is an action performed by the cardiovascular system, respiratory system and musculoskeletal system together (10). They are physical activities performed for fitness, physical performance and health. The human organism has a form suitable for exercise.

Today's changing living conditions can have negative effects on people's health. In order to correct the negative effects that may arise due to this decrease in

movement, advanced diagnosis and treatment methods based on science are required. Exercise changes lifestyle to move towards optimal health and is an important step in maximizing physical fitness (11).

Exercise Intensity

Although classified as mild, moderate or intense, exercise intensity uses percentage values of the VO_2max capacity of the individual or a certain ratio of the number of heartbeats, but the most effective classification is based on the exercise-lactic acid relationship. If there is no increase in blood-lactate level during exercise, it is called light or moderate exercise intensity, if the blood-lactate level is increased and is balanced, it is called high intensity exercise, and if it continuously increases without balancing, it is called severe exercise intensity (12).

Women's health and exercise

Improvement of muscle strength and attaining optimal performance capacity in female athlete are great important. Especially exercise intently becomes determinant factor on potential negative effects of exercise and menstrual cycle (13).

According to the literature, it was reported that the greatest contribution of exercise was in the psychological field in a study conducted on women who exercise. Physical activity improves aerobic performance, cardiovascular endurance, muscle strength and flexibility, and body composition. Despite the increase of oxidative stress, exercise has many beneficial effects on body systems including cardiac respiratory and energy regulatory hormones in young females (14). In addition, it reduces anxiety, increases self-confidence and self-respect.

As a result, exercising for 30-60 minutes three times a week (at one day intervals) positively contributes to women's heart health, pregnancy, recovery from obesity and their psychological health (15). The exercise and the menstrual cycle is a complex condition and their effects on physiological functions of the body systems are become great interest (16, 17). It will be valuable to improvement of our understanding the impact of menstrual cycle on body metabolic system and exercise performance (18).

Acute exercise during menstruation

Individuals participating in maximal treadmill exercise during the early follicular (EF), late follicular (LF) and middle luteal (ML) phases of menstruation were studied for ventilation and blood lactate responses. In this study in the literature, VO_2 max, V_E max, VCO_2 max, blood lactate and depletion times after exercise were similar during menstruation. It was concluded that, with the exception of the relative ventilation threshold, the metabolic and performance variables measured during maximal treadmill exercise are not dependent on menstrual phases (19, 20). In addition, menstrual cycle has been shown no significant effects on blood lactate concentration and cardiopulmonary variables (21).

Anaerobic power measurement results in menstruation and normal periods were found to be close to each other. It was reported that there are no negative findings in terms of anaerobic performance in the menstrual period (22). In addition, performing an aerobic exercise for 8 weeks' period provide good medications for primary dysmenorrhea (23). Various respiratory function parameters (FVC, FEV1, PEFR, FEF 25-75%) were recorded during the menstrual phase, follicular phase, and luteal phase with a spirometer under resting conditions and within five minutes after cessation of isometric exercise. There was no statistically significant difference between the various respiratory function parameters during the three phases. In all stages after the isometric exercise, a significant decrease was only reported for peak expiratory flow rate (PEFR), but a non-significant decrease was reported for other parameters (24). Improvement of cardiorespiratory system efficiency in luteal phase of menstrual cycle in normal weight subjects performing aerobic exercise (25).

Acute high intensity resistance exercise increases arterial stiffness. It was reported that changes in blood concentrations of estrogen and progesterone associated with the menstrual cycle affect the degree of arterial stiffness. Therefore, high-intensity resistance exercise was reported to affect arterial stiffness differently depending on the phase of the menstrual cycle. During the follicular phase, the brachial-ankle pulse wave velocity increased significantly from baseline 30 and 60 minutes after resistance exercise, while a significant difference was reported immediately after resistance exercise in the luteal phase. As a result, high-intensity resistance exercise affects arterial stiffness differently depending on the phase of the menstrual cycle (26).

Premenstrual syndrome is one of the most common problems that can interfere with women's daily life. Symptoms such as bloating, headache, fatigue, dizziness, breast tenderness, cramps, and pain may be present. Regular aerobic exercise for 8 weeks in people with premenstrual syndrome causes a significant reduction in some of the physical symptoms of the syndrome. Therefore, a regular exercise program is recommended for all women of reproductive age (26). In a study conducted among nurses with primary dysmenorrhea, it was concluded that stretching exercises were effective in reducing pain intensity. In other words, selected muscle stretching exercises were suggested for use as a non-pharmacological method of pain relief in dysmenorrhea (27). After acute resistance exercise training in women, an increase in central artery stiffness and a decrease in peripheral artery stiffness were found. It was suggested that the menstrual cycle phase may not affect changes in arterial stiffness in response to acute resistance exercise (28). Physiological relaxation training applied during menstruation reduces the severity of pain (29).

Given the overall health benefits of exercise and the relatively low risk of side effects reported in the general population, it was reported that women may consider exercising alone or in combination with other methods such as non-steroidal anti-inflammatory drugs to reduce menstrual pain (30).

A study was conducted of women trained in eccentric exercise to evaluate whether the menstrual cycle and its underlying hormonal fluctuations affect muscle damage and inflammation. Blood markers of muscle damage and inflammation were reported in the early follicular phase, late follicular phase, and middle luteal phase of the menstrual cycles (in an eccentric squat-based exercise program) and were not affected by the menstrual cycle. Only the middle luteal phase reflected a possible inflammatory response for interleukin-6 (31). Higher estrogen levels in this phase could be reason for his protective effects (32, 33).

Chronic exercise in menstruation

The literature shows that fluctuations in female reproductive hormones throughout the menstrual cycle do not affect muscle contraction properties. Most studies reported that many determinants of VO_2max, such as lactate response to exercise, body weight, plasma volume, hemoglobin concentration, heart rate, and ventilation, did not undergo any changes in the menstrual cycle. Therefore, it is not surprising that the literature shows that VO_2max is not affected by the menstrual cycle. These findings suggest that regularly menstruating female athletes competing in strength-specific and intense anaerobic / aerobic sports do not need to adjust training to the menstrual cycle phase to maximize performance. However, for long-term exercise performance, the menstrual cycle was thought to have an effect (34).

In a study of moderate intensity long-term exercise, three phases of the menstrual cycle characterized by very different estrogen-progesterone concentrations were compared. No difference was observed in whole body carbohydrate or lipid oxidation. Although the intensity of exercise was increased in the luteal phase compared to both follicular phases, there was no difference in glucose and insulin concentrations during the cycle phases (35).

Hormonal differences based on gender of the subjects causes different physiologic changes in respiratory system (36). In a study investigating whether there is a relationship between the menstrual cycle phase and exercise-induced bronchoconstriction (EIB) in female athletes with mild atopic asthma, there was a negative correlation between the percentage change in FEV 1 (maximum value in forced expiratory volume) before and after exercise and the salivary progesterone

concentration. However, no such correlation was found between salivary estradiol and the percentage change in FEV 1 before and after exercise. For the first time, it was demonstrated that menstrual cycle phase is an important determinant of the severity of EIB (exercise-induced bronchoconstriction) in female athletes with mild atopic asthma. In other words, it was emphasized that asthmatic female athletes should adjust their training and competition programs according to their menstrual cycles and consider the potential negative effects of the luteal phase of the menstrual cycle on exercise performance (37).

In temperate conditions, while there is no change in long-term exercise performance during the menstrual cycle, it was found that exercise performance decreased in hot and humid conditions, especially in the luteal phase (38). Students with high levels of physical activity had less menstruation time and daily pad count, and the incidence of dysmenorrhea and polymenorrhea was lower than for students with low physical activity levels (39).

In a study to evaluate the effectiveness of treadmill-based aerobic exercise on pain and symptoms of primary dysmenorrhea, 70 women with primary dysmenorrhea received 4 weeks of controlled aerobic exercise training, followed by 6 months of home exercise. Pain, quality of life and sleep parameters were evaluated. As a result of the study, the current pain was significantly reduced. It was reported that the important benefits of quality of life and exercise last for 7 months (40).

Comparison of exercises with different intensity

Attempts were made to determine the effect of ovarian hormone levels associated with the early follicular and midluteal phases of the menstrual cycle on maximal and submaximal exercise performance at sea level (SL) and acute altitude (AA). Although progesterone levels increased significantly during the middle luteal phase, exercise minute ventilation was not reported to increase at SL or AA. Moreover, neither maximal nor submaximal exercise performance was affected by the menstrual cycle phase in SL or during AA exposure. This study also reported that resting minute ventilation was increased in the middle luteal phase, but resting chemosensitivity was not affected by the cycle phase in SL. It has been reported that minute ventilation and physical performance at acute altitude are not affected by the menstrual cycle phase (41). However, exercise performed under the acute hypobaric-hypoxic condition may cause alteration of menstrual cycle induced ventilatory response (42)

Submaximal exercise was performed in cases after one night sleep deprivation during the follicular and luteal phases. In this case, it did not cause changes in cardiorespiratory responses on spirometric parameters (43). In a study in the literature, low, medium and high intensity exercises were performed. The evaluation parameters in this study were maximum vital capacity (FVC), maximum voluntary ventilation capacity (MVV) and lipid profile (HDL, LDL, TGL). While LDL levels did not change with both medium-intensity and high-intensity aerobic exercise, a significant improvement was observed in HDL, TGL VO_2 max, FVC, and MVV levels. These parameters remained significantly unchanged with low intensity aerobic exercise (44). Performing moderate intensity aerobic exercise under the condition of early follicular, midfollicular and midluteal phase of menstrual cycle did not have any significant effects of substrate utilization (45).

Conclusions

Interest has increased widely in recent years concerning physiological changes during menstrual cycle and exercise performance. There are a lot of conflicting results with regarding hormonal fluctuation and their impact on energy levels and performance.

In the late follicular and mid-luteal phase of the menstrual cycle, estrogen levels become higher. Thus, estrogen is thought to have valuable protective effects against exercise induced muscle damaged, muscle soreness and inflammation.

Despite the controversy among the studies, there is no strong evidence that menstrual cycle has significant changes on VO_2max, lactate, ventilation, heart rate, haemoglobin levels.

Further studies need to understand the effects of menstrual cycle on exercise performance and body metabolic systems.

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