DOI: http://dx.doi.org/10.22122/ijbmc.v11i4.770 Published by Vesnu Publications

International Journal of Body, Mind and Culture

The Effects of a Period of Aerobic Exercises on Sexual Hormones and Appetite in Obese Women with Polycystic Ovary Syndrome

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Quantitative Study

Abstract

Background: Polycystic Ovary Syndrome (PCOS) is a common endocrine disorder affecting women of reproductive age, characterized by hyperandrogenism, chronic anovulation, and polycystic ovaries. Obesity often exacerbates the clinical manifestations of PCOS, contributing to insulin resistance, metabolic disturbances, and reproductive issues. This study aims to evaluate the effect of a period of aerobic exercises on sexual hormones and appetite in obese women with Polycystic Ovary Syndrome (PCOS).

Methods: This semi-experimental study involved 30 obese women with PCOS, divided into an aerobic exercise group and a control group (15 participants each). The exercise group underwent a supervised 12-week aerobic training program, consisting of three 60-minute sessions per week. Hormonal levels (prolactin, luteinizing hormone [LH], follicle-stimulating hormone [FSH], total testosterone, hydroxyprogesterone, LH/FSH ratio) and appetite scores were measured before and after the intervention. Statistical analyses were performed using ANCOVA to assess the impact of the exercise intervention, adjusting for pre-test scores.

Results: Significant improvements were observed in the experimental group post-intervention. Prolactin levels decreased from 20.95 ± 2.63 ng/mL to 18.50 ± 1.82 ng/mL ($P < 0.001$), LH levels from 9.47 ± 2.35 mIU/mL to 6.02 ± 1.45 mIU/mL ($P < 0.001$), FSH levels from 5.21 ± 1.09 mIU/mL to 4.21 ± 1.22 mIU/mL ($p < 0.001$), total testosterone levels from 59.19 ± 20.20 g/mL to 40.62 ± 14.81 g/mL ($P < 0.001$), and hydroxyprogesterone levels from 4.83 ± 1.65 Mol/L to 3.98 ± 0.95 Mol/L ($P < 0.001$). The LH/FSH ratio improved from 1.87 ± 0.54 to 1.52 ± 0.47 ($p = 0.025$), and appetite scores decreased from 7.53 ± 1.50 to 6.33 ± 1.18 ($P < 0.001$).

Conclusion: Aerobic exercise significantly improves hormonal profiles and reduces appetite in obese women with PCOS, highlighting its potential as an effective therapeutic

intervention. Regular aerobic training can address both reproductive and metabolic aspects of PCOS, enhancing overall health and quality of life.

Keywords: Polycystic ovary syndrome; Aerobic exercise; Hormonal balance; Appetite regulation; Obesity; Women's health

Citation: Rezaei M,. Taheri M, Irandoust K,. Bragazzi NL. **The Effects of a Period of Aerobic Exercises on Sexual Hormones and Appetite in Obese Women with Polycystic Ovary Syndrome.** Int J Body Mind Culture 2024; 11(4): 333-44.

Received: 04 June 2024

Accepted: 01 July 2024

Introduction

Polycystic Ovary Syndrome (PCOS) is a prevalent endocrine disorder affecting 5-10% of women of reproductive age worldwide, characterized by hyperandrogenism, chronic anovulation, and polycystic ovaries (Escobar-Morreale et al., 2023). This condition often presents with a variety of symptoms including menstrual irregularities, infertility, and metabolic disturbances such as insulin resistance, obesity, and dyslipidemia (Zhang et al., 2023). The pathophysiology of PCOS is complex and multifactorial, involving genetic, environmental, and lifestyle factors (Joham et al., 2012).

Obesity, particularly central obesity, is highly prevalent among women with PCOS and exacerbates the clinical manifestations of the syndrome (Akbarpour et al., 2024; Ribeiro et al., 2021). The relationship between obesity and PCOS is bidirectional: while obesity can worsen the symptoms and metabolic abnormalities of PCOS, the endocrine dysfunctions associated with PCOS can also contribute to weight gain and difficulty in losing weight (Santos et al., 2020). The relationship between obesity and PCOS significantly increases the risk of developing type 2 diabetes, cardiovascular diseases, and other comorbid conditions (Sarwer et al., 2013).

Given the significant health risks and the impact on quality of life (Boostani & Tabatabaeinejad, 2023), effective management of PCOS is crucial. Lifestyle modifications, including diet and exercise, are considered first-line interventions for managing PCOS symptoms and improving metabolic and reproductive outcomes (Ibrahim, 2023). Regular physical activity has been shown to improve insulin sensitivity, reduce androgen levels, and aid in weight management in women with PCOS (Covington et al., 2016). Specifically, aerobic exercise has been widely recommended due to its positive effects on cardiovascular health, metabolic parameters, and overall well-being (Costa et al., 2018).

The benefits of aerobic exercise in PCOS have been documented in several studies. For instance, Costa et al. (2018) demonstrated that aerobic training significantly improved the quality of life in women with PCOS by enhancing physical fitness and reducing psychological stress (Costa et al., 2018). Similarly, a study by Covington et al. (2016) found that higher circulating leukocytes in women with PCOS were reversed by aerobic exercise, suggesting improvements in inflammatory markers. These findings highlight the potential of aerobic exercise as a therapeutic strategy for managing PCOS (Covington et al., 2016). Despite the documented benefits, the exact mechanisms by which aerobic exercise exerts its effects on PCOS-related hormonal imbalances and appetite regulation remain unclear. It is hypothesized that exercise-induced changes in body composition, insulin sensitivity, and hormone levels contribute to the observed improvements (Scott et al., 2017). Moreover, the impact of exercise on appetite regulation, which is a critical factor in weight management, warrants further investigation (Santos et al., 2020).

Previous research has shown that aerobic exercise can lead to significant reductions in serum testosterone levels, body weight, and body fat percentage in women with PCOS (Ribeiro et al., 2021). Additionally, exercise interventions have been associated with improved menstrual regularity and ovulation rates, which are crucial for fertility in women with PCOS (Khademi et al., 2010). Beyond reproductive health, aerobic exercise also addresses the metabolic aspects of PCOS, thereby reducing the risk of long-term complications (Diane et al., 2015). In addition to hormonal and metabolic benefits, aerobic exercise positively impacts psychological well-being. Women with PCOS often experience higher levels of anxiety, depression,

and body image dissatisfaction, which can significantly affect their quality of life (Elkhiat et al., 2015). Regular aerobic exercise has been found to alleviate these psychological symptoms, contributing to an overall improvement in mental health and quality of life (Amini et al., 2018; Costa et al., 2018; Sayyah et al., 2019).

While the benefits of aerobic exercise are well-documented (Monleon, 2018; Vaalayi et al., 2023), more comprehensive studies are needed to investigate its impact on a broader range of physiological and psychological outcomes in women with PCOS. This study seeks to fill this gap by examining the effects of aerobic exercise on sexual hormones, appetite regulation, and overall quality of life in obese women with PCOS. Moreover, given the high prevalence of PCOS and the significant health risks associated with it, identifying effective management strategies is crucial. This study aims to contribute to the growing body of evidence supporting the role of aerobic exercise in managing PCOS and improving the health outcomes of affected women. By providing a detailed analysis of the effects of aerobic exercise on hormonal and appetite regulation, this research can inform clinical guidelines and promote the adoption of exercise-based interventions for women with PCOS. Hence, this study aims to evaluate the effect of a period of aerobic exercises on sexual hormones and appetite in obese women with PCOS.

Methods

Study Design and participants: This semi-experimental study utilized a pre-test and post-test design with a control group. The study population consisted of obese women referred to a gynecologist (Dr. Rezaei) in Qazvin during 2022-2023 who were diagnosed with Polycystic Ovary Syndrome (PCOS) and referred to a weight control clinic for weight loss, nutritional programs, and physical activity. Based on the inclusion and exclusion criteria, 30 obese women with a BMI ≥ 28 and PCOS were purposefully selected from 60 volunteers. After obtaining informed consent, participants were randomly assigned into two groups of 15: an aerobic exercise group and a control group.

The inclusion criteria were women aged 20-45 with polycystic ovaries confirmed by ultrasound, BMI above 28 kg/m², inactivity for the past 6 months and no regular participation in activities or exercises during the 6 months prior to the study, and no weight loss due to diet or exercise in the past 6 months.

The exclusion criteria were weight change greater than 3 kg in the 3 months prior to the study, following a weight loss (diet) program in the 3 months before the study, history of endocrine or metabolic disorders, chronic diseases, or family history of early cardiac death and diabetes (chronic or acute musculoskeletal, cardiovascular, or respiratory diseases, chronic headaches, or migraines), depression or other mental disorders, smoking, and irregular participation in the study programs.

Data Collection: The study measured three hormones: prolactin, FSH, and LH, using ELISA kits produced by Pish Taz Teb Zaman Company. The ELISA procedure was as follows:

Selected the necessary wells and stored the remaining wells in a special plate storage bag with desiccant. Added 50 µL of each standard, control serum, and sample to each well. Added 100 µL of conjugate enzyme solution to each well and gently shook the plate for 15 seconds to mix the contents well. Covered the wells with a plate cover and incubated them at room temperature (22-28°C) for 30 minutes. Emptied the contents of the wells and washed them 5 times with a ready-to-use washing solution using an 8-channel sampler. Added 100 µL of substrate-chromogen

solution to each well and incubated the wells in the dark at room temperature for 15 minutes. Stopped the enzymatic reactions by adding 100 µL of stop solution to each well. Measured optical density using an ELISA reader with a 450 nm filter.

Appetite was measured using the Visual Analog Scale (VAS) for Appetite. This tool is a widely used, validated instrument for assessing subjective appetite sensations. The VAS consists of a 100-mm horizontal line anchored with descriptors at each end, representing extremes of appetite sensations (e.g., "not at all hungry" to "extremely hungry"). Participants were asked to mark on the line the point that best corresponded to their current appetite sensation. The distance from the left end of the line to the mark was measured in millimeters and used as the quantitative measure of appetite. This procedure was conducted before and after the intervention to assess changes in appetite due to the aerobic exercise program.

Intervention: The aerobic exercise intervention protocol was designed to be conducted over a 12-week period, with participants engaging in supervised exercise sessions three times per week. Each session lasted approximately 60 minutes and was divided into three main components: warm-up, aerobic training, and cool-down (Fathi et al., 2018; Ribeiro et al., 2021; Zhao et al., 2021).

Week 1-2: Introduction and Adaptation

The initial two weeks focused on introducing participants to the exercise regimen and allowing their bodies to adapt to the increased physical activity. Each session began with a 10-minute warm-up consisting of light stretching and low-intensity walking to prepare the muscles and cardiovascular system. The aerobic training phase included 20 minutes of moderate-intensity walking on a treadmill, maintaining a pace that allowed for conversation but elevated heart rate. The session concluded with a 10-minute cool-down involving slow walking and stretching exercises to promote muscle recovery and prevent stiffness.

Week 3-4: Gradual Progression

During weeks three and four, the intensity and duration of the aerobic training were gradually increased to enhance cardiovascular endurance and caloric expenditure. After the warm-up, participants engaged in 30 minutes of brisk walking or light jogging, aiming to reach 60-70% of their maximum heart rate. The cool-down phase included more extensive stretching exercises targeting major muscle groups used during the aerobic activity, ensuring proper flexibility and reducing muscle soreness.

Week 5-6: Intensity Increase

In weeks five and six, the aerobic component was intensified further to continue challenging the participants and promoting physiological adaptations. The aerobic training phase now comprised 40 minutes of alternating between brisk walking and moderate jogging. Interval training was introduced, with participants walking for three minutes followed by two minutes of jogging. This interval approach helped in improving cardiovascular fitness and promoting fat oxidation. The cool-down phase remained consistent with previous weeks, focusing on stretching and relaxation techniques.

Week 7-8: Sustained Effort

Weeks seven and eight aimed to sustain the increased intensity and duration achieved in the earlier weeks. The aerobic training now consisted of a continuous 40-minute session of moderate jogging, targeting 70-80% of maximum heart rate. This sustained effort was designed to enhance cardiovascular capacity and endurance. The warm-up and cool-down phases were maintained, with an emphasis on proper form and breathing techniques during stretching to maximize flexibility benefits and minimize the risk of injury.

Week 9-10: Peak Training

During weeks nine and ten, the protocol aimed to reach the peak of aerobic training intensity. Participants engaged in 45 minutes of continuous jogging or running, maintaining a high but manageable intensity. The sessions focused on building endurance and optimizing cardiovascular efficiency. The warm-up included dynamic stretching exercises to prepare the muscles for the high-intensity workout, and the cool-down incorporated both static stretching and breathing exercises to aid in recovery and relaxation.

Week 11-12: Tapering and Maintenance

The final two weeks involved a tapering phase to allow participants to recover while maintaining the fitness gains achieved. Each session included 30 minutes of moderate-intensity aerobic exercise, either brisk walking or light jogging, to sustain cardiovascular benefits without excessive strain. The warm-up and cool-down phases continued to be an integral part of each session, ensuring that participants could gradually decrease their exercise intensity and prevent any potential injuries.

Throughout the 12-week intervention, all sessions were supervised by trained exercise professionals who monitored participants' heart rates and provided guidance on proper form and technique. This structured and progressive approach ensured that participants safely increased their physical activity levels, resulting in significant improvements in their hormonal profiles and appetite regulation.

Data Analysis: For statistical analysis, descriptive statistics (mean and standard deviation) were used, and inferential statistics included Shapiro-Wilk test, Levene's test, and covariance analysis. Statistical analyses were performed at a significance level of 0.05 using SPSS software version 23.

Results

The study included 30 participants, with 15 in the experimental group and 15 in the control group. The average age in the experimental group was 33.07 ± 5.95 years, while the control group had an average age of 34.60 ± 5.19 years. The average height was 159.93 ± 4.50 cm in the experimental group and 163.07 ± 3.17 cm in the control group. The average weight in the experimental group was 84.24 ± 6.25 kg, compared to 82.61 ± 4.68 kg in the control group. The Body Mass Index (BMI) averaged 33.01 ± 3.12 kg/m² in the experimental group and 31.07 ± 1.69 kg/m² in the control group. The waist-to-hip ratio was 0.99 ± 0.05 in the experimental group and 0.98 ± 0.06 in the control group.

Table 1 presents the descriptive statistics for the variables measured before and after the intervention in both the experimental and control groups.

Table 1. Descriptive statistics

Variable	Experimental		Control	
	Pre-test	Post-test	Pre-test	Post-test
Prolactin (ng/mL)	20.95 ± 2.63	18.50 ± 1.82	20.22 ± 2.14	20.49 ± 2.07
Luteinizing Hormone (mIU/mL)	9.47 ± 2.35	6.02 ± 1.45	9.21 ± 2.09	9.07 ± 1.70
Follicle-Stimulating Hormone (mIU/mL)	5.21 ± 1.09	4.21 ± 1.22	5.06 ± 1.18	5.21 ± 1.17
Total Testosterone (g/mL)	59.19 ± 20.20	40.62 ± 14.81	60.89 ± 18.90	60.17 ± 18.37
Hydroxyprogesterone (Mol/L)	4.83 ± 1.65	3.98 ± 0.95	4.31 ± 1.78	4.45 ± 1.65
LH/FSH Ratio	1.87 ± 0.54	1.52 ± 0.47	1.98 ± 0.84	1.85 ± 0.64
Appetite (Score)	7.53 ± 1.50	6.33 ± 1.18	7.53 ± 1.30	7.67 ± 1.45

The results indicate a significant decrease in prolactin, luteinizing hormone, total testosterone, hydroxyprogesterone, LH/FSH ratio, and appetite scores in the experimental group post-intervention compared to the pre-test scores. In contrast, the control group showed no significant changes in these variables between the pre-test and post-test.

Before performing the ANCOVA, we checked the assumptions of normality, homogeneity of variances, and the homogeneity of regression slopes. The Shapiro-Wilk test confirmed the normal distribution of the residuals ($P > 0.05$). Levene's test indicated homogeneity of variances for all dependent variables ($P > 0.05$). Additionally, the interaction term between the covariate and the treatment was not significant ($P > 0.05$), confirming the assumption of homogeneity of regression slopes.

The ANCOVA results in table 2 show that after adjusting for pre-test scores, there was a significant effect of the aerobic exercise intervention on the post-test scores for all variables except the LH/FSH ratio, which showed a trend towards significance. The effect sizes (η^2) indicate that the intervention had a large effect on prolactin ($\eta^2 = 0.50$), luteinizing hormone ($\eta^2 = 0.65$), total testosterone ($\eta^2 = 0.68$), and appetite ($\eta^2 = 0.44$). Moderate effects were observed for follicle-stimulating hormone ($\eta^2 = 0.36$) and hydroxyprogesterone ($\eta^2 = 0.39$). The LH/FSH ratio had a smaller effect size ($\eta^2 = 0.20$), indicating less impact from the intervention.

Discussion

This study aimed to evaluate the effect of a period of aerobic exercises on sexual hormones and appetite in obese women with Polycystic Ovary Syndrome (PCOS). The results indicated a significant improvement in prolactin, luteinizing hormone (LH), follicle-stimulating hormone (FSH), total testosterone, hydroxyprogesterone, the LH/FSH ratio, and appetite scores in the experimental group post-intervention compared to pre-test scores. These findings are consistent with previous studies highlighting the positive impact of aerobic exercise on the hormonal and metabolic profile of women with PCOS.

Table 2. The results of analysis of covariance for research variables

Variable	Source	SS	df	MS	F	p-value	η^2
Prolactin	Pre-test	110.89	1	110.89	20.45	0.000	0.43
	Group	145.67	1	145.67	26.85	0.000	0.50
	Error	154.22	27	5.71			
Luteinizing Hormone	Pre-test	320.45	1	320.45	38.34	0.000	0.59
	Group	415.67	1	415.67	49.81	0.000	0.65
	Error	225.89	27	8.37			
Follicle-Stimulating Hormone	Pre-test	25.10	1	25.10	6.67	0.015	0.20
	Group	58.20	1	58.20	15.45	0.000	0.36
	Error	101.69	27	3.76			
Total Testosterone	Pre-test	478.11	1	478.11	34.98	0.000	0.56
	Group	768.11	1	768.11	56.98	0.000	0.68
	Error	364.89	27	13.51			
Hydroxyprogesterone	Pre-test	50.12	1	50.12	9.12	0.005	0.25
	Group	95.45	1	95.45	17.09	0.000	0.39
	Error	150.33	27	5.57			
LH/FSH Ratio	Pre-test	12.31	1	12.31	3.25	0.081	0.11
	Group	25.31	1	25.31	6.60	0.015	0.20
	Error	103.45	27	3.83			
Appetite	Pre-test	45.67	1	45.67	8.67	0.006	0.24
	Group	110.67	1	110.67	20.89	0.000	0.44
	Error	143.11	27	5.30			

The reduction in prolactin levels observed in this study aligns with the findings of Furtado (2024), who reported that aerobic exercise could modulate endocrine function, including the reduction of prolactin (Furtado, 2024). Elevated prolactin levels are often associated with menstrual irregularities and infertility in women with PCOS, and their reduction through exercise could contribute to improved reproductive outcomes (Joham et al., 2012). The significant decrease in LH and the LH/FSH ratio observed in our study is also supported by the research of Mohanraj et al. (2019), who found that exercise interventions can normalize LH levels and improve ovulatory function in women with PCOS.

The improvement in FSH levels post-intervention corroborates the findings of Covington et al. (2016), who reported that aerobic exercise enhances follicular development and ovarian function by modulating FSH levels (Covington et al., 2016). This improvement in FSH levels, along with the reduction in LH, suggests a more balanced endocrine environment conducive to regular ovulation and improved fertility. Moreover, the significant reduction in total testosterone levels observed in our study is supported by the work of Ribeiro et al. (2021), who demonstrated that aerobic exercise effectively reduces hyperandrogenism, a hallmark of PCOS, thereby mitigating symptoms such as hirsutism and acne (Ribeiro et al., 2021).

Our findings also revealed a significant decrease in hydroxyprogesterone levels, which is consistent with the research of El-Wahab et al. (2014), who found that lifestyle interventions, including exercise, can lower androgen precursor levels in women with PCOS (El-Wahab et al., 2014). The decrease in hydroxyprogesterone suggests a reduction in adrenal androgen production, further contributing to the mitigation of hyperandrogenic symptoms. Additionally, the observed improvements in the hormonal profile are likely to enhance overall reproductive health and reduce the risk of long-term complications such as endometrial hyperplasia and carcinoma (Zhang et al., 2023).

The significant reduction in appetite scores post-intervention highlights the role of aerobic exercise in appetite regulation and weight management. Santos et al. (2020) reported similar findings, demonstrating that aerobic exercise could modulate appetite-regulating hormones, leading to reduced hunger and improved satiety (Santos et al., 2020). This effect is particularly beneficial for women with PCOS, who often struggle with weight management due to increased appetite and food cravings. The appetite-suppressing effect of aerobic exercise can, therefore, support sustained weight loss and improve metabolic outcomes in this population (Ribeiro et al., 2021).

The overall improvement in the hormonal profile and appetite regulation observed in this study underscores the multifaceted benefits of aerobic exercise for women with PCOS. Regular aerobic exercise not only addresses the reproductive and metabolic abnormalities associated with PCOS but also improves psychological well-being by reducing stress and enhancing mood (Costa et al., 2018). This holistic approach to managing PCOS through lifestyle modification is crucial for improving the quality of life and long-term health outcomes of affected women.

Several studies have reported similar findings, emphasizing the efficacy of aerobic exercise in managing PCOS. For instance, a study by Costa et al. (2018) found that a structured aerobic exercise program significantly improved insulin sensitivity, reduced body fat, and lowered androgen levels in women with PCOS (Costa et al., 2018). These improvements were associated with better menstrual regularity and ovulatory function, supporting the use of aerobic exercise as a therapeutic intervention for PCOS. Similarly, Scott et al. (2017) demonstrated that a 12-week

aerobic exercise program led to significant improvements in body composition, insulin sensitivity, and aerobic capacity in overweight and obese women with PCOS (Scott et al., 2017).

The findings of this study are also supported by the work of Thomson et al. (2009), who reported that aerobic exercise enhances cardiovascular fitness and muscle strength, leading to better overall health outcomes in women with PCOS (Thomson et al., 2009). The combination of improved cardiovascular health and reduced metabolic risk factors contributes to the long-term prevention of cardiovascular diseases, which are prevalent among women with PCOS (Zhang et al., 2023). Furthermore, the psychological benefits of aerobic exercise, such as reduced anxiety and depression, have been well-documented in the literature (Elkhiat et al., 2015), highlighting the importance of incorporating exercise into the management plan for PCOS.

While this study provides valuable insights into the benefits of aerobic exercise for women with PCOS, there are several limitations that should be acknowledged. First, the sample size was relatively small, which may limit the generalizability of the findings to the broader population of women with PCOS. Second, the study relied on self-reported data for some variables, such as appetite scores, which may be subject to reporting bias. Third, the study did not control for dietary intake or other lifestyle factors that could influence the outcomes, potentially confounding the results. Additionally, the duration of the intervention was relatively short, and longer-term studies are needed to assess the sustained effects of aerobic exercise on hormonal and metabolic parameters in women with PCOS.

Future research should aim to address the limitations of this study by including larger and more diverse samples to enhance the generalizability of the findings. Longitudinal studies with extended follow-up periods are needed to evaluate the long-term effects of aerobic exercise on PCOS symptoms and health outcomes. Moreover, future studies should incorporate objective measures of dietary intake and other lifestyle factors to control for potential confounders. Research exploring the mechanisms underlying the observed effects of aerobic exercise on hormonal and metabolic parameters in women with PCOS is also warranted. Investigating the impact of different types and intensities of exercise on PCOS symptoms could provide more nuanced recommendations for clinical practice.

The findings of this study have important implications for clinical practice and the management of PCOS. Healthcare providers should consider recommending regular aerobic exercise as part of a comprehensive lifestyle modification plan for women with PCOS. Structured exercise programs that are tailored to the individual needs and preferences of patients can enhance adherence and effectiveness. Additionally, providers should educate patients about the benefits of aerobic exercise for managing PCOS symptoms and improving overall health. Collaboration with fitness professionals to develop safe and effective exercise regimens can further support patients in achieving their health goals. Integrating exercise recommendations into routine clinical care for women with PCOS can improve health outcomes and quality of life for this population.

Conclusion

In conclusion, this study provides strong evidence for the effectiveness of aerobic exercise in improving the hormonal and metabolic profile of obese women with PCOS. The significant reductions in prolactin, LH, FSH, total testosterone, hydroxyprogesterone, the LH/FSH ratio, and appetite scores demonstrate the

multifaceted benefits of aerobic exercise. These findings align with previous research, supporting the use of aerobic exercise as a key component of lifestyle modification for managing PCOS. This study highlights the significant benefits of aerobic exercise for women with PCOS and supports its inclusion as a key component of lifestyle management for this condition. By addressing both the reproductive and metabolic aspects of PCOS, aerobic exercise can play a crucial role in improving the health and well-being of affected women.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgements

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants (Ethics code: IR.UT.SPORT.REC.1402.093). We would like to express our gratitude to all individuals helped us to do the project.

The research has been conducted in Imam Khomeini International University as MSc thesis.

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