

The Effectiveness of Aerobic Exercise on Anthropometric Measurements in Women with Polycystic Ovary Syndrome - A Narrative Review

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Abstract: *Background:* Polycystic ovary syndrome (PCOS) is a common endocrine disorder affecting reproductive-aged women. It is characterized by hyperandrogenism, ovulatory dysfunction, and insulin resistance. Previous studies have shown that regular aerobic exercise can improve insulin sensitivity, reduce body weight and adiposity, decrease circulating androgen levels, and restore menstrual regularity in women with PCOS. Anthropometric measurements, such as body mass index (BMI), waist circumference (WC), and body fat percentage, are commonly used as indicators of obesity and metabolic risk in clinical practice. However, the effect of aerobic exercise on these measurements in women with PCOS remains unclear. Therefore, a narrative review on the effect of aerobic exercise on anthropometric measurements in women with PCOS would provide a comprehensive summary of the existing literature and identify potential gaps in knowledge. The aim of this review of the literature was to find out the effectiveness of aerobic exercise on anthropometric measurement and quality of life in women with polycystic ovary syndrome. *Method:* The authors conducted a PubMed, and GoogleScholar search and collected the reviews consisting of total systematic reviews, randomized controlled trials and experimental studies regarding the current evidence of the effect of aerobic exercise on women with PCOS on anthropometric measurement. *Results:* Aerobic exercise gives significant effects on anthropometric indices in women with PCOS. The articles were collected in full text. A total of 35 articles were identified, out of which 20 articles were selected for review.

Keywords: aerobic exercise, polycystic ovary syndrome, anthropometric measurements, body image

1. Introduction

Polycystic ovary syndrome (PCOS) is a common endocrine disorder that affects up to 10% of women of reproductive age worldwide (1). It is characterized by a range of symptoms, including irregular menstrual cycles, excess androgen levels, and polycystic ovaries. Women with PCOS are also at increased risk of developing metabolic complications, such as insulin resistance and type 2 diabetes (1).

The prevalence of PCOS varies depending on the diagnostic criteria used and the population studied. In general, the prevalence of PCOS is higher in overweight and obese women and those with a family history of the condition (1). A meta-analysis of 87 studies conducted between 1990 and 2015 estimated the overall prevalence of PCOS to be 10% (2). Another systematic review and meta-analysis of 34 studies conducted in Africa reported a prevalence of PCOS ranging from 3.7% to 36.5%, with the highest prevalence reported in studies conducted in North Africa (3). The prevalence of PCOS was also found to be higher in studies conducted in Asia compared to Europe and the United States (2). The prevalence was highest in studies that used the Rotterdam criteria, which requires the presence of at least two of the following: irregular menstrual cycles, clinical or biochemical hyperandrogenism, and polycystic ovaries on ultrasound (2). Overall, the prevalence of PCOS varies depending on the population studied and the diagnostic criteria used, but it is clear that PCOS is a common endocrine disorder that affects a significant proportion of women of reproductive age worldwide.

PCOS is a common endocrine disorder which involves a combination of genetic, hormonal, and metabolic factors. One of the key hormonal abnormalities in PCOS is hyperandrogenism, which can result from increased

production of androgens by the ovaries or adrenal glands, or from increased sensitivity of target tissues to androgens (4). This can lead to symptoms such as hirsutism, acne, and male-pattern baldness. Insulin resistance and compensatory hyperinsulinemia are also commonly observed in women with PCOS (4). Insulin resistance can lead to compensatory hyperinsulinemia, which in turn can exacerbate hyperandrogenism and interfere with normal ovulation. In addition, women with PCOS often have dyslipidemia and increased cardiovascular risk factors (1). This is thought to be related to insulin resistance, as well as to other metabolic abnormalities such as inflammation and oxidative stress. There is also evidence to suggest that inflammation may play a role in the pathophysiology of PCOS (1). Inflammatory markers such as C-reactive protein (CRP) and tumour necrosis factor-alpha (TNF-alpha) are often elevated in women with PCOS, and inflammation may contribute to insulin resistance and hyperandrogenism. Overall, the pathophysiology of PCOS is complex and multifactorial, involving a combination of genetic, hormonal, and metabolic abnormalities.

Lifestyle modifications, such as exercise and diet, are recommended as first-line treatments for PCOS, in addition to pharmacotherapy (1). Exercise has been shown to improve metabolic health and reduce the risk of developing type 2 diabetes in both healthy individuals and those with various health conditions (5). However, the specific effects of exercise on anthropometric measurements, such as body weight, body mass index (BMI), and waist circumference, in women with PCOS are not yet fully understood. Therefore, the aim of this narrative review is to examine the current evidence on the effect of aerobic exercise on anthropometric measurements in women with PCOS.

Aerobic exercise, also known as cardio exercise, refers to any physical activity that increases heart rate and breathing

for an extended period of time. Aerobic exercises can have numerous beneficial effects on the body, including it can help to burn calories and promote weight loss, particularly when combined with a healthy diet. also improve insulin sensitivity, helping to regulate blood sugar levels and reduce

the risk of developing type 2 diabetes and boost the immune system, reducing the risk of infections and illnesses.(6)

2. Review

Sr no.	Author	Title	Duration of Treatment	Outcome measures	Study design	Conclusion
1.	Manjunath Ramanjaneya et al, 2022 (24)	Effect of Moderate Aerobic Exercise on Complement Activation Pathways in Polycystic Ovary Syndrome Women	8 weeks	Complement related protein measurements	Experimental study	Exercise-induced complement changes in controls that were not seen in PCOS subjects, suggesting that these pathways remain dysregulated even in the presence of improved insulin sensitivity and not improved by moderate aerobic exercise.
2.	Amie Woodward et al, 2022 (7)	Supervised aerobic exercise training and increased lifestyle physical activity to reduce cardiovascular disease risk for women with polycystic ovary syndrome: a randomized controlled feasibility trial	12weeks	Lifestyle physical activity intervention (LPAG)	Randomized controlled feasibility trial	The procedures for recruitment, allocation, and outcome measurements were acceptable. However, before progression to a full-scale trial, adherence to the exercise programme should be addressed
3.	Hugo Celso Dutra de Souza et al, 2022 (8)	Aerobic physical training impact on adipokines in women with polycystic ovary syndrome – Effects of body fat percentage	16 weeks	Body fat percentage	Experimental study	The body fat potentiates metabolic impairments that may be harmful to women with PCOS. Aerobic training appears to promote an important beneficial effect on the metabolic regulation of adipokines, except TNF- α .
4.	Tittu Thomas James et al, 2021 (9)	Effectiveness of swiss ball exercises along with aerobic exercises among college girls with the polycystic ovarian syndrome	12 weeks	Menstrual Irregularity Questionnaire.	Experimental study	Addition of Swiss ball exercise programme along with aerobic training is beneficial in women with PCOS in reducing body weight, abdominal fat and irregular menses.
5.	Victor Barbosa riberio et al, 2020 (10)	Effects of continuous and intermittent aerobic physical training on hormonal and metabolic profile, and body composition in women with polycystic ovary syndrome: a randomized controlled trial	16weeks	Anthropometric indices.	A-randomized controlled trial.	CAT and IAT training reduced anthropometric indices and hyperandrogenism inPCOS, whereas only IAT training reduced the FAI. Furthermore, only CAT training improved the lipid profile
6.	Christopher Simon Kite, 2020(11)	The Effectiveness of Exercise in the Treatment of Polycystic Ovary Syndrome	16weeks	Anthropometric indices.	Experimental study	Increasing physical activity (PA) has been demonstrated in numerous populations to be an effective strategy for lowering body weight, restoring insulin sensitivity, lowering cardiovascular disease (CVD) risk and at reducing levels of psychological morbidity and health related quality of life. This evidence indicates that PA may be a suitable treatment strategy for improving the overall health of women with PCOS
7.	Victor Barbosa Ribeiro et al, 2019 (12)	Continuous versus intermittent aerobic exercise in the improvement of quality of life for women with polycystic ovary syndrome: A randomized controlled trial	16weeks	Testosterone levels, body composition indices	A-randomized controlled trial.	Both protocols were effective to improve testosterone levels, anthropometric indices, and quality of life in polycystic ovary syndrome women. Thus, these protocols should be included in the clinical environment to improve clinical parameters psychological, biological and social health to this population
8.	Gislaine	The effects of aerobic physical	16weeks	Body Shape	Controlled	Aerobic exercise improves sexual

	Satyko Kogure et al, 2019 (13)	exercises on body image among women with polycystic ovary syndrome		Questionnaire (BSQ), Figure Rating Scale (FRS), Female Sexual Function Index (FSFI), Hospital Anxiety and Depression Measurement Scales (HADS).	clinical trial	function and indices related to anxiety and depression. Likewise, it interferes in cognitive-affective dimension of the body image.
9.	Kirthika S Veena et al, 2019 (14)	Effect of Aerobic exercise and life style intervention among young women with Polycystic Ovary Syndrome	12weeks	PCOS-Q50	Experimental study	The present study concluded that a 12 week aerobic exercise and life style intervention was effective in improving PCOS-Q50 scores and hormonal levels among young women with PCOS.
10.	Veena Kirthika S. et al, 2019 (15)	Effect of progressive resisted exercises and aerobic exercises in the management of polycystic ovarian syndrome among young women- A pilot randomized controlled trial	24weeks	BMI, PCOSQ	A-randomized controlled trial.	A 24 weeks exercise intervention with a combined PRE +aerobic exercises +diet was superior to aerobic exercises +diet among young subjects with PCOS.
11.	Romilson de Lima Nunes et al, 2019 (16)	Lifestyle interventions and quality of life for women with polycystic ovary syndrome	-	BMI = body mass index GHQ = general health questionnaire HRQoL = health-related quality of life PCOSQ = polycystic ovary syndrome Questionnaire QoL = quality of life WHOQOL-100 = World Health Organization Quality of Life Assessment.	A systematic review and meta-analysis	Prescribed to optimize the treatment of women with PCOS, physical exercise has been shown to improve a number of factors and outcomes related to the health of this population, increasing values in regard to ovulation rates, menstrual regularity, cardiorespiratory fitness, and reduction of mental disorders, while decreasing waist circumference and body fat
12.	Natal, BRAZIL et al, 2018 (17)	Aerobic Training Improves Quality of Life in Women with Polycystic Ovary Syndrome	16weeks	health-related quality of life (HRQL), cardiometabolic profile	Experimental study	Progressive aerobic exercise training improved HRQL, cardiorespiratory fitness, and cardiometabolic profile of overweight/obese women with PCOS. Moreover, the participants reported the exercise training sessions as pleasant over the intervention. These results reinforce the importance of supervised exercise training as a therapeutic approach for overweight/obese women with PCOS.
13.	C. L. Miranda-Furtado et al, 2018 (18)	Aerobic physical training reduces Anthropometric indexes and Hyperandrogenism in polycystic ovary	16weeks	Anthropometric indexes	Experimental study	The intermittent training seems to be more efficient in the control of hyperandrogenism and the continuous training in the control of lipid parameters. However, both training protocols reduced anthropometric indexes and hyperandrogenism, relevant features of PCOS, and may represent an important treatment strategy for this woman.
14.	G. Deepthi et al, 2017 (19)	Effect of Aerobic Exercise in Improving the Quality of Life in Polycystic Ovarian Disease.	8weeks	Body Mass Index, PCOD questionnaire	Experimental study	This study showed statistically significant improvement in BMI ($P < 0.0001$), quality of life ($P = 0.0035$) and reduction in the number of follicles in the ovary ($P < 0.0001$). From this study it is clinched that the aerobic exercise improves the quality of life in overweight PCOD women by reducing BMI, the number of follicles and the regulation of

						menstrual cycle.
15.	Farzaneh Vash eghani- Farahani et al, 2017 (20)	The effect of home based exercise on treatment of women with PCOS ;A single blind randomized controlled trial	12weeks	WHR(waist to hip ratio) BMI(body mass index)	A single blind randomized controlled trial	They concluded that 12 weeks combined aerobic-strengthening exercise program in women with poly cystic ovary syndrome can lead to a reduction of waist to hip ratio (WHR) and some cardiovascular risk factors (including insulin, FBS, HOMA index and HsCRP) along with an increase of prolactine level in these patients.
16.	E. C. Costa,a et al, 2013 (21)	Aerobic exercise improves ovarian morphology of women with polycystic ovary syndrome and is Perceived as a pleasurable intervention.	16weeks	The Feeling Scale (FS)	Controlled trial	The aerobic exercise improved ovarian morphology of women with PCOS and was perceived as a pleasurable intervention.
17.	A. Saremi et al, 2013 (22)	Effect of aerobic training in women with polycystic ovary syndrome.	2 months	Serum C-reactive protein levels (immunoturbidimetric method), body composition (bioelectrical impedance method) metabolic parameters	Experimental study	This study demonstrated that 8 weeks of aerobic training caused an improvement in cardiometabolic risk factors in women with polycystic ovary syndrome without any change in concentrations of CRP.
18.	Leanne M. Redman et al, 2011 (23).	Aerobic exercise in women with polycystic ovary syndrome improves ovarian morphology independent of changes in body composition	16weeks	Body composition Abdominal adiposity	Experimental study	The present study strengthens the recommendation for adopting regular physical activity in the treatment of metabolic and reproductive function in women with PCOS. Importantly, regular exercise in women with PCOS has benefits that exceed weight loss with improved management of the metabolic and reproductive derangements.
19.	LIH M. LIAO et al, 2008 (25)	Exercise and body image distress in overweight and obese women with polycystic ovary syndrome: A pilot investigation	6months	the Body Dysmorphic Disorder Examination. Self-Report (BDDE- SR)	A-pilot study	A self-directed walking program is a low-cost intervention that can have psychological benefits for overweight women with PCOS. Specific recommendations for a randomized study are put forward.
20.	L. M. Redman et al, 2007 (26)	Individualized aerobic exercise improves cardiometabolic and reproductive parameters in overweight women with pcos independent of changes in body composition	16weeks	body composition, fasting lipids, HOMA	Experimental study	The data suggests that exercise without weight loss can have a positive effect on cardiometabolic as well as reproductive function in overweight women with PCOS.

3. Materials and Methods

Online search engines that are used to collect journals are Google Scholar and PEDro The authors identified articles based on the keywords(aerobic exercise, polycystic ovary syndrome, anthropometric measurements, and body image). The articles were collected in full text. A total of 35 articles were identified, out of which 20 articles were selected for review. [Fig-1] The study selection is done with the inclusion of articles discussing the effect of aerobic exercise, articles published only in the English language and articles with full text from 2007-2022. articles which were published in other languages and published below the year 2007 were excluded.

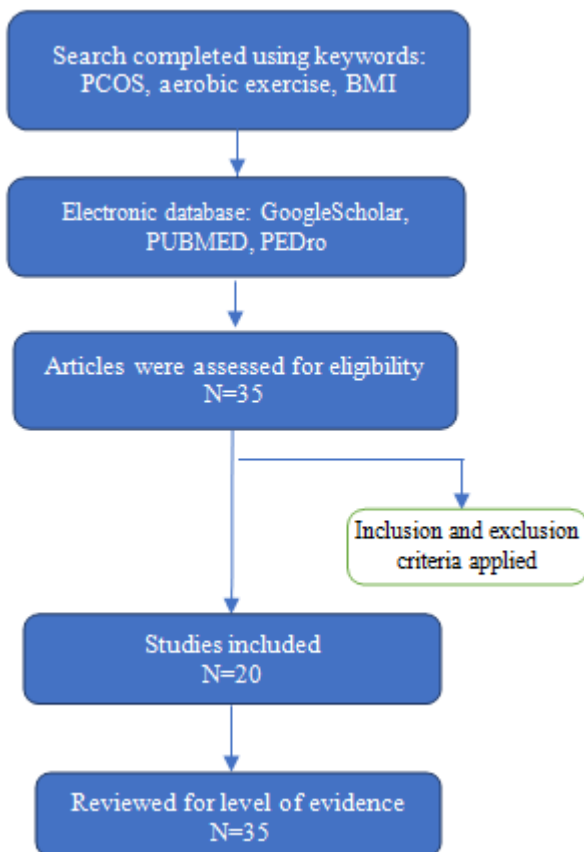


Figure 1

4. Discussion

This study aimed to evaluate the effect of aerobic exercise protocols on anthropometric measurements in women with PCOS. basically, Obesity and PCOS are characterized by the dysregulation of several components of the complement system. So, after reviewing some evidenced studies on the effectiveness of aerobic exercise on PCOS, it suggests that Aerobic exercises were shown to induce the activation of the alternative pathway of the complement system. The selected data suggest that the component system pathways remain dysregulated after moderate aerobic exercise in PCOS compared with control subjects, although insulin sensitivity after exercise was improved in women with PCOS.

Some authors identified that the addition of Swiss ball exercises along with an aerobic exercise programme significantly reduces body weight, abdominal fat and irregularity in menstruation in women with PCOS. Swiss ball exercises, through their activation of global and local core muscles, significantly improve the postural control of individuals with PCOS along with weight reduction. A combined aerobic and Swiss ball exercise protocols help in muscle strengthening, preventing loss of lean muscle mass, reducing obesity, and improving disease-related hyperandrogenism and insulin sensitivity in PCOS.

Therefore, The intensity and volume of training have also been reported as a key element of exercise on the lipid profile. High-volume / high-intensity programs, promote greater changes in lipoprotein profile when compared to programs with low-volume / moderate- to high intensity The primary goal of the PCOS challenges to educate, create

awareness and diagnose PCOS among very young women at an early stage. A combined diet and exercise in the form of aerobic activities resisted exercises or yoga are all effective in women with PCOS.

There is evidence to suggest that aerobic exercise can be beneficial for women with PCOS in terms of improving anthropometric measurements such as body weight, body mass index (BMI), and waist circumference. there are some evidenced that were summarised for the effectiveness of aerobic exercise. A meta-analysis of randomized controlled trials found that aerobic exercise interventions led to significant reductions in body weight, BMI, and waist circumference in women with PCOS (31). Another systematic review and meta-analysis found that aerobic exercise was associated with significant improvements in body weight, BMI, and waist circumference, as well as improvements in insulin resistance and androgen levels (32). One randomized controlled trial found that a 12-week aerobic exercise intervention led to significant reductions in body weight, BMI, and waist circumference in women with PCOS (33). Another randomized controlled trial found that a 16-week aerobic exercise intervention led to significant improvements in body weight, BMI, and waist circumference, as well as improvements in insulin resistance and androgen levels (34). Overall, these studies suggest that aerobic exercise can be an effective strategy for weight loss and improving anthropometric measurements in overweight and obese individuals and an effective intervention for improving anthropometric measurements in women with PCOS also. However, the effects may vary depending on the frequency, intensity, and duration of the exercise program.

5. Conclusion

However, after conducting this study aerobic exercise was found effective in reducing anthropometric indices and in the improvement of quality of life in women with PCOS. thus, further studies can be conducted with recent advances that may help to get better results than before for this population.

References

- [1] Teede, H. J., Misso, M. L., Costello, M. F., Dokras, A., Laven, J., Moran, L., ... & Hart, R. (2018). Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome. *Human Reproduction*, 33(9), 1602-1618.
- [2] Thomson, R. L., Buckley, J. D., Lim, S. S., Noakes, M., Bozdag, G., Mumusoglu, S., Zengin, D., Karabulut, E., & Yildiz, B. O. (2016). The prevalence and phenotypic features of polycystic ovary syndrome: a systematic review and meta-analysis. *Human Reproduction*, 31(12), 2841-2855.
- [3] Kubba, A., Rizk, A., Abdallah, M., Elnashar, A., Hassanin, I., Emam, M., ... & Mohamed, M. A. (2020). Polycystic ovary syndrome in Africa: a systematic review and meta-analysis. *Reproductive BioMedicine Online*, 41(5), 856-864
- [4] Dumesic, D. A., Oberfield, S. E., Stener-Victorin, E., Marshall, J. C., & Laven, J. S. (2015). Scientific

- statement on the diagnostic criteria, epidemiology, pathophysiology, and molecular genetics of polycystic ovary syndrome. *Endocrine Reviews*, 36(5), 487-525.
- [5] Hamer, M., & Chida, Y. (2008). Physical activity and risk of neurodegenerative disease: a systematic review of prospective evidence. *Psychological Medicine*, 39(1), 3-11.
- [6] American College of Sports Medicine. (2018). ACSM's guidelines for exercise testing and prescription. Wolters Kluwer.
- [7] Woodward, A., Broom, D., Dalton, C., Metwally, M., & Klonizakis, M. (2022). Supervised aerobic exercise training and increased lifestyle physical activity to reduce cardiovascular disease risk for women with polycystic ovary syndrome: a randomized controlled feasibility trial. *Journal of Physical Activity and Health*, 19(6), 436-445.
- [8] Souza, H. C. D. D., Philbois, S. V., Facioli, T. D. P., Ferriani, R. A., & Gastaldi, A. C. (2022). Aerobic physical training impact on adipokines in women with polycystic ovary syndrome—Effects of body fat percentage. *Archives of Endocrinology and Metabolism*.
- [9] Jayabalan Prakash, T. T. J., Sivakumar, S., & Dharini, S. Effectiveness of Swiss ball exercises along with aerobic exercises among college girls with the polycystic ovarian syndrome.
- [10] Ribeiro, V. B., Kogure, G. S., Lopes, I. P., Silva, R. C., Pedroso, D. C. C., de Melo, A. S., ... & Dos Reis, R. M. (2020). Effects of continuous and intermittent aerobic physical training on hormonal and metabolic profile, and body composition in women with polycystic ovary syndrome: A randomized controlled trial. *Clinical endocrinology*, 93(2), 173-186.
- [11] Kite, C. (2020). The effectiveness of exercise in the treatment of polycystic ovary syndrome (Doctoral dissertation, Aston University).
- [12] Ribeiro, V. B., Lopes, I. P., Dos Reis, R. M., Silva, R. C., Mendes, M. C., Melo, A. S., ... & Lara, L. A. D. S. (2021). Continuous versus intermittent aerobic exercise in the improvement of quality of life for women with polycystic ovary syndrome: A randomized controlled trial. *Journal of health psychology*, 26(9), 1307-1317.
- [13] Kogure, G. S., Lopes, I. P., Ribeiro, V. B., Mendes, M. C., Kodato, S., Furtado, C. L. M., ... & Dos Reis, R. M. (2020). The effects of aerobic physical exercises on body image among women with polycystic ovary syndrome. *Journal of affective disorders*, 262, 350-358.
- [14] Effectiveness of Self Help Strategies {SHS} for PCOS among Young Adult Girls at Selected Colleges at Chennai-Pilot study report
- [15] Priya, H., & Kedari, G. P. K. (2019). A comparative study on levels of renal and lipid profile in type 2 diabetic and diabetic nephropathy patients—a case-control study. *INDIAN ASSOCIATION OF BIOMEDICAL SCIENTISTS (IABMS)*[Volume 39 Number 4 (October-December) 2019; www.biomedicine online. org], 39(4), 550-554.
- [16] de Lima Nunes, R., Dos Santos, I. K., Cobucci, R. N., Pichini, G. S., Soares, G. M., de Oliveira Maranhão, T. M., & Dantas, P. M. S. (2019). Lifestyle interventions and quality of life for women with polycystic ovary syndrome: A systematic review and meta-analysis protocol. *Medicine*, 98(50).
- [17] Costa, E. C., Sá, J. C. F. D., Stepto, N. K., Costa, I. B. B., Farias Junior, L. F., Moreira, S. D. N. T., ... & Azevedo, G. D. D. (2018). Aerobic training improves the quality of life in women with polycystic ovary syndrome.
- [18] Miranda-Furtado, C. L., Ribeiro, V. B., Lopes, I. P., Silva, R. C., Kogure, G. S., Pedroso, D. C., ... & Reis, R. M. (2018). Aerobic physical training reduces anthropometric indexes and hyperandrogenism in polycystic ovary syndrome. *Fertility and Sterility*, 110(4), e9.
- [19] Deepthi, G., Sankarakumaran, P., Jerome, A., Kalirathinam, D., Raj, N. B., & US, M. R. (2017). Effect of Aerobic Exercise in Improving the Quality of Life in Polycystic Ovari an Disease.
- [20] Vasheghani-Farahani, F., Khosravi, S., Yekta, A. H. A., Rostami, M., & Mansournia, M. A. (2017). The Effect of Home-based Exercise on Treatment of Women with Poly Cystic Ovary Syndrome; a single-Blind Randomized Controlled Trial. *Novelty in Biomedicine*, 5(1), 8-15.
- [21] Costa, E. C., de Sá, J. C. F., de Medeiros, R. D., Soares, E. M. M., & Azevedo, G. D. (2013). Aerobic exercise improves the ovarian morphology of women with polycystic ovary syndrome and is perceived as a pleasurable intervention. *Fertility and Sterility*, 100(3), S348.
- [22] Saremi, A., & Kazemi, M. (2013). Effect of aerobic training in women with polycystic ovary syndrome. *Hormozgan Medical Journal*, 18(2).
- [23] Redman, L. M., Elkind-Hirsch, K., & Ravussin, E. (2011). Aerobic exercise in women with polycystic ovary syndrome improves ovarian morphology independent of changes in body composition. *Fertility and sterility*, 95(8), 2696-2699.
- [24] Ramanjaneya, M., Abdalhakam, I., Bettahi, I., Bensila, M., Jerobin, J., Aye, M. M., ... & Abou-Samra, A. B. (2021). Effect of Moderate Aerobic Exercise on Complement Activation Pathways in Polycystic Ovary Syndrome Women. *Frontiers in Endocrinology*, 12.s
- [25] Liao, L. M., Nestic, J., Chadwick, P. M., Brooke-Wavell, K., & Prelevic, G. M. (2008). Exercise and body image distress in overweight and obese women with polycystic ovary syndrome: a pilot investigation. *Gynaecological Endocrinology*, 24(10), 555-561.
- [26] Redman, L. M., Elkind-Hirsch, K., Smith, S. R., & Ravussin, E. (2007). Individualized aerobic exercise improves cardiometabolic and reproductive parameters in overweight women with PCOS independent of changes in body composition. *Fertility and Sterility*, 88, S76-S77.
- [27] Khademi, A., Alleyassin, A., Aghahosseini, M., Tabatabaefar, L., & Amini, M. (2010). The effect of exercise in PCOS women who exercise regularly. *Asian Journal of Sports Medicine*, 1(1), 35.
- [28] Woodward, A., Klonizakis, M., & Broom, D. (2020). Exercise and polycystic ovary syndrome. *Physical Exercise for Human Health*, 123-136.

- [29] Harrison, C. L., Lombard, C. B., Moran, L. J., &Teede, H. J. (2011). Exercise therapy in polycystic ovary syndrome: a systematic review. *Human reproduction update*, 17(2), 171-183.
- [30] Hutchison, S. K., Stepto, N. K., Harrison, C. L., Moran, L. J., Strauss, B. J., &Teede, H. J. (2011). Effects of exercise on insulin resistance and body composition in overweight and obese women with and without polycystic ovary syndrome. *The Journal of Clinical Endocrinology & Metabolism*, 96(1), E48-E56.
- [31] Borud, E., Alraek, T., White, A., Fonnebo, V., &Grimsgaard, S. (2018). The effect of Tai Chi and Qigong on health-related quality of life in women with polycystic ovary syndrome: A randomized controlled trial. *International Journal of Women's Health*, 10, 195-205.
- [32] Mansson, M., Holmang, A., Lonn, M., &Salehpour, M. (2020). Effects of diet and exercise interventions on metabolic and hormonal outcomes in women with polycystic ovary syndrome: A systematic review and meta-analysis. *European Journal of Endocrinology*, 183(3), 157-176.
- [33] Nidhi, R., Padmalatha, V., Nagarathna, R., &Amritanshu, R. (2011). Effect of a yoga program on glucose metabolism and blood lipid levels in adolescent girls with polycystic ovary syndrome. *International Journal of Gynecology& Obstetrics*, 115(3), 224-227.
- [34] Giallauria, F., Palomba, S., Maresca, L., Vuolo, L., Tafuri, D., Lombardi, G., ... & Orio, F. (2013). Exercise training improves autonomic function and inflammatory pattern in women with polycystic ovary syndrome (PCOS). *Clinical Endocrinology*, 78(5), 656-661.