

Efficacy of Swiss Ball Exercise and Resistance Training in Polycystic Ovarian Syndrome

Meenakshi M¹, Anitha A², Ramana K³, Kamalakannan M⁴

¹Post Graduate, ^{2,4}Associate Professor, ³Assistant Professor, Saveetha College Of Physiotherapy, Saveetha Institute Of Medical & Technical Sciences, Chennai, Tamil Nadu, India.

How to cite this article: Meenakshi M, Anitha A, Ramana K et. al. Efficacy of Swiss Ball Exercise and Resistance Training in Polycystic Ovarian Syndrome. Indian Journal of Physiotherapy and Occupational Therapy / Volume 18, Year 2024.

Abstract

Background: Women of reproductive age are frequently affected with Polycystic Ovarian Syndrome, an endocrine disorder that causes anovulation and infertility. There is a paucity in the evidence of comparing the effectiveness of the Swiss ball and resistance training among PCOS subjects.

Purpose: To compare the effect of Swiss ball exercise and Resistance training in symptoms females with Polycystic Ovarian Syndrome.

Materials and Method: A total of 30 subjects were selected from Private Institute. As outcome measures, the menstrual irregularity questionnaire (MIQ), BMI, and abdominal girth measurement were used. Subjects were divided randomly into resistance training group (n = 15) received exercises with dumbbells and Swiss ball training group (n = 15) received exercises with Swiss ball, in addition to aerobic exercise.

Results: Females with PCOS symptoms in RTG experienced statistically significant improvement in BMI from 28.3 ± 3.3 to 25.3 ± 3.3 , in Abdominal girth 93.6 ± 4.6 to 88.8 ± 4.6 , in MIQ 18.3 ± 3.8 to 13.5 ± 3.3 , with a p value of < 0.05 than in SBG which had BMI from 28.3 ± 3.7 to 27.9 ± 3.5 , Abdominal girth 93.6 ± 5.3 to 92.6 ± 5.3 , MIQ 18.1 ± 3.5 to 16.4 ± 3.8 , with a p value < 0.05 .

Conclusion: In comparison to a Swiss ball exercise, resistance training programme combined with aerobic activity is more effective at helping women with PCOS symptoms.

Key Word: Stein-Leventhal syndrome, Menstrual Irregularities, PCOS, Resistance training, Hormonal Imbalance.

Introduction

4–12% of women of childbearing age have polycystic ovarian syndrome, a prevalent disorder that affects females¹. A diagnosis that consists of prolonged anovulation or hyperandrogenism without any adrenal or pituitary problems is known

as polycystic ovarian syndrome². Hyperandrogenism and prolonged anovulation are the most common findings in individuals with Polycystic Ovarian Syndrome³.

A consensual definition of Polycystic Ovarian Syndrome was developed in Rotterdam, the

Corresponding Author: Anitha A, Associate Professor, Saveetha College of Physiotherapy, Saveetha Institute of Medical & Technical Sciences, Chennai, India.

E-mail: anitha.scpt@saveetha.com

Netherlands, in 2003 by the American Society for Reproductive Medicine and the European Society of Human Reproduction and Embryology². The Rotterdam criteria, which defines Polycystic Ovarian Syndrome, states that two of the following three factors must be present for a diagnosis to be made: ¹oligo or anovulation, ²elevated circulating androgen concentrations (hyperandrogenemia; for example, elevated testosterone, dehydroepiandrosterone), or clinical manifestations of androgen excess (hyperandrogenism; for instance, hirsutism, acne, alopecia), and ³polycystic ovaries identified by ultrasound. The standard diagnosis of polycystic ovarian syndrome that is most frequently accepted is the Rotterdam version².

The aetiology of Polycystic Ovarian Syndrome has not been fully clarified because the source of the condition is uncertain⁴. According to the current theory, an inherited disorder called polycystic ovarian syndrome is brought on by the combination of protecting and predisposing genetic variations, which are subsequently altered by environmental factors (such physical inactivity)⁶. The clustering of patients within families provides evidence for a genetic component and points to an autosomal dominant mode of inheritance⁷. There have been numerous candidate genes examined for a potential causative role in Polycystic Ovarian Syndrome. These researches, however, are still conflicting and unconvincing⁸. So far, no one gene has been definitively linked to the development of Polycystic Ovarian Syndrome⁹.

Resistance exercise might be prescribed to Polycystic Ovarian Syndrome women for physiological reasons. The disease's interconnected traits of insulin resistance and androgen excess lead to its aggravation. Given that individuals with Type II diabetes mellitus and Polycystic Ovarian Syndrome share several fundamental characteristics of insulin resistance, resistance training may also improve clinical outcomes in Polycystic Ovarian Syndrome¹⁰. It has been repeatedly demonstrated that resistance exercise increases insulin responsiveness among these patients. Four studies that used resistance training as part of a lifestyle-based intervention indicate that it is possible to recommend this type of training. Despite the obvious knowledge gaps, resistance training

can be used to treat Polycystic Ovarian Syndrome, according to sufficient empirical evidence exercise prescription guidelines¹¹.

Exercise and nutrition programs are thought to be useful in the management of Polycystic Ovarian Syndrome, especially in obese people⁹. This improves their psychological well-being, self-esteem, anxiety, and so on. As a result, exercises are beneficial to clinical and metabolic health in both the short and long term⁶. In the study by Pitchai et al, 62 percent of the participants were aware of the benefits of exercise in the management of PCOS, and 39 percent were doing so on a regular basis. 95% of the participants in the study agreed to make lifestyle changes as part of their Polycystic Ovarian Syndrome treatment. Weight loss strategies adopted by subject's aid in the normalization of androgen, gonadotropin, and insulin levels, as well as the restoration of menstrual functions⁷.

Exercise also has beneficial effects in reproductive function and cardiorespiratory fitness according to Maiya et al., aerobic activities are useful in reducing weight in obese infertile women with Polycystic Ovarian Syndrome by reducing cyst size and boosting ovulation and pregnancy chances²⁰. Although there is evidence to support the use of aerobic workouts in Polycystic Ovarian Syndrome management, there is little evidence to support the use of Swiss ball and resistance exercises.

Aim

The aim of this study is to compare the effectiveness between Swiss Ball Exercise and Resistance Training on improving BMI, Abdominal girth and Menstrual Irregularity Questionnaire (MIQ) in females with Polycystic Ovarian Syndrome.

Materials and Method

A total of forty-two subjects were chosen by convenient sampling method and were randomly assigned into two groups using concealed envelope method. The study was conducted from the month of September to December 2022 at Private institute, Chennai. Baseline characteristics (age, age of Menarche and average cycle length) were similar for both the groups. BMI, abdominal girth and menstrual irregularity questionnaire (MIQ) was recorded for

pre and post-test and evaluated after 8 weeks of intervention. Each subject was monitored both in person and through video calls based upon their convenience.

Inclusion criteria:

- Between the ages of 18 and 35 years
- Subjects with confirmed diagnosis of Polycystic Ovarian Syndrome
- BMI ranging from 23-35 kg/m²
- Subjects having at least two of three Rotterdam criteria.

Exclusion criteria:

- Subjects who exercised regularly
- Subjects who had recent abdominal surgery
- Subjects with a history of systemic illness.
- Subjects who were receiving treatment like oral contraceptives and Nutritional therapy for PCOS.

Outcome measures:

BMI (Body Mass Index), Abdominal girth, and Menstrual Irregularity Questionnaire (MIQ)¹² were used as outcome measures. It measures obesity, waist circumference and menstrual activity respectively.

Procedure

A total of 42 females between the age group of 18-35 years with the symptoms of Polycystic Ovarian Syndrome were selected for the study. Out of 42 females 8 females did not meet the inclusion criteria and 4 females declined to participate in the study. Following a thorough explanation of the study and informed consent, using inclusion and exclusion criteria, 30 subjects were selected, and the consent was obtained prior to the commencement of the intervention. The selected subjects were randomly assigned to the Resistance training group (RTG) (n = 15) and Swiss ball group (SBG) (n = 15) using concealed envelope methods. In addition to the structured exercises both the groups received aerobic exercises, warm up and a cool down session. Resistance training was performed using dumbbells.

Intervention Protocol

The resistance training group's exercise protocol and the Swiss ball training group's exercise protocol both have three phases: warm-up, dynamic phase, and cool-down. Both groups underwent a warm-up and cool-down period of 10 minutes. The warm phase includes breathing exercise, stretching of major muscle groups (Pectoralis Major, Triceps, Biceps, Calf, Hamstrings and Quadriceps). In the warm up phase diaphragmatic breathing was done for 3 minutes and each stretch for 10 second hold with 3 repetitions. The cool down phase includes breathing exercise (diaphragmatic breathing) for 3 minutes and ankle-toe movements, 4 sets with 8 repetitions for both the groups.

Jumping jacks, hopping up onto chairs, wall sits, running in place, high knees and lunges are among aerobic activities included in the first half of the dynamic phase in both groups. Aerobic exercises were performed for 15 minutes, each exercise 4 sets with 8 repetitions. In addition to that resistance training subjects received abdominal curl ups, abdominal oblique curl up, bridging, half-kneeling wood chop, leg raise and dumbbell deadlift up and squats during the second half of the dynamic phase for another 15 minutes, 4 sets with 8 repetitions. The resistance was prescribed according to Delorme's 10RM theory and progressed each week. The second half of the dynamic phase in the Swiss ball training group was given abdominal curl ups, abdominal oblique curl ups, bridging, lower trunk rotation, back extension, side plank and front plank for 15 minutes.

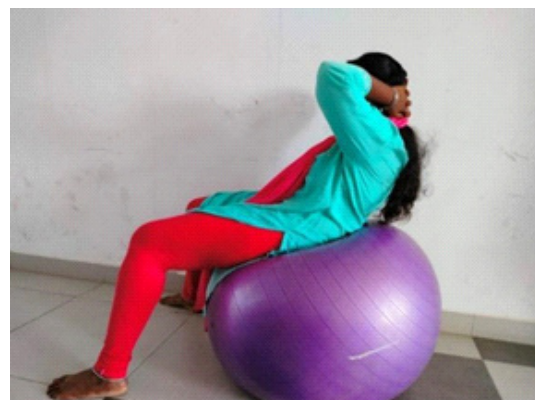


Fig 1: Abdominal curl ups with swiss ball

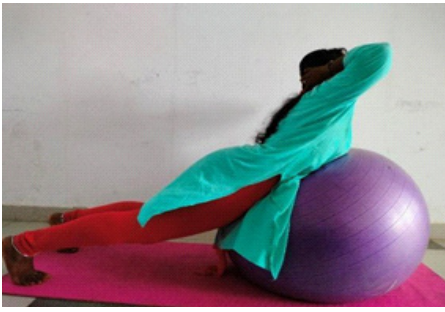


Fig 2: Back Extension with Swiss ball



Fig 3: Bridging with Swiss ball



Fig 4: Abdominal curl ups with dumbbell



Fig 5: Half-kneeling wood chop with dumbbell



Fig 6: Abdominal oblique curl up with dumbbell

Data analysis

SPSS version 27.0 was the software used in this study's statistical analysis. Normality was assessed using the Shapiro-Wilk test. Independent t test and paired t test was used for normal distributed variables BMI and Menstrual irregularity questionnaire. Mann Whitney and Wilcoxon tests were used for non-normal distributed variable abdominal girth measurement. The significant results were confirmed if $p < 0.05$.

Result

The mean age of the subjects in the Resistance Training group (RTG) was 25.56 ± 4.7 years and in the Swiss ball training group (SBG) was 25.4 ± 4.8 years respectively. The baseline variables (age, age of menarche and average length of cycle) were assessed for normality. Normality was assessed using the Shapiro-Wilk test. Independent t test and paired t test was used for normal distributed variable age. Mann Whitney and Wilcoxon tests were used for non-normal distributed variable age of menarche and average length of cycle. The p value for age was 0.852, for age of menarche was 0.982 and for average length of cycle was 0.403 indicating that the baseline variables had Statistically no difference between the ($p > 0.05$).

In this study, Table 1 shows the mean and standard deviation (SD) values of both the experimental groups [Resistance Training group (RTG) and Swiss ball training group (SBG)] for BMI, abdominal girth and menstrual irregularity questionnaire. The mean

value of BMI was $28.3 \pm 3.32 \text{ kg/m}^2$ at the baseline and $25.31 \pm 3.3 \text{ kg/m}^2$ post intervention for Resistance Training group (RTG) and was $28.3 \pm 3.73 \text{ kg/m}^2$ at the baseline and $27.94 \pm 3.5 \text{ kg/m}^2$ post intervention for Swiss ball training group (SBG) (Graph 1). The abdominal girth measured by inch tape had a mean value of 93.64 ± 4.62 pre intervention and was 88.86 ± 4.6 post intervention for Resistance Training group (RTG) and for Swiss ball training group (SBG) it was 93.9 ± 5.3 pre-intervention and was 92.66 ± 5.32 post intervention (Graph 1). The mean value of the menstrual irregularity assessed by menstrual irregularity questionnaire for Resistance Training group (RTG) was 18.33 ± 3.8 at the baseline and 13.53 ± 3.3 at the end of the study, and for Swiss ball training group (SBG), the mean value was 18.13 ± 3.5 at the baseline and 16.40 ± 3.8 at the end of the study (Graph 1).

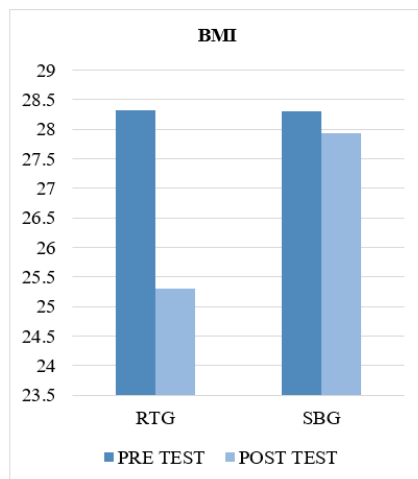
After the completion of the intervention, the mean and SD values of BMI for the Resistance

Training group (RTG) was 25.31 ± 3.3 and for Swiss ball training group (SBG) was 27.94 ± 3.5 . The mean \pm SD values of abdominal girth measurement for the Resistance Training group (RTG) was 88.86 ± 4.6 and for the Swiss ball training group (SBG) was 92.66 ± 5.3 . Similarly, the mean \pm SD values of the menstrual irregularity questionnaire for the Resistance Training group (RTG) was 13.53 ± 3.3 and for Swiss ball training group (SBG) was 16.40 ± 3.8 . The *p* values of BMI were 0.045, for abdominal girth measurement was 0.032 and for the menstrual irregularity questionnaire was 0.039 thereby indicating the statistically significant difference between the groups as $p < 0.05$ for all the three variables. The differences in the mean \pm SD of the three variables indicated that the participants who received resistance training along with aerobic exercise (Resistance Training group (RTG)) were highly benefitted than those who received swiss ball exercise along with aerobic exercise protocol (Swiss ball training group (SBG)).

Table 1: Analysis of differences between the groups for outcome measures

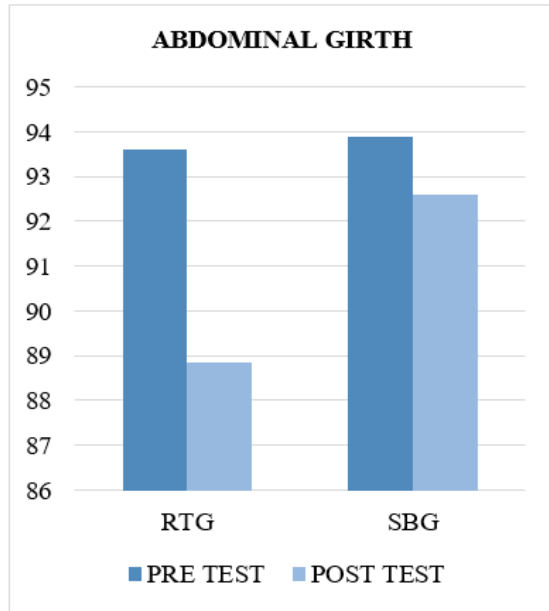
STATISTICAL ANALYSIS	GROUP	MEAN \pm SD		p VALUE
		PRE-TEST VALUES	POST TEST VALUES	
BMI (kg/m ²)	RTG	28.3 ± 3.3	25.3 ± 3.3	0.045*
	SBG	28.3 ± 3.7	27.9 ± 3.5	
ABDOMINAL GIRTH (cm)	RTG	93.6 ± 4.62	88.8 ± 4.6	0.032*
	SBG	93.9 ± 5.3	92.6 ± 5.3	
MENSTRUAL IRREGULARITY QUESTIONNAIRE	RTG	18.3 ± 3.8	13.5 ± 3.3	0.039*
	SBG	18.1 ± 3.5	16.4 ± 3.8	

RTG - Resistance training group, SBG - Swiss Ball Training group * = statistically significant



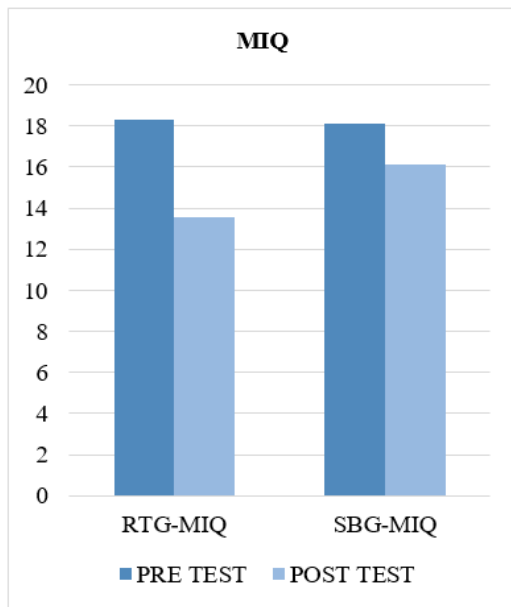
Graph No 1

INTERPRETATION: Difference in the BMI (kg/m²) between the groups before and after the interventions



Graph No 2

INTERPRETATION: Difference in the Abdominal girth (cm) between the groups before and after the interventions



Graph No 3

INTERPRETATION: Difference in the MIQ between the groups before and after the interventions

Discussion

The aim of our study was to compare the effect of resistance training program with swiss ball training program on reducing BMI, abdominal girth and menstrual irregularity in individuals with Polycystic Ovarian Syndrome. Around 30 participants received the resistance training along with aerobic exercise (resistance training group) and swiss ball training along with aerobic exercise (swiss ball training group). The participant BMI as measured by weight and height was found to be reduced with mean (SD) 25.31 (3.3) kg/m² in resistance training group when compared with mean (SD) 27.94 (3.5) kg/m² in swiss ball training group. Which indicates participants who received resistance exercise responded well compared with the swiss ball training group. The abdominal girth as measured by inch tape was reduced with a mean (SD) of 88.86 (4.6) cm in resistance training group and 92.66 (5.32) cm in swiss ball training group indicating the higher reduction in waist circumference in resistance training group than swiss ball training group. The menstrual irregularities measured by menstrual irregularity questionnaire was found to be reduced with a mean (SD) 13.53 (3.3) in resistance training group and 16.40 (3.8) in swiss ball training group which indicated that participants in resistance training group had better improvement when compared to those in swiss ball training group.

Analyzing resistance training and Swiss ball exercises in the treatment of PCOS among fertile females is not well supported by the available research. In PCOS sufferers, we discovered that including Swiss ball exercises in a routine of aerobic exercise dramatically reduced belly fat and menstrual abnormalities with just a minor impact on BMI. Resistance training exercises were observed to help people lose more body weight than their equivalents who received Swiss ball with aerobic exercises.

We discovered safe, enjoyable, moderately intense Swiss ball activities and resistance exercises that make people with PCOS feel better. Exercise-induced weight loss benefits people by boosting ovulation, restoring hormonal balance, and addressing irregular menstruation.

Exercises with a Swiss ball offer an unstable surface that causes the abdominal muscles to contract,

increasing the demands placed on proprioception and raising the strength of the core muscles to their highest possible degree. There will be a co-contraction of the pelvic floor muscles and the transverse abdominis muscle during abdominal activities that target the abdominal muscles, particularly the transverse abdominis. The fasting insulin and insulin resistance are thought to be decreased by aerobic exercise. Interval aerobic exercise raises testosterone levels and affects the central obesity index. Resistance training falls under the genre of anaerobic exercise, which involves making repeated motions against a certain resistance to cause the muscles to contract. The contraction of the muscle, which consists of both mechanical and metabolic qualities, is facilitated by resisted exercise. Exercise improves insulin sensitivity, increases glucose intake, and boosts functional strength.

A study done by Jayabalan Prakash (2021) has found the effect of similar swiss ball exercise protocol in reducing BMI, abdominal fat and menstrual irregularity with a mean difference of 2.9kg and -0.6kg post intervention¹². Subjects in their study had also undergone a 12-week aerobic exercise along with swiss ball training protocol. In comparison to their study, the subjects of our study have undergone either swiss ball exercise or resistance exercise protocol.

Our findings were also supported by an experimental study reported by Gislaine Satyko Kogure (2016)¹³ to determine the impact of progressive strength training, waist circumference, muscle mass index and lean muscle mass which was found to have a p value < 0.01 post intervention.

Studies done by Almenning I¹⁴ and Pericleous P¹⁵ suggested that the performance of resistance exercises improves the overall endurance of the body, hormonal levels, insulin resistance and reduces obesity, thereby having an effect on Polycystic Ovarian Syndrome which supports our findings of strength training exercise also being effective in reducing BMI, abdominal girth and menstrual irregularities. In addition to the designated exercise protocol, all the subjects also received aerobic exercise which had a supplementary effect in reducing BMI. Along with abdominal girth and menstrual irregularity was also evaluated in our study using inch tape and menstrual irregularity questionnaire and the results state that performance of exercises along with aerobic exercise

has an effect on reduction in the waist circumference i.e. the abdominal fat.

A Study by Narmadha M (2022)¹⁶ concluded that performance of resistance exercises majorly focusing on core and pelvic floor enhances body composition, skeletal muscle size, together with a decrease in visceral fat, and glycemic control. The major cause of PCOS, hyperandrogenemia, is shut down by this glycol-regulation, which also lowers androgen production. Regular exercise lowers insulin resistance and contributes to the reduction of visceral fat. In order to increase metabolic rate, exercise has an effect that controls insulin protein signaling in skeletal muscles. By managing menstrual cyclicality, increasing ovulation rate, and improving sex hormones, insulin levels, and waist circumference, proper exercise training combined with a hypocaloric high protein diet has addressed reproductive concerns thereby, supporting our findings of resistance training protocol being more effective than the swiss ball training protocol in reducing BMI, abdominal girth and menstrual irregularity.

Blood tests to examine the hormonal alterations due to the effect of exercises could be evaluated in future studies.

Conclusion

This study compared the effects of resistance training and swiss ball training on PCOS women, and it was shown that resistance training had a better effect than swiss ball training after 8 weeks. According to the study's findings, resistance training with aerobic exercise is more effective than a Swiss ball exercise regimen with aerobic activity to help females with Polycystic Ovarian Syndrome to reduce weight, reduce fat around the abdomen, and address erratic periods. Resistance training has good impacts on PCOS-afflicted women's health outcomes, but it also improves body composition in PCOS patients. Women with PCOS can benefit from the exercise protocols as a non-pharmacological approach to changing their lifestyle and managing their discomforts.

ISRB approval: This research work has been approved by the ISRB committee.

Source of Funding: Self

Conflict of Interest: No conflict of interest during this research.

References

1. Knochenhauer ES, Key TJ, Kahsar-Miller M, Waggoner W, Boots LR, Azziz R. Prevalence of the polycystic ovary syndrome in unselected black and white women of the southeastern United States: a prospective study. *The Journal of Clinical Endocrinology & Metabolism*. 1998 Sep 1;83(9):3078-82.
2. Homburg R. What is polycystic ovarian syndrome? A proposal for a consensus on the definition and diagnosis of polycystic ovarian syndrome. *Human Reproduction*. 2002 Oct 1;17(10):2495-9.
3. Sultan C, Paris F. Clinical expression of polycystic ovary syndrome in adolescent girls. *Fertility and sterility*. 2006 Jul 1;86: S6.
4. Sekendiz B, Cug M, Korkusuz F. Effects of Swiss-ball core strength training on strength, endurance, flexibility, and balance in sedentary women. *The Journal of Strength & Conditioning Research*. 2010 Nov 1;24(11):3032-40.
5. Lawson S, Webster JD, Pacy PJ, Garrow JS. Effect of a 10-week aerobic exercise programme on metabolic rate, body composition and fitness in lean sedentary females. *The British journal of clinical practice*. 1987 Apr;41(4):684-8.
6. Lin AW, Kazemi M, Jarrett BY, Vanden Brink H, Hoeger KM, Spandorfer SD, Lujan ME. Dietary and physical activity behaviors in women with polycystic ovary syndrome per the new international evidence-based guideline. *Nutrients*. 2019 Nov 8;11(11):2711.
7. Nagarathna P, Rajan PR, Koneri R. A detailed study on poly cystic ovarian syndrome and it's treatment with natural products. *Int J Toxicol Pharmacol Res*. 2014;5(4):109-20.
8. Huber-Buchholz MM, Carey DG, Norman RJ. Restoration of reproductive potential by lifestyle modification in obese polycystic ovary syndrome: role of insulin sensitivity and luteinizing hormone. *The Journal of Clinical Endocrinology & Metabolism*. 1999 Apr 1;84(4):1470-4.
9. Bhattacharya SM, Jha A. Prevalence and risk of depressive disorders in women with polycystic ovary syndrome (PCOS). *Fertility and sterility*. 2010 Jun 1;94(1):357-9.
10. Dağ ZÖ, Dilbaz B. Impact of obesity on infertility in women. *Journal of the Turkish German Gynecological Association*. 2015;16(2):111.
11. Marshall P, Murphy B. Changes in muscle activity and perceived exertion during exercises performed on a swiss ball. *Applied physiology, nutrition, and metabolism*. 2006 Aug;31(4):376-83.
12. Jayabalan Prakash TT, Sivakumar S, Dharini S. Effectiveness of swiss ball exercises along with aerobic exercises among college girls with polycystic ovarian syndrome. *IP Journal of Urology, Nephrology & Hepatology Science*. April-June 2021;4(2):34-37.
13. Kogure GS, Miranda-Furtado CL, Silva RC, Melo AS, Ferriani RA, De Sá MF, Dos Reis RM. Resistance exercise impacts lean muscle mass in women with polycystic ovary syndrome. *Med Sci Sports Exerc*. 2016 Apr 1;48(4):589-98.
14. Almennig I, Rieber-Mohn A, Lundgren KM, Shetelig Løvvik T, Garnæs KK, Moholdt T. Effects of high intensity interval training and strength training on metabolic, cardiovascular and hormonal outcomes in women with polycystic ovary syndrome: a pilot study. *Plos one*. 2015 Sep 25;10(9):e0138793.
15. Pericleous P, Stephanides S. Can resistance training improve the symptoms of polycystic ovary syndrome?. *BMJ open sport & exercise medicine*. 2018 Aug 1;4(1):e000372
16. OBG MN. Effect of Swiss Ball Exercise and Progressive Resisted Exercise in Polycystic Ovarian Syndrome among Young Obese Women. *Specialusis Ugdymas*. 2022;1(43):43.
17. Kirthika SV, Paul J, Selvam PS, Priya VS. Effect of aerobic exercise and life style intervention among young women with polycystic ovary syndrome. *Research Journal of Pharmacy and Technology*. 2019;12(9):4269-73.
18. Harrison CL, Lombard CB, Moran LJ, Teede HJ. Exercise therapy in polycystic ovary syndrome: a systematic review. *Human reproduction update*. 2011 Mar 1;17(2):171-83.
19. Bansal A, Sethi J, Parasher RK. Role of structured exercise programs in polycystic ovary syndrome: a systematic review. *Physical Therapy Reviews*. 2022 Dec 29:1-1.
20. Maiya AG, Sheela RK, Kumar P. Exercise-induced weight reduction and fertility outcomes in women with polycystic ovarian syndrome who are obese and infertile: A preliminary report'. *Journal of exercise science and physiotherapy*. 2008 Jun;4(1):30-4.
21. Dumitrescu R, Mehedintu C, Briceag I, Purcarea VL, Hudita D. The polycystic ovary syndrome: an update on metabolic and hormonal mechanisms. *Journal of medicine and life*. 2015 Apr;8(2):142.
22. Dunaif A. Insulin resistance and the polycystic ovary syndrome: mechanism and implications for pathogenesis. *Endocrine reviews*. 1997 Dec 1;18(6):774-800.
23. Das C, Baruah T. Cross-Sectional Study Of Polycystic Ovarian Syndrome Among Bodo Community In Rural Areas Of North Guwahati, Kamrup Ditric, Assam. *The Researchers' International Research Journal*. 2022 Mar 1;8(1):1-3.
24. Patten RK, Boyle RA, Moholdt T, Kiel I, Hopkins WG, Harrison CL, Stepto NK. Exercise interventions in polycystic ovary syndrome: a systematic review and meta-analysis. *Frontiers in physiology*. 2020:606.