The Role of Life style Modification in Management of Polycystic Ovary Syndrome

Kalpana Sharma[1], S.K Srivastava[2]

[1]Research scholar, Department of Psychology, Gurukul Kangri Vishwavidyalaya, Haridwar, India (corresponding author), [2]Professor, Department of Psychology, Dean Faculty of Humanities, Gurukul Kangri Vishwavidyalaya, Haridwar, India

Abstract

Polycystic ovary syndrome is a common endocrine disorder affecting women of reproductive age group characterized by various metabolic and reproductive dysfunctions. There are evidences that environmental toxins play a potential role in disrupting reproductive health. In this review we summarized existing research on a variety of environmental factors involved in the etiology, prevalence and management of polycystic ovary syndrome. Pubmed, PsycINFO and Google Scholar were searched for the reviews and studies from last five years included in this study. All searches were limited to human studies. We concluded that symptoms of polycystic ovary syndrome are reduced with certain dietary supplement, restricted diet and exercise. Health related quality of life along with weight, body hair, infertility, acne score improves well with an intervention of about 24-weeks of lifestyle modification. That is why a healthy lifestyle is usually recommended to improve overall health and fertility.

Key words: *Polycystic ovary syndrome, dietary habits and exercise*

Introduction

Polycystic ovary syndrome is most common endocrine-metabolic disorders affecting 8% to 13% women of reproductive age group and is associated with ovulatory dysfunction, hyperandrogenism and cardiometabolic risk. Due to sedentary lifestyle and stress incidence of metabolic disorders like PCOS are increasing day by day. Polycystic ovary syndrome is characterized by insulin resistance, elevated circulating leukocytes, and hypothesized to have higher adipose tissue inflammation. The condition is marked by presence of cysts on the ovaries leading to their obstructed functioning. Amenorrhea, infrequent menstruation & anovulation, imbalanced hormonal levels, chronic pelvic pain and irregular bleeding are the common symptoms of Polycystic Ovary Syndrome. Women with polycystic ovary syndrome have higher prevalence of infertility compared with women without PCOS. 'The overweight-obese women having PCOS appears to have exacerbated reproductive dysfunction and cardio metabolic risk.[1] Early diagnosis and treatment may reduce the risk of long-term complications such as metabolic disorders, obesity, diabetes, and coronary disease, and malignancies such as breast and endometrial cancer. Obesity worsens the presentation of PCOS and weight management is supposed to be an initial treatment strategy. Khademi 2010 et.al found that 'Obese PCOS women show more difficulty in losing weight by exercise than lean women with PCOS'.[1] Though this target can be achieved through lifestyle modifications, by incorporating restricted diet, exercise and behavioral interventions. That is why a healthy lifestyle is usually recommended to improve overall health and fertility.

The actual cause of PCOS is unknown but environmental factors such as dietary habits play an important role in prevention and treatment of this syndrome. 'Weight reduction even of about 5% can improve problems such as insulin resistance, high level of androgens, reproductive system dysfunctions in women with PCOS. Thus, lifestyle modification can be used as therapeutic strategies in these patients'.[2] Lifestyle intervention may improves secondary reproductive outcome, free androgen index, may reduce weight and BMI. Women inducing lifestyle intervention shows

significant improvement in cardio respiratory fitness and reduces resting heart rate. It may also be used for improvement of health related quality of life and other psychological complications in women with PCOS. This can make enormous difference and relieve symptoms like eating habits, participating in regular physical activity, maintaining healthy weight, reducing androgen level, reducing risk of DM and CVD. 'Lifestyle intervention helps improving body composition parameters including BMI, waist circumference, waist hip ratio, body fat, total cholesterol, C-reactive protein and peak VO2 MD'.[3]Knowledge about these interventions increases healthy eating, active living, health care satisfaction, feelings and experiences about intervention and health concerns.[4] Losing just 5-10% of your body weight helps regulating menstrual cycle and improving symptoms of polycystic ovary syndrome. Thirty minutes of moderate to vigorous intensity exercise at least 4 days a week along with healthy diet can help women with PCOS lose weight.

Effect of Exercise on Polycystic Ovary Syndrome

Healthy lifestyle including nutritious and balanced diet, yoga & exercise are found effective in management of polycystic ovary syndrome. Weight loss programs hold promise and efficient hospital or community-based programs may prove beneficial in women with PCOS. Regular exercise also increases quality of life in these women. In overweight and obese women with or without PCOS exercise contributes to lower insulin and free androgen levels which helps restoring hypothalamic-pitutary-gonadal axis regulation of ovulation. The mechanism by which exercise affects ovulation is probably via modulation of hypothalamic-pitutary-gonadal axis. 'Despite various researches supporting weight loss as primary measure for PCOS management there is lack of studies comparing types of physical activity, intensity and settings. These gaps may be responsible for delaying an efficient and effective use of exercise as a therapeutic modality to treat anovulatory infertility including PCOS. Exercise with or without diet can lead to resumption of ovulation. Regular exercise for 30-60 min is associated with reduced risk of anovulatory infertility'.[5] Moderate aerobic exercise intervention for more than or equals to a period of three months have favorable effects on various cardio-metabolic risk factors in women with polycystic ovary syndrome. Some of these factors include total cholesterol level, fasting glucose, waist circumference and waist to-hip ratio, testosterone, sex hormone, C-reactive protein and systolic blood pressure.[6] Continuous aerobic training and intermittent aerobic training both helps in reduction of anxiety and depression. After approximately four months or sixteen weeks of aerobic training significant reduction in testosterone level are found. 'CAT significantly increases the total score of Female Sexual Function Index, improves FSFI domains of satisfaction and pain and reduced WHR. Intermittent aerobic training increases total FSFI score and improves desires, excitation, lubrication, orgasm and satisfaction in women with polycystic ovary syndrome'.[7] Beneficial effects of exercise are found for a range of metabolic, anthropometric and cardio respiratory fitness related outcomes. 'Short duration and aerobic exercise significantly affects fasting insulin level, total cholesterol, low density cholesterol, and triglycerides. Exercise also improves VO2 max, waist circumference and body fat percentage'.[8] Moderate intensity exercise independent of substantial weight loss improves endothelial function in women with PCOS by reducing circulating CD105+MP.[9] Physical resistance exercise alone can improve hyperandrogenism, reproductive function, and body composition by decreasing visceral fat and increasing lean muscle mass. 'PRT reduces plasma testosterone and fasting glucose, increased androstenedione concentration and sex hormone binding globulin concentration decreases in women with PCOS'.[10] Regular physical activity is associated with better anthropometric and androgenic profile in women with PCOS. As compared to sedentary women with PCOS active women have lower waist circumference, lipid accumulation product and low androgen levels.[11]

When compared to oral contraceptives which treat hyperandrogenism and menstrual disturbances structured exercise training program is helpful in effective management of anthropometric measures, insulin sensitivity indexes, lipid profile, cardiopulmonary function, inflammatory marker and frequency of menstrual cycle in women with PCOS.[12] 'Obese adolescents having PCOS who have experienced childhood trauma can lose weight and acquire its health benefits when intervened with weight loss, mood, and sleep'.[13] Weight loss, fertility hormones, FSH, prolectin, oestrogen, antral follicle count, baseline anti-mullerian

hormone and adiponectine are significantaly correlated with reproductive function. Physical activity changes the level of anti-mullerian hormone and adiponectin. Moderate aerobic exercise for around twelve weeks had significant effect on reproductive functions by modulating adiposity, levels of adiponectine anti-mullerian hormones and fertility hormones. 'Participants who respond to aerobic exercise intervention show significant improvement in reproductive function, with lower baseline anti-mullerian hormone level, weight loss and increased adiponectine level. These women also shows significant improvement in ovarian process and a restoration of menstrual cycle'.[14] Resistance training has beneficial effects on morphology of the ovaries and the glycemic index in women with PCOS. It has good effect on insulin resistance index, improves ovaries volume, body composition indices including weight, body mass index and body fat.[15]

Polycystic ovary syndrome is characterized by insulin resistance, elevated circulating leukocytes and more tissue inflammation. In obese individuals aerobic exercise reduces circulating leukocytes and improves insulin sensitivity. Women with polycystic ovary syndrome have higher circulating leukocytes. This condition can be reversed by aerobic exercise and is associated with improvement in insulin sensitivity. WBC is fond higher and total adiponectin level is lower in PCOS women performing regular exercises. 'Regular aerobic exercise for four weeks reduces serum leptin; ratio of leptin to high molecular weight adiponectine after eight weeks and significantaly increases serum dehydroepiandrosterone sulfate after sixteen weeks'.[16] Exercise may normalize amino acid metabolite in women with PCOS. 'If regular exercise is performed, Lucien, glutamate, methionine, ornithine, phenylalanine, tyrosine and proline in women with PCOS may normalize and become equal to women without PCOS'.[17]

'Aerobic exercise increase vagal modulation, decrease sympathetic modulation and increases parasympathehic modulation, decrease resting heart rates and systolic blood pressure irrespective changes in BMI, fasting insulin and testosterone level'.[18] Women with PCOS who meet department of health and human services guidelines for exercise have superior metabolic health parameters. Vigorous exercise is associated with reduced metabolic dysfunctions independent of age, BMI and total energy expenditure. 'When compared with inactive women and moderate exercisers, it was found that vigorous exercisers had lower body mass index, higher level of HDL and sex hormone binding globulin and reduced prevalence of the metabolic syndrome'.[19] Homeostatic assessment of insulin resistance improves after high intensity interval training, high density lipoprotein increases, endothelial function increases and body fat decrease.[20] Progressive aerobic exercise improves health related quality of life, cardio respiratory fitness and cardio metabolic profile of overweight/ obese women with polycystic ovary syndrome. While glancing psychological aspects 'exercise improves following domains of health related quality of life - physical functioning, general health and mental health'.[21]

Effect of Yoga on Polycystic Ovary Syndrome

Women with PCOS also suffer from emotional ill health, anxiety and depression. Medical yoga therapy is emerging as an effective modality in the management of much non-communicable disease. Yoga therapy also addresses psychological morbidity. Yoga has calming effect on the mind and body through balancing sympathetic and parasympathetic nervous system. Lifestyle modification including diet, exercise and weight loss is very important component of management of PCOS. 'Thus yoga results in multiple beneficial effects on neuroendocrine axis and facilitates adoption of healthier lifestyle addressing underlying hyperandrogenemia and insulin resistance in PCOS'.[22] Due to disturbance in hypothalamo-pitutary-ovarian axis various symptoms like anxiety, depression, insomnia, loss of concentration, acne, infertility etc. appears in syndrome. It is a psychosomatic disorder too, so it is important to provide psychic and somatic treatment also. Yoga is the complete prescription for the healthy body and mind which deals with the root cause of this disorder i.e., obesity and stress. 'Daily yoga with for thirty minutes with four asans, four pranayam, meditation, and shavasan helps in weight reduction and stress management, thus normalizing hypothalamo-pitutary-ovarian axis and cuing polycystic ovary syndrome. Asans like suryanamaskar, paschimottan asan, bhujangasan, shalabhasan etc. helps in weight reduction and toxin exerction from the body. Pranayam and relaxing yoga posture like Shavasana, makarasan etc. helps curing stress'.[23]Yoga and naturopathy therapy

for twelve weeks improves ovarian morphology and anthropometric measurements.[24] Regular mindful yoga practice can be used as complementary therapeutic option for women with PCOS. This lowers serum androgen (dehydroepiandrosterone) and free testosterone levels. Improvement occurs even in absence of weight loss and persists even if there is a lapse in practice.[25]

Dietary Modification and PCOS

Overweight women with PCOS related infertility have eating behaviors inconsistent with achieving a healthy body weight. They have poor dietary intake, particularly related to whole grains, fiber and iron.[26] 'PCOS women consume high glycemic index food items and lower legumes and vegetables'.[27]There is high prevalence of overweight status, obesity, and increased visceral fat in these women. Diet quality is negatively associated with obesity. Two of the primary ways diet affect PCOS are weight management and insulin production and resistance. 'Diet therapy in these patients must reach specific goals such as improving insulin resistance, metabolic and reproductive function. Low-calorie diet can be used to achieve weight loss or maintaining a healthy weight. Diet must focus on limited intake of simple sugars, refined carbohydrates and intake food with low glycemic index, reduction of saturated and trans-fat. Attention must be paid to possible deficiencies of vitamin D, chromium and omega-3 fatty acid'.[2] Energy restriction and weight loss in PCOS improves ovulation rates, conception, hyperandrogenemia, glucose and insulin level, insulin resistence, and satiety hormones. Diet low in carbohydrate as compared to standard diet has 1-5% significant additional effect to caloric restriction in terms of weight loss.[28] Carbohydrates are the main stimulators of insulin release. Dairy products and starches elicit great postprandial insulin secretion than non-starchy vegetables and fruits. 'Eight week dietary intervention using a low starch/low dairy diet in women with PCOS is effective in reducing weight, BMI, waist circumference, waist to hip ratio, fasting insulin and homeostasis model assessment of Insulin Resistance (HOMA-IR), total testosterone, free testosterone, and ferriman- Gallwey score'.[29] High dietary GI and low fibre intake are associated with PCOS.[30] Low carbohydrate diet is more beneficial in weight loss, reducing insulin and serum testosterone. 'This diet when combined with exercise results in weight loss, decreased body fat, increased insulin sensitivity, improved estradiol and LH: FSH ratio and other reproductive measures'.[31]Dietary weight loss in adolescent women with polycystic ovary syndrome resulted in significant improvement in menstrual regularity, BMI, waist circumference, and hirsutism score.[32] 'When these women are subjected to an anti-inflammatory hypocaloric diet with physical activity they show significant improvements in body composition, hormones, menstrual cycle, blood pressure, glucose homeoststis, dyslipidemia, C-reactive protein and serum amyloid acid and improved fertility with 12% spontaneous pregnancy rate'.[33]A proper low-calorie diet with low glycemic index should be recommended along with PA to improve psychological, reproductive, and cardiovascular parameters for women with polycystic ovary syndrome.

There is currently no standard diet for PCOS. However, a widespread agreement about food which seems to be beneficial for these women are: A) A low glycemic such as whole grains, legumes, nuts, seeds, fruits, starchy vegetables, unprocessed and low carbohydrate good. B) An anti-inflammatory diet such as berries, fish, green leafy vegetables, extra virgin oil etc. C) DASH (dietary approaches to stop hypertension) diet which includes poultry, fruits, vegetables, whole grain, and low fat dairy products. DASH diet reduces hypertension and risk of heart disease. Other foods that can be included in diet are: natural unprocessed food, high fiber food, fatty fish, salmon, spinach, dark red fruit, blue& blackberries cherries, broccoli and cauliflower, dried beans, lentil; healthy fats such as olive oil, avocados, coconut; nuts like walnut, almonds, pistachios; spices like turmeric and cinnamon; and dark chocolate. Food to be avoided is: sugary beverages such as sodas and energy drinks; refined carbohydrates such as pastries, cakes, white processed bread; processed meat etc.

Other beneficial dietary habits are including small frequent meals, consumption at regular times, majority of carbohydrates consumption at lunch time or equally distributed through out the day and drinking plenty of water.

Conclusion

Due to sedentary lifestyle and stress incidence of metabolic disorders like PCOS are increasing

day by day. Early diagnosis and treatment including lifestyle modification may reduce the risk of long-term complications such as metabolic disorders, obesity, diabetes, and coronary disease, and malignancies such as breast and endometrial cancer. Losing just 5-10% of your body weight helps regulating menstrual cycle and improving symptoms of polycystic ovary syndrome. Moderate to vigorous regular physical exercise along with healthy and restricted diet helps these women achieving healthy body weight, normalizing hormonal profile and improving metabolic and reproductive functioning. Including yoga in daily life routine helps in both mental and physical health maintenance. Lifestyle modification is thus an effective measure in improving mental and physical health of women with PCOS.

Conflict of Interest: There were no conflicts of interest

Ethical Clearance- Not required

Source of Funding- Self

References

1. Khademi, A., Alleyassin, A., Aghahosseini, M., Tabatabaeefar, L., & Amini, M. (2010). The Effect of Exercise in PCOS Women Who Exercise Regularly. Asian J of Sports Med, 1(1), 35–40. doi: https://doi.org/10.5812/asjsm.34874
2. Zeinab Faghfoori, Siavash Fazelian, Mahdi Shadnoush and Reza Goodarzi. Nutritional Management in Women with Polycystic Ovary Syndrome: A Review Study, Diabetes & Metabolic Syndrome. Clin Res Rev. 2017;11(1):S429-S432. doi: https://doi.org/10.1016/j.dsx.2017.03.030.
3. Haqq L, McFarlane J, Dieberg G , Smart N (2015). The Effect of Lifestyle Intervention on Body Composition, Glycemic Control, and Cardiorespiratory Fitness in Polycystic Ovarian Syndrome: A Systematic Review and Meta-Analysis. Int J Sport Nutr Exerc Metab. 2015;25(6):533-40, doi:10.1123/ijsnem.2013-0232
4. Kazemi M, McBreairty LE and Zello GA, et al (2020). A Pulse-Based Diet and the Therapeutic Lifestyle Changes Diet in Combination with Health Counseling and Exercise Improve Health-Related Quality of Life in Women with Polycystic Ovary Syndrome: Secondary Analysis of a Randomized Controlled Trial. J Psychosom Obstet Gynaecol. 2020;41(2):144-53, doi:10.1080/0167482X.2019.1666820
5. Hakimi O, Cameron LC (2017). Effect of Exercise on Ovulation: A Systematic Review. Sports Medicine, 2017;47(8):1555-67. doi:10.1007/s40279-016-0669-8
6. Woodward A, Broom D, Harrop D, et.al (2019). The Effects of Physical Exercise on Cardio Metabolic Outcomes in Women with Polycystic Ovary Syndrome not Taking the Oral Contraceptive Pill: A Systematic Review and Meta-Analysis. J diabetes metabol disord 2019;18(2):597-12. doi:10.1007/s40200-019-00425-y
7. Lopes IP, Ribeiro VB and Reis RM, et al. Comparison of the Effect of Intermittent and Continuous Aerobic Physical Training on Sexual Function of Women With Polycystic Ovary Syndrome: Randomized Controlled Trial. J Sex Med. 2018;15(11): 1609-19. doi:10.1016/j.jsxm.2018.09.002
8. Kite C, Lahart IM and Afzal I, et.al (2019). Exercise, or Exercise and Diet for the Management of Polycystic Ovary Syndrome: A Systematic Review and Meta-Analysis. ***Systematic Reviews***, 8(1), 51, Doi:10.1186/s13643-019-0962-3
9. Kirk RJ, Madden LA, Peart DJ, Aye MM, Atkin SL, Vince RV. Circulating Endothelial Microparticles Reduce in Concentration Following an Exercise Programme in Women With Polycystic Ovary Syndrome. Front Endocrinol (Lausanne). 2019;10:200. doi:10.3389/fendo.2019.00200
10. Kogure GS, Miranda-Furtado CL and Silva RC, et al. Resistance Exercise Impacts Lean Muscle Mass in Women with Polycystic Ovary Syndrome. Med and Sci in Sports and Exercise 2016;48(4):589-98. doi:10.1249/MSS.0000000000000822
11. Mario FM, Graff SK and Spritzer PM. Habitual Physical Activity is Associated with Improved Anthropometric and Androgenic Profile in PCOS: A Cross-Sectional Study, ***J Endocrinol Inves***, 2017;40(4):377-84. Doi:10.1007/s40618-016-0570-1
12. Orio F, Muscogiuri G, Giallauria F, et al (2016). Oral Contraceptives versus Physical Exercise on Cardiovascular and Metabolic Risk Factors in Women with Polycystic Ovary Syndrome: A Randomized Controlled Trial. Clin Endocrinol

(Oxf). 2016; 85(5): 764-71. doi:10.1111/cen.13112

13. Rofey DL, El Nokali NE, Jackson Foster LJ, Seiler E, McCauley HL, Miller E. Weight Loss Trajectories and Adverse Childhood Experience among Obese Adolescents with Polycystic Ovary Syndrome. J Pediatr Adolesc Gynecol. 2018;31(4):372-75. doi:10.1016/j.jpag.2018.03.001
14. Al-Eisa E, Gabr SA, Alghadir AH. Effects of Supervised Aerobic Training on the Levels of Anti-Mullerian Hormone and Adiposity Measures in Women with Normo-Ovulatory and Polycystic Ovary Syndrome. J Pak Med Assoc. 2017;67(4):499-07.
15. Esmaelzadeh toloee, Mohammadraze & Afshar nezhad, Taher & Yazdani, Fereshteh & Ahmadi ,Beheshteh. The Effect of 8 Weeks of Resistance Training on Ovary Morphology, Glycemic control and Body Composition on Women with Polycystic Ovary Syndrome. Med J Mashhad Univ Med Sci.2015;58(7): 381-89.
16. Covington JD, Tam CS, Pasarica M, Redman LM. Higher Circulating Leukocytes in Women with PCOS is Reversed by Aerobic Exercise. Biochimie. 2016;124:27-33. doi: 10.1016/j.biochi.2014.10.028
17. Halama, A, Aye M M, Dargham SR, Kulinski M, Suhre K, Atkin S L. Metabolomics of Dynamic Changes in Insulin Resistance Before and After Exercise in PCOS. Front Endocrinol. 2019;10:116. doi: https://doi.org/10.3389/fendo.2019.00116
18. Joceline CF, Sá Eduardo CC, Ester da Silva, Nayara YT, Alberto P, Leany FM, Telma MAM. Lemos, Elvira MM Soares, George DA. Aerobic Exercise Improves Cardiac Autonomic Modulation in Women with Polycystic Ovary Syndrome, Int J Cardiol**.** 2016;202:356-61. doi: https://doi.org/10.1016/j.ijcard.2015.09.031.
19. Eleni AG, Martha WN, Chia-Ning Kao, Kanade S, Lauri AP, Marcelle IC, Heather GH. Vigorous Exercise is Associated with Superior Metabolic Profiles in Polycystic Ovary Syndrome Independent of Total Exercise Expenditure. Fertil Steril. 2016;105(2):486-93. doi: https://doi.org/10.1016/j.fertnstert.2015.10.020.
20. Almenning 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;10(9):e0138793. doi:10.1371/journal.pone.0138793
21. Costa EC, DE Sá JCF, Stepto NK, et al. Aerobic Training Improves Quality of Life in Women with Polycystic Ovary Syndrome. Med Sci Sports Exerc. 2018;50(7):1357-66. doi:10.1249/MSS.0000000000001579
22. Patil Anushree D, Vaidya Rama A, Pathak Satish D, Chauhan Sanjay L, Surve Suchitra V, Kokate Pratibha P , Joshi Beena N. Yoga Therapy: The Fourth Dimension in the Multidisciplinary Management of Women with Polycystic Ovary Syndrome, A Narrative Review. Indian Pract 2019;71(4):45-51.
23. Dei Laxmipriya & Verma, Anjali & Dhiman, Kamini. Management of PCOS: A Psychosomatic Disorder by Yoga Practice. Int J Innov Research develop. 2015; 4:216-19.
24. Ratnakumari ME, Manavalan N, Sathyanath D, Ayda YR, Reka K (2018). Study to Evaluate the Changes in Polycystic Ovarian Morphology after Naturopathic and Yogic Interventions. Int J Yoga. 2018;11(2):139–47. doi: https://doi.org/10.4103/ijoy.IJOY_62_16
25. Patel Vishesha, Heather Menezes, Christian Menezes, Stephanie Bouwer, Chevelta A. Bostick-Smith, Diana L. Speelman. Mindful Yoga Practice as a Method to Improve Androgen Levels in Women With Polycystic Ovary Syndrome: A Randomized, Controlled Trial. J Am Osteopath Assoc. 2020;120(5):323-35. doi:10.7556/jaoa.2020.050
26. Gabrielle Turner-McGrievy, Charis R. Davidson, Deborah L. Billings. Dietary Intake, Eating Behaviors, and Quality of Life in Women with Polycystic Ovary Syndrome who are Trying to Conceive. Hum Fertil 2015;18(1):16-21 doi: 10.3109/14647273.2014.922704
27. Shishehgar F, Ramezani Tehrani F, Mirmiran P, Hajian S, Baghestani AR, Moslehi N. Comparison of Dietary Intake between Polycystic Ovary Syndrome Women and Controls. Glob J Health Sci. 2016; *8*(9):54801. doi: https://doi.org/10.5539/gjhs.v8n9p302
28. Frary JM, Bjerre KP, Glintborg D, Ravn P. The Effect of Dietary Carbohydrates in Women with Polycystic Ovary Syndrome: A Systematic Review. Minerva Endocrinol 2016;41(1):57-69

29. Phy, JL, Pohlmeier AM, Cooper JA, Watkins P, Spallholz J, Harris KS, Berenson AB, Boylan, M. Low Starch/Low Dairy Diet Results in Successful Treatment of Obesity and Co-Morbidities Linked to Polycystic Ovary Syndrome (PCOS). J Obes Weight Loss Therapy. 2015;5(2):259, doi: https://doi.org/10.4172/2165-7904.1000259
30. Eslamian G, Baghestani AR, Eghtesad S, Hekmatdoost A. Dietary Carbohydrate Composition is Associated with Polycystic Ovary Syndrome: A Case-Control Study. J Hum Nutr Diet. 2017;30(1):90-97. doi:10.1111/jhn.12388
31. Kat Sweatt, Fernando Ovalle, Ricardo Azziz, Barbara Gower. The Effect of Diet and Exercise in Women with Polycystic Ovary Syndrome. FASEB J. 2015;29(1)_supplement
32. Tayseer M. Marzouk, Waleed A, Sayed Ahmed. Effect of Dietary Weight Loss on Menstrual Regularity in Obese Young Adult Women with Polycystic Ovary Syndrome. J Pediatr Adolesc Gynecol. 2015;28(6):457-61.
33. Salama, AA, Amine EK, Salem HA, Abd El Fattah NK. Anti-Inflammatory Dietary Combo in Overweight and Obese Women with Polycystic Ovary Syndrome. N Am J Med Sci. 2015;7(7): 310–316. doi: https://doi.org/10.4103/1947-2714.161246
34. Bahrami, Homa and Mohseni, Maryam and Amini, Leila and Karimian, Zahra (2019). The Effect of Six Weeks Yoga Exercises on Quality of Life in Infertile Women with Polycystic Ovary Syndrome (PCOS). Iran J Obstet Gynaecol Infertil. 2019;22(5):18-26.
35. Rodrigues AM. dos S, Martins LB, Franklin AMT, Candido AL, dos Santos, LC, Ferreira AVM. Poor quality diet is associated with overweight status and obesity in patients with polycystic ovary syndrome. J Hum Nutr Diet. 2014; doi: 10.1111/jhn.12205