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Nutritional and Lifestyle Management in Polycystic Ovary Syndrome (Pcos)

Sangeeta Kulshrestha[1]

[1]K. L. Mehta Dayanand College for Women, Faridabad (Haryana)

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ABSTRACT

Polycystic ovary syndrome (PCOS) is a complex endocrine disorder affecting 6-26% reproductive age women in the world. It is often associated with obesity, insulin resistance and various other metabolic impairment. Common treatment strategies include nutritional and lifestyle management along with pharmacological treatment. Studies have recommended that nutrition and exercise are key factors in the maintenance of health in women with PCOS. This narrative review aims to identify dietary and nutritional aspects of PCOS, role of nutritional supplements and exercise in prevention and treatment of PCOS in view of various studies. This will help to allow for an individual approach that will avoid unduly restrictive or nutritionally unbalanced diets.

Keywords: *Polycystic ovary syndrome (PCOS), nutrition, lifestyle management, exercise, yoga, probiotics*.

1. INTRODUCTION

Polycystic ovary syndrome (PCOS) is one of the most prevailing endocrine and metabolic disorder affecting females of reproductive age group. It is also called Stein – Leventhal syndrome (1). Most of the cases are identified between the ages of 20 and 30 (2). PCOS affects 3.7- 22.5% females in India and 6- 26% females worldwide (2,3).

Signs and symptoms of PCOS include enlarged ovaries with numerous small cysts, irregular menstrual cycles (oligomenorrhoea), excessive hair growth (hirsutism), often obesity, infertility, pelvic pain, hair loss (alopecia) and acne (1). PCOS is described as a condition where at least one ovary has an ovarian volume greater than 10 ml and at least one ovary has an estimated ten small cysts, with diameters ranging from 2 to 9 mm, develop (4). Clinical signs of PCOS include elevated luteinizing hormone (LH) & gonadotropin-releasing hormone (GnRH) levels, whereas follicular stimulating hormone (FSH) levels are unchanged. As a result, ovarian thecal cells produce more androgen (5). Approximately 25% of patients with PCOS have elevated prolactin levels (6).

PCOS is linked with several comorbidities like increased prevalence of cardiometabolic risk factors including dyslipidemia, hypertension, myocardial infarction, impaired glucose tolerance, chronic inflammation, anxiety, depression, endometrial cancer and sleep apnea (4,7). Individuals with PCOS have been shown to have higher body weight, fat mass, body fat percentage, body mass index (BMI), waist- to- hip ratio (WHR) compared to women without PCOS (4). Kutananaee et al. (2019) found that women with PCOS had lower sleep quality and daytime function and were more likely to utilize medication to assist with sleep (8).

According to Szczuko et al. (2021), the four main causes of the physiological basis of PCOS (9) include:

- disorders of gonadotropin hormonal synthesis
- the appearance of insulin resistance
- the influence of the presence of excessive body fat
- the metabolic pathways involved in PCOS (the secretion and activity of insulin, encoding for steroidogenesis and other metabolic and hormonal pathways)

Management Approach

The management approach of PCOS and the choice of the best therapeutic option depend on the patient, her age, needs, priorities, etc. (10). Complications can vary from seeking fertility to regulating menstrual cycle, weight loss or relief of hyperandrogenic (11). Therefore, to achieve the best result for each patient, the management approach should be individualistic. Till date, there is no ideal or definitive therapy for PCOS. For this reason, the current approach is characterised

by a symptomatic therapy with many drugs, including oral contraceptives, insulin sensitizers, cyclic progestins or antiandrogens and fertility treatments associated with lifestyle changes (12,13). On the basis of the results of their study, Rajbanshi et al. (2023) have suggested that PCOS should be diagnosed and treated early in adolescence (14).

Lifestyle Management Lifestyle change is the first line of treatment for the management of women with PCOS but is not an alternative to its pharmacological treatment (15). The International Evidence- Based Guideline for the Assessment and Management of PCOS also emphasizes lifestyle intervention as the primary early management strategy (16). The 2023 International Evidence-Based Guidelines for the Assessment and Management of PCOS recommends that healthy lifestyle interventions including improving dietary intake and increasing physical activity should be tailored to allow for a flexible, individual approach that avoids unduly restrictive or nutritionally unbalanced diets (17). In the PCOS Guideline (2018), lifestyle management is recommended for general health benefits for women with PCOS. The guideline promotes weight management, which includes weight gain prevention in all women with PCOS and achieving & maintaining modest weight loss in women with excess weight (16). While there is not a specific 'PCOS diet' that can completely reverse the syndrome, several dietary principles should be followed to improve its symptoms (18).

Obesity and PCOS PCOS patients are not always markedly overweight but it is strongly associated with abdominal obesity and insulin resistance (19). Studies have shown that approximately 60-40% of PCOS cases are overweight or obese (20). Several studies have reported the positive effects of lifestyle intervention leading to 5-10% weight loss on reducing the risk factors for cardiovascular disease, type 2 diabetes, endocrine and reproductive parameters in PCOS (21,22,23). Women suffering from PCOS often complain about the lack of or slow rate of weight loss in spite of a strict calorie restricted diet (24,25). Georgopoulos et al. (2009) found that women with PCOS, with or without insulin resistance, have a lower basal metabolic rate compared to healthy women (26).Xenou and Gourounti (2021) concluded that the change in the diet of women brought positive results in terms of clinical appearance of PCOS (27). On the basis of 9 randomized controlled trials, Yang et al. (2024) have concluded that calorie restricted diets, low-calorie-low-carb combined diets had advantages over other dietary interventions and can improve the clinical manifestations of PCOS and pregnancy rates in patients with a BMI≥25kg/m^2 (28). In another study, higher adherence to the MIND(Mediterranean-DASH Intervention for Neurogenerative Delay) diet is found to be associated with a lower risk of PCOS (29).

Dietary Patterns and PCOS Barrea et al. (2019) observed in their study in Italy that women with PCOS consumed less virgin oil, legumes, fish, nuts, fewer complex carbohydrates, fibre, unsaturated fatty acids as compared to control group. They concluded that there seems to be a direct correlation between the adherence to the Mediterranean diet and women with PCOS (30). Kazemi et al. (2020) also showed that the alternative Mediterranean diet (aMED} and dietary approaches to stop hypertension (DASH) diets improved the appearance of the ovaries. These diets are characterised by favourable combinations of dietary ingredients, which include high dietary fibre, processed composition and ratio of macronutrients, vitamins & minerals and other dietary agents with antioxidant properties (31). In Italy, Paoli et al. (2020) studied the effect of a ketogenic Mediterranean diet on women with PCOS. They could consume green leafy vegetables, cruciferous vegetables, zucchini, cucumbers and egg plants in unlimited quantity but the amount of meat, eggs and fish was limited. Subjects were given dietary supplements, which were high in protein and very low in carbohydrates. After 12 weeks, there was a considerable decrease in body weight, BMI, fat free mass, decrease in blood glucose and insulin levels, triglycerides, total cholesterol & LDL and increase in HDL (32). In obese women with PCOS and liver dysfunction, ketogenic diet improves the menstrual cycle, lowers blood glucose and body weight, improves liver function and treats fatty liver (33). According to Calcaterra et al. (2024), among the different types of ketogenic diet (KD) studies, very low-calorie ketogenic diets (VLCKD) can be considered an effective short term dietary intervention for the patients with PCOS (34). It leads to weight loss very rapidly with improvement in body composition and metabolic profile. Even though ketogenic diets are extremely advantageous, their long-term use is unsustainable due to important restrictions required for ketosis development. Thus, a combination of high-fat diets with more nutrient-rich nutritional regimens, such as Mediterranean diet, can amplify positive effects for individuals with PCOS (34).Particular eating patterns, such as eating smaller more frequent meals across the day (35) and eating a larger breakfast and smaller dinner (36), have also been found to be beneficial for insulin sensitivity and androgen reductions. A study by Kulshreshtha et al. (2022) showed that although there was no difference in the total energy and macronutrient distribution among the lean and obese PCOS women compared to weight matched controls, there was a higher junk intake and lower fibre intake among women with PCOS. Around 40% PCOS women had a late/missed breakfast pattern compared to 15% of healthy controls. It was observed that late breakfast and late lunch patterns were associated with PCOS independent of BMI (37). In another study, it was found that girls with PCOS were less likely to have cereals for breakfast. They were more likely to eat an evening meal and eat this over an hour later when compared to controls (38).

On the basis of various studies, Konikaj et al. (2022) summarised that the higher rates of eating disorders (for example, binge eating disorder, night eating syndrome, anorexia nervosa and bulimia nervosa) were found among the PCOS groups compared to control groups of women (39).

Energy Calorie restricted diets can help in weight loss in obese women with PCOS and improvement in hirsutism, insulin resistance and androgen levels (40). Neves (2020) suggested energy intake of 1000-1500 Kcal/day whereas Moran et al. (2008) suggested 500-1000 Kcal/day along with regular activity for weight loss strategy (40,41). The extent of the deficit in calories should be tailored to individual needs, including dietary preferences, habits, cultural factors, metabolic objectives, and physical activity levels (42).

Dietary Carbohydrates There is no optimum amount of carbohydrate intake for women with PCOS and therefore, any range (about 40-55%) of dietary carbohydrate can be taken according to individual's needs and preferences. A beneficial approach is to evenly spread carbohydrate across meals throughout the day or larger portion during lunch time (43).

There are ample evidences which support the benefits of diets with a low glycaemic index (GI) in women with PCOS. Low GI foods improve insulin resistance (44,45), whereas, high GI foods exert opposite effects (46). Pandey and Niroula (2024) have concluded that low-GI diets are helpful for successful weight loss, increase insulin sensitivity & reduce insulin resistance, fasting insulin, LDL cholesterol, triglycerides, waist circumference, total testosterone and maintaining menstrual regularity when compared to high GI diets (43).

The DASH diet, which is low-GI and high in complex carbohydrate, demonstrated positive effects on weight loss, insulin metabolism and inflammation markers in PCOS women (42). The pooled result of 12 studies showed that the dietary fibre intake was significantly lower in PCOS women than those of controls, however, there was non-significant difference in their total energy intake (47).

Protein In women with PCOS, higher protein intakes may be superior at suppressing androgen levels when compared to high carbohydrate diets (48). Studies have found that a diet higher in protein may yield several positive health outcomes, including weight loss, improved glycaemic control and control of other cardiovascular disease risk factors (43). Addition of 7-15g of dietary protein to meals and snacks might offer health benefits to PCOS women, particularly regarding insulin sensitivity and post prandial glucose levels (43).

Fats and Fatty Acids Farshchi et al. (2007) have recommended that fat should be restricted to less than or equal to 30% of total calories in the diets of PCOS patients with a low proportion of saturated fat (19). Diets high in fat, especially saturated fat and trans-fatty acids mainly reduce insulin sensitivity and increase the risk of type 2 diabetes, metabolic syndrome and cardiovascular disease, while receiving foods containing unsaturated fats reduces the risk of PCOS (49,50). Low-fat hypocaloric diet can help reduce body weight and composition compared to high-fat hypocaloric diets. A diet moderately low in carbohydrates (43%) but rich in unsaturated fatty acids may lead to a significant decrease in fasting insulin levels (43).

Omega-3 Fatty acids are often lacking in the diets of PCOS patients. These enhance reproductive performance by affecting hormone secretion and ovarian functions (9). Omega-3 fatty acids, specifically EPA and DHA, have antioxidant, anti-inflammatory, insulin sensitizing and anti-obesity properties. However, the result of its supplementation on PCOS patients is not yet confirmed because of the mixed study results on lipid profiles, waist circumference and menstrual regularity (43).

Micronutrients Women with PCOS often have deficiencies of essential micronutrients like vitamin D, vitamin C, zinc, selenium, vitamin E, folic acid, vitamin B_{12} and magnesium (43). Sometimes, PCOS patients are treated with metformin, but its chronic intake may lead to deficiencies of thiamine and cobalamin (51). Eslamian and Hekmatdoost (2019) reported higher risk of PCOS among women with high loadings for sodium, biotin, copper, iron, fluoride, zinc and calcium as compared to those having nutrient pattern having high loadings for riboflavin, niacin, pyridoxine, thiamine, magnesium, pantothenic acid, cobalamin, vitamin C, Folate, vitamin D, selenium, phosphorus, vitamin E, manganese, vitamin K and potassium (52). Herbert and Woolf (2023) have also summarised lower intake of vitamin A, folate, vitamin C, Vitamin D and magnesium among women with PCOS (4). Brilliant et al. (2022) found a significant negative correlation between the free androgen index (FAI) and intake of vitamin B1, vitamin B2, niacin, vitamin B6, calcium and iron in the NA (normoandrogenic) group while this association was absent in the HA (hyperandrogenic) group (53).In their study on 310 females with PCOS and 602 age-matched controls, Shoaibinobarian et al. (2022) concluded that there was a relationship between high total antioxidant capacity (TAC) diets and lower odds of PCOS (54).

For corpus luteum formation and supporting progesterone production essential for implantation, zinc (an antioxidant) is crucial (55). Results of the supplementation studies suggest potential benefits of at least 50 mg zinc/ day for 8 weeks in the management of PCOS (43).Low selenium levels in PCOS women compared with healthy controls have been reported and showed a negative correlation between serum testosterone level and selenium (56). In PCOS patients, selenium intake benefits by reducing oxidative stress along with insulin resistance and hyperandrogenism with its levels correlating with oestrogen changes during menstrual cycle (9). Results of different randomized trials showed that 200µg daily selenium supplementation for 8-12 weeks in PCOS women showed improved pregnancy rates, reduced alopecia, acne and lowered inflammatory markers (43). Reduced levels of magnesium have been reported in women with high levels of testosterone or insulin resistance, such as type 2 diabetes and metabolic syndrome. Hence, magnesium supplementation seems to be effective in the adjustment and improvement of insulin resistance (57).Vitamin C, an antioxidant, is involved in endometrial health and ovarian regulation. Vitamin C levels modulate throughout the menstrual cycle, affecting ovulation and progesterone production. The vitamin's level decline immediately before ovulation and again increase after post-ovulation temperature rises (43). Brilliant et al. (2022) showed in their study that the intake of vitamin C had significant effect on free androgen index (FAI) (53). Vitamin C intake may play a role in regulating menstrual cycle irregularities in women with PCOS, but further research is needed (58).Vitamin E shows its potential in counteracting reproductive system oxidative stress, impacting oocyte quality and countering pregnancy-related diseases (59). In a clinical trial on PCOS women, a 100 mg/day short term vitamin E supplementation resulted in improved endometrial thickness and oestrogen levels, however, no significant impact on pregnancy rates was observed (58,59).The prevalence of vitamin D deficiency in women with PCOS is about 67-85% with serum concentrations of 25(OH)D<20ng/ml (60). Vitamin D deficiency is closely related to symptoms such as central obesity, ovulatory & menstrual irregularities, insulin resistance, infertility, hirsutism and increased risk of cardiovascular disease (1,43,61). Vitamin D and calcium supplementation enhances insulin levels, reduces insulin resistance, improves menstrual regularity and lipid profile (43). Vitamin D supplementation also helps PCOS patients with their mental issues and their capacity to reproduce (61). Shen et al. (2023) suggested a causal relationship between increased level of vitamin A and decreased risk of PCOS (62). Vindhya et al. (2023) have suggested that the injection of retinol as promising new therapy to treat women with PCOS as it has both protective and ameliorative effects (63). As a result, treating PCOS in women with vitamin A improves hyper-insulinemia and boosts insulin sensitivity (64,65).

Herbs Supporting Treatment of Women with PCOS Many studies have indicated that use of certain herbs also support the treatment of PCOS. Studies exhibited consumption of 30 g/day of flax seeds for 4 months and 1000 mg flaxseed oil omega-3 fatty acids (1000mg capsule) for 12 weeks resulted in improved insulin levels, reduced BMI, testosterone and improved other metabolic markers (66,67). Flax seeds are rich sources of omega-3 fatty acids, lignans, fibre, niacin, vitamin E, minerals, proteins and peptides (66). Many clinical trials have used 500- 1500 mg of curcumin (found in turmeric) extract for 6 -12 weeks, showed beneficial effects on body weight and glycaemic control among women with PCOS (43). A study on women with PCOS, consumption of cinnamon powder capsules (1.5 g/day in 3 doses) for 12 weeks showed reductions in fasting insulin, insulin resistance and LDL levels (68).

Probiotics In recent years, several studies have been conducted to explore the relationship between PCOS and changes in the gut microbiota of suffering women. Studies have indicated that the gut microbiome of women with PCOS is less diverse than in women without PCOS and there was also evidence of higher intestinal permeability. These characteristics are closely related to hyperandrogenism and increased levels of systemic inflammation. This decrease in microbial diversity is marked by decrease in beneficial bacteria such as Lactobacilli and Bifidobacteria, whereas, often there is an increase in pathogenic bacteria like Escherichia and Shigella (69). Probiotics supplementation studies on PCOS patients have shown beneficial effects on PCOS. It has been seen that supplementation with L. casei, L. acidophilus and B. bifidum for 12 weeks is capable of leading to a reduction in BMI with favourable reduction in glycemia, VLDL and triglycerides in PCOS patients (70). Another study showed that 8 weeks of supplementation with L. casei, L. acidophilus, L. rhamnosus, L. bulgaricus, B. breve, B. longum and S. thermophiles resulted in significant reduction in plasma glucose and serum insulin levels (71). Probiotics naturally occur in fermented foods and contain live beneficial microorganisms. Prebiotics are non-digestible food components that serve as food for live microbes, promoting the growth and activity of beneficial microorganisms, particularly in the gut. Shamasbi et al. (2019) found that regular consumption of resistant dextrin (a Prebiotic) may help to regulate metabolic parameters and reduce hyperandrogenism, hirsutism and menstrual cycle abnormalities in PCOS women (72).

Physical Exercise and Yoga Many researches have already been performed on the impact of exercise on women with PCOS. The results of a meta-analysis found that improvements in health outcomes are more dependent on exercise intensity in women with PCOS. The results of this study showed that the use of exercise and that vigorous intensity

exercise may have the greatest impact on cardiorespiratory fitness, insulin resistance and body composition (73). Another study also found that vigorous aerobic exercise and resistance training improves insulin sensitivity and androgen measurements in women with PCOS (74). The minimum aerobic activity per week should be 120 minutes (73). Yoga has been recommended as an example of moderate physical activity in the 2018 evidence-based PCOS guideline (16). As Yoga is considered a mind-body therapy that incorporates aspects of meditation, it may provide additional benefits beyond those gained through other forms of exercise (75). Patel et al. (2020) concluded in their study that 3 months of regular mindful yoga practice can be a useful, complementary therapeutic option for women with PCOS, particularly for improving serum androgen levels (76). A study done on women with PCOS showed a 9-week yoga practice significantly reduced anti-Mullerian hormone, LH, and testosterone levels, with normalization in hormone levels leading to the restoration of menstrual cyclic pattern, hirsutism, and acne. A decrease in the severity of depression, anxiety, and stress following yoga practice was also observed (77). In a study, a yoga program for 12 weeks was found to be significantly better than physical exercise in improving PCOS in adolescent girls (emotional disturbances and menstrual problems) (78,79).

2. CONCLUSION

All over the world, PCOS is one of the most prevailing reproductive disorder occurring in young females. Its management approach and the choice of the best therapeutic option depend on the patient and her priorities. To treat a woman suffering with PCOS, pharmacological treatments are helpful but these medicines treat only the symptoms and they may also have certain side effects. Hence, lifestyle intervention should be used as the primary early management strategy. Individual approach should be followed to improve dietary intake. There is no specific 'PCOS diet' that can completely reverse the syndrome. Emphasis should be on 5-10% weight reduction in case of obese subjects. Faulty dietary pattern and eating disorders including skipping of breakfast was also found to be common among women suffering from PCOS. Therefore, more emphasis should be there on improving their dietary pattern. Calorie restricted diets with low glycaemic index, high fibre, high protein and low-fat foods should be recommended. Diets of women suffering from PCOS should be rich in omega-3 fatty acids, vitamin D, vitamin C, zinc, selenium, vitamin E, folic acid, vitamin B_{12} and magnesium. Certain herbs (like flaxseeds, curcumin and cinnamon powder) and probiotics have also been found to be useful in some studies but extensive researches need to be done in these areas. Vigorous intensity exercise and Yoga practice can also be a complementary therapeutic option for women with PCOS as studies have shown quite encouraging results. It is recommended that for the management of PCOS, a holistic individualised approach should be followed. Dietary and lifestyle modifications should be prioritized because of their potential benefits and cost-effectiveness. With rising interest in holistic health care, health care providers need to broaden their knowledge based on scientific researches and seek the ways how these therapies can be safely and appropriately used as combination or supportive therapies to conventional pharmacological treatment or as monotherapies in earlier stages

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