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## Impact of nutrition and exercise on polycystic ovarian syndrome

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### Abstract

Polycystic Ovarian Syndrome (PCOS) is basically a menstrual disorder, with associated physiological problems. This review article shows the benefits of a good diet and exercise in their daily routine. Doing so can be beneficial in reducing the intensity of PCOS and the related complications, like Insulin Resistance leading to Diabetes, Obesity, Hirsutism, Alopecia, and Cardiovascular diseases. This is one of the best examples of “You Are What You Eat”, as healthier the diet is, the better it is in dealing with this complex condition. It is necessary that the women know the alternatives to deal with this condition, than opting for various hormonal treatment, as they can cause adverse effects too. It must be kept in mind that the age group varies, as it can begin after menarche and gradually increase, or also begin later in life, depending upon the lifestyle of women. In younger women with PCOS, nutritional therapy is better than HRT, as they are still growing, and it may affect the normal development.

**Keywords:** PCOS: Polycystic ovarian syndrome, Hirsutism: Facial hair growth, Alopecia: Hair loss, Menarche: Beginning of the menstrual cycle, HRT: Hormone Replacement Therapy, Syndrome

### Introduction

Polycystic ovarian syndrome (PCOS) is a complex condition where the elevation of androgen levels (Hyperandrogenism), irregularities in the menstrual cycle, the growth of the cysts in one or both ovaries are seen. The issues with PCOS include, acne, facial hair growth, insulin resistance, difficulties in conceiving and infertility, etc. Women with PCOS face many issues, have much higher rate of being tested positive for diabetes mellitus, dyslipidaemia, cardiovascular diseases, and development of endometrial cancer.

While it is important for them to have a hormonal therapy, it has its own set of drawbacks. Dietary modification and physical activity can have a positive impact in dealing with PCOs. The idea is to check a different set of diets with slight modifications, keeping in mind their anthropometric measurements, reproductive age and their severity of physical activity and exercise, for improving their overall wellbeing. The diets are tailored for greater weight loss, improved menstrual cycles, reduced insulin resistance, betterment of mental health and depressive bouts, encouraging and building a good self-esteem. These diets include MUFA diet, diets which improve androgen levels, high carbohydrate diet, HDL improved diets, low glycaemic index diet, and increased variety of simple and complex protein diet. The cases where their excess weight must be dealt, it is suggested to provide them with a controlled caloric diet, that provides sufficient basic nutrition, while cutting off the extra energy that increases the body weight. While it is not necessary that the majority of PCOs are always subjected with obesity, but the higher rates show abdominal obesity and insulin resistance.

### Prevalence

Polycystic Ovarian Syndrome is a complex, wide-ranging endocrine disorder, usually seen in the women in their reproductive age. It usually begins with the irregularity of the menstrual cycles, problems such as acne, unexplained weight gain and the difficulty to lose the weight, leading to the person becoming obese. Hirsutism, which is also known in layman's term as excessive facial hair growth, is often seen in these cases. As this condition progresses, the cysts continue their growth and leads to more complicated conditions. The condition can be as simple as menstrual delaying, and as serious as infertility [1, 2, 3]. The prevalence falls among 3% to 10% of the women population. National Institute of Health (NIH)'s diagnostic criteria were used to examine the prevalence of polycystic ovarian syndrome in women from different ethnic groups and geographical areas. A review article reported that the prevalence of PCOS in India varies between 3.7% to 22.5% based on the geographical area and the different diagnostic criteria required [17].

The results showed that the lowest prevalence was in Chinese women (4.4-7.3%), then in the increasing rate in

Caucasians (4.8-6.3%) and Middle Eastern (11.3-14.2%), and in Black women (5.3-7.1%) [2].

**Table 1:** Estimated prevalence of PCOS in unselected female population (Tao Ding, *et al.* 2017) [2]

Ethnicity	Estimated prevalence (%) of PCOS in general female population (with 95% CrI)		
	1990 NIH	2003 Rotterdam	2006 AES
White (Caucasian)	5.5 (4.8–6.3)	–	–
Black (African American and Afro-Brazilian)	7.4 (6.3–8.7)	–	–
Chinese	–	5.6 (4.4–7.3)	–
Middle East (Iranian and Turkish)	6.1 (5.3–7.1)	16.0 (13.8–18.6)	12.6 (11.3–14.2)

### Role of Nutrition in PCOS

#### Role of Omega-3 in PCOS

Around 40-50% of women suffering from PCOS are either overweight or obese, which is a major risk factor, because excess accumulation of fat in adipose tissues leads to adipose dysfunction, which results in complications like insulin resistance. It is said that the n-3 PUFA, specifically DHA is related to obesity and the increase in waist circumference in women with obesity. It is shown that the changes in the n-3 PUFA also helps in improving the body composition, reducing body weight and alters energy metabolism. The condition where the response of the tissues to insulin is reduced, which is insulin resistance, impacts the metabolism of glucose. The impairment in gluconeogenesis, glycogenolysis in the liver and glucose output are the drawbacks caused by insulin resistance. It is reported that there are 30% of lean and 75% of obese women with PCOS have insulin resistance. It is studied that improvement in insulin resistance after completion of a weight loss intervention has shown to play a positive role in women with PCOS. Omega-3 fatty acids have shown a beneficial impact on insulin sensitivity by thinning or diminishing the endoplasmic reticulum, stress and increasing  $\beta$ -oxidation of mitochondrial fatty acids. As the inflammatory processes come down, thereby enhancing insulin sensitivity [4].

The efficiency of omega-3 fatty acids in improving insulin resistance in case of women suffering from polycystic ovarian syndrome has been reported. The treatment with omega-3 fatty acids helps in decreasing hyperandrogenism along with insulin resistance. The treatment is considered much cheaper compared to high-cost treatments like HRT. The high levels of androgen lead to failure of ovaries. Hence it is recommended to decrease insulin resistance in improving and treating PCOS. Omega-3 fatty acids improve the insulin sensitivity by enhancing the anti-inflammatory adipokines. The level of cholesterol absorption is also controlled as the low-density lipoprotein receptor processing in the site of synthesis, which is liver, increases the catabolism. And decreasing the risk factors associated with increasing levels of cholesterol in women having PCOS. Dietary interventions require time to show their benefits [5].

#### Role of Low Starch/Low Dairy diet in PCOS

Generally, women dealing with PCOS are identified to have elevated fasting and postprandial respiratory exchange ratio (RER), which shows the inability to oxidize fats after a high fat meal or after an overnight fasting. It is also observed that there is a reduction in weight, BMI, fat mass, fasting and 2-hour insulin, and hormones, especially the testosterone, after 8-week dietary intervention. Though there was an improvement in the level of insulin resistance, which might be related to decrease in the BMI, although there is a great

deal of difficulties faced while doing so. As much as the low starch and low dairy diet helped in improvement, the high protein and high fibre content gave them a feeling of satiety and kept them content, leading to cutting off on the excess calories. This type of dietary modification shows a positive impact in lives of women dealing with PCOS [18].

The reduction in the use of starch and dairy, has improved the postprandial fat oxidation. Thereby reducing and preventing the fat oxidation and thus reducing the chances of becoming overweight and obese. This type of diet therapy needs to be encouraged in the women with PCOS. [18].

#### Role of increased dietary protein to carbohydrate ratio in PCOS

The reduction of carbohydrates with the high protein diets, seems to facilitate glucose metabolism and help is weight loss. The high protein of 30% with reduced carbohydrate of 40% with a 1000Kcal deficit, seems to benefit in preventing the weight gain, thus resulting in significant weight loss. A mean loss of 7.7 +/- 0.7kg is seen in HP (High Protein) diet among PCOS women. This diet *also* showed decrease in the levels of testosterone. Thus, it also improves the insulin resistance and the lipid profile, while maintaining a minor improvement for HDL. The high- protein diet resulted in greater weight and body-fat loss. There was also a larger reduction in waist circumference associated with the high-protein diet. The high-protein diet *also* gave rise to lower levels of glucose. Other factors remained relatively the same. Thus, replacing carbohydrates with proteins may help lose weight and improve glucose metabolism; this may be independent of weight-loss [7]. Hypocaloric diets in the case of obese women with PCOS are not well understood. The authors investigated by working with 60 obese women (with PCOS), who did not use insulin-sensitising agents. Two hypocaloric diets were proposed, and the subjects were randomly assigned one of them for a single-blind clinical trial. The two diets were: a conventional hypocaloric diet, and a modified hypocaloric diet (high-protein, low-glycaemic diet). The resulting weight-loss across the two groups, though significant, was comparable. There was a marked reduction in testosterone for both groups. FSH, LH, and blood lipids remained relatively unchanged, except for LDL-C. However, the modified diet gave rise to reduction in insulin levels, and decreased hsCRP concentrations [8].

#### Dietary macronutrient restriction to enhance weight loss in PCOS

Dietary macronutrient restriction showed a significant improvement in the reproductive and metabolic variables along with weight loss in women with PCOS. A meal replacement seems to be an effective approach to deal with weight reduction and improvement of overall health of a

person. Women with PCOS often show difficulties in following dietary changes, due to the various restrictions and their inability to feel satiated. Meal replacement focuses on dietary flexibility along with energy reducing diet, while ensuring nutritional adequacy and promoting weight loss. The main criteria of the study were to compare effects of fat or carbohydrate restriction in maintaining weight and to check for the improvement in reproductive and metabolic health. The carbohydrate restriction of 20-30g/d showed a greater result in weight loss (3months), than compared to usual fat restriction weight loss (6 months). The authors justified the diet by the reasoning that, the restriction of food products or increase in protein intake, in turn provides satiety and aids in maintaining lean body mass. It also explains the role of glycaemic index and glycaemic load, and the associated weight loss. The reduction in GL by the reduction in GI by significant control in carbohydrate results in controlling the hunger and provides satiety. At the end of the study, it was seen that the subjects showed an average weight loss of 4.7kg, and decrease in waist circumference, insulin resistance, and testosterone levels. It was attributed to the maintenance of optimum levels of GI, GL, and protein intake alterations. Generally, weight gain is linked with diabetes, hence by improving the values of GL improved the chances of weight loss. However, they specify that there is no relation between GI, GL, and weight loss. It is necessary that the procedures applied are followed up with increased physical activity and dietary counselling [9].

**Table 2:** Eating behaviour in PCOS women. (Y. Jeanes, *et al.* 2009)

Category	Mean	SD
Eating frequency including drinks (episodes per d)	9	2.7
Eating frequency excluding drinks (episodes per d)	5	1.5
Sweet snacks (episodes per d)	2	1.3
Savoury snacks (episodes per d)	0.6	0.6

The BMI and eating score were directly related to one another. The score is relatively high in women who are overweight or are obese, compared to women with normal BMI. Though the study reports that there is no impact of eating frequency on BMI, it must be taken care, to help the women, achieve a better and healthy lifestyle [11].

#### **Exercise therapy and diet for the management of PCOS**

This study was done to substantiate the effectiveness of exercise in the management of PCOS. This was done by considering the cases: usual care, diet alone, exercise-combined diet. The trials were conducted on a randomised or quasi-randomised basis to measure the long-term effects of exercise in the group of interest. Compared to the control group (usual care), several positive changes were observed – improved lower waist circumference, lower body-fat percentage. Some other parameters such as BP, fasting glucose, HDL levels saw no significant changes. However, some more positive changes were found through post-intervention analysis – lower fasting insulin, lower cholesterol, lower BMI, and lower resting heart rate. In sum, markedly better effects of exercise were found for a range of metabolic, anthropometric, and cardio-respiratory parameters. However, there were insignificant differences between exercise-combined diet and diet alone. Thus, there is scope for more rigorous research [12]. The first and most important way to deal with PCOS, is to change the lifestyle approach and improve their level of physical activity and

#### **Eating behaviours and BMI in PCOS**

A group of obese women (BMI  $39.9 \pm 6.1$ ) with PCOS participated in a study on having a healthy diet for improved reproductive health. BMI, diet, physical activity, eating behaviours, and PCOSQ index were measured for each subject, to serve as a baseline. A group of obese women without PCOS was used to contrast the differences in measured outcomes. The subjects had high-fat diets that were low in fibre, folate, and iron, while the women in the control group (without PCOS) enrolled in a behavioural weight-loss programme. Participants had low EBI (Eating Behaviour Inventory), hunger scores and moderate dietary restraint. PCOSQ (PCOS Health-Related Quality of Life) scores were the lowest for infertility and weight; but the overall score across domains remained low. It was found that the women with PCOS-related infertility have poor diets and unhealthy eating behaviours [10].

Around 10% of the population of UK women, they suffer with obesity and PCOS. The hormonal imbalance creates a need for emotional bingeing and varied food cravings. The study was conducted to observe the eating patterns and the eating habits among a group of subjects who were reported to have PCOS. The testing was done through TFEQ (Three Factor Eating Questionnaire), the data obtained from this questionnaire was analysed for various eating scores. The selected subjects were divided into sub-groups based on their BMI. The categories include,  $<25\text{kg/m}^2$ ,  $25\text{-}29.9\text{kg/m}^2$ , and  $>30\text{kg/m}^2$  [11].

exercise. Not only does exercise help in dealing with PCOS, but also the risk factors it brings along with it for example, reduced cases of CVD (cardiovascular diseases) weight gain, and prevention of obesity [13]. The study reports that there was positive improvement in the women with PCOS, especially in their ovulations and weight loss. The changes can also depend upon the intensity of the physical activity and exercise too. The report suggests that the women who are suffering from PCOS need to be encouraged to involve themselves in at least 90 mins of aerobic activity per week, at an intensity of 60-70%, to see the positive results [13].

#### **Lifestyle of person with PCOS**

Polycystic ovarian syndrome is a problem faced by many women now a days. The clinical condition takes a turn to worse if the lady who is diagnosed is overweight or obese. The most prominent changes that are seen is irregular menstrual cycles, imbalanced hormones, change in the regularities of ovulation, and infertility. It is also seen that the women who have PCOS are more prone to have cardiovascular disease and diabetes because of insulin resistance. It is studied that these women face a lot of mental health issues, like anxiety and depression. Hence it is necessary that they have a healthy and balanced diet with regular physical exercise to maintain ideal body weight. It is studied that changes in the lifestyle brings changes in the anthropometric markers like weight and BMI in women with PCOS. It was reported that around 5%-10% weight

loss is associated with improvement in reproductive, metabolic, and mental health benefits. Lifestyle modifications decreases impaired glucose tolerance, showing an improvement in decreasing risk factors associated with cardiovascular diseases and type 2 diabetes [14].

The detrimental factors of PCOS is that it effects the quality of living. Mental health problems like depression and anxiety are seemingly more, therefore emphasising the need to change to a healthy lifestyle. To check on the relation between physical activity and emotional status and the improvement, a PCOSQ scoring was done. This scoring also gave an idea about the improvements in the field of infertility. It however, does not give a clear-cut idea about the menstrual cyclicity [14].

## Management of PCOS

### Nutritional supplements and herbal medicines in PCOS

In this methodical review, 7 nutritional supplements and 4 herbal medicines were researched on, which include calcium with vitamin D, *cinnamomum sp.*, vitamin B8 (inositol), omega-3 fatty acids and vitamin D. The review article talks about the therapeutic role of inositol. It is reported that consumption of inositol improves the metabolic profile, along with reduction in hyperandrogenism, better ovulation and increased chances of pregnancies [15].

### Pharmacological Approaches in PCOS

#### Clomiphene

Clomiphene citrate is used for inducing ovulation in PCOS women. The dosage usually starts with a small dosage, and it might increase depending upon the results shown per person. The use of drugs shows 30% chances of successful pregnancies, while 20% of these women had high incidence of spontaneous abortions or still births. The drug also shows few adverse effects like ovarian enlargement; ovarian hyperstimulation syndrome (OHSS); multiple pregnancies, hot flashes, and gastrointestinal distention, bloating and discomfort [16].

#### Antidiabetic agents

Antidiabetic drugs showed increased fertility, decreased insulin resistance, and decreased circulating androgen levels. The major role of Metformin in treatment of women with PCOS, showed in a study of 320 women. The treatment provided a significantly higher rates of pregnancy (%) and live births (41.9%), compared with placebo. Although metformin is generally well tolerated, it is usually associated with gastrointestinal disturbances, including diarrhoea and nausea [16].

#### Gonadotropins

In case of failure of treatment provided by metformin and/or clomiphene therapy, Human menopausal gonadotropin (HMG) and FSH can be used to stimulate ovulation. In the study of 302 PCOS women, 132 were given low dose of FSH, and 123 PCOS women were given clomiphene. Pregnancy rates were higher in case of FSH, and much more live births were reported. It needs to be noted that, the higher doses are related with higher risks of multiple pregnancies, hence low levels of FSH are advisable [16].

## Conclusion

The problems related to PCOS are a daunting thing to

comprehend and manage. The best methods to deal with these problems may vary from person to person, and ideally suggested to follow what the person is capable of handling, whether it maybe a slow and gradual processes of lifestyle and dietary modification, or the hormonal treatment. It is necessary that the women are educated regarding the issue and given proper options on how they can deal with such scenarios. With developing health related problems day by day, it is necessary that we are cautious about the lifestyle we follow and encourage the necessity to incorporate exercise and good nutrition in our day to day lives.

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