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Polycystic Ovary Syndrome (PCOS): A Growing Women's Health Challenge in the Modern World

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Polycystic Ovary Syndrome (PCOS) is one of the most prevalent endocrine and metabolic disorders affecting women of reproductive age globally. The condition is characterized by hyperandrogenism, ovulatory dysfunction, insulin resistance, and polycystic ovarian morphology, leading to reproductive, metabolic, and psychological complications. This review highlights the pathophysiology, symptoms, phenotypes, diagnosis, and nutritional management strategies associated with PCOS. Hormonal imbalance, chronic low-grade inflammation, genetic predisposition, and insulin resistance play major roles in disease progression. Common clinical manifestations include irregular menstrual cycles, acne, hirsutism, obesity, infertility, mood disorders, and metabolic abnormalities. The Rotterdam Criteria remain the most widely accepted diagnostic guideline for identifying PCOS phenotypes. Nutritional management is considered a cornerstone in the management of PCOS, with emphasis on low glycemic index diets, balanced macronutrient intake, high dietary fiber, anti-inflammatory foods, micronutrient optimization, and healthy weight management. Lifestyle modifications including dietary regulation, hydration, and regular physical activity significantly improve insulin sensitivity, hormonal balance, ovulation, and overall quality of life. Early diagnosis and multidisciplinary management are essential to reduce long-term complications such as type 2 diabetes, cardiovascular disease, and infertility. Increased awareness and personalized nutritional interventions can play a significant role in improving health outcomes among women with PCOS.

Keywords: Polycystic Ovary Syndrome (PCOS); Insulin Resistance; Hyperandrogenism; Nutritional Management; Hormonal Imbalance; Women's Health

Introduction

Polycystic Ovary Syndrome (PCOS) is one of the most common endocrine and metabolic disorders affecting women of reproductive age worldwide. Once considered only a reproductive disorder, PCOS is now recognized as a complex condition that influences hormonal balance, metabolism, mental health, and long-term quality of life. Recent estimates suggest that nearly 1 in 10 women globally are affected by PCOS, while prevalence in India ranges from 9–22%, making it a major public health concern (Teede *et al.*, 2023; Avery *et al.*, 2022). PCOS is primarily characterized by hyperandrogenism (excess male hormones), irregular ovulation, and polycystic ovarian morphology. Women with PCOS often experience irregular menstrual cycles, acne, excessive facial hair growth, scalp hair thinning, weight gain, and infertility. Beyond reproductive complications, the syndrome is strongly linked with insulin resistance, obesity, type 2 diabetes, cardiovascular disease, anxiety, and depression (Escobar-Morreale, 2018). The increasing prevalence of sedentary lifestyles, processed food consumption, stress, and sleep disturbances has further accelerated the burden of PCOS, especially among adolescents and young adults.

Understanding the Hormonal Imbalance

The underlying mechanism of PCOS involves a disruption in hormonal and metabolic pathways considered as inflammatory-metabolic condition. One of the central features is insulin resistance, where body cells fail to respond effectively to insulin. As a result, the pancreas produces excess insulin, which stimulates the ovaries to produce more androgens such as testosterone. Elevated androgen levels interfere with normal follicular development, leading to anovulation and the formation of multiple immature follicles within the ovaries (Zeng *et al.*, 2020). Research indicates that nearly 50–75% of women with PCOS exhibit insulin resistance, regardless of whether they are obese or lean (Avery *et al.*, 2022). Hyperinsulinemia also reduces the production of sex hormone-binding globulin (SHBG), thereby increasing free circulating testosterone levels. This hormonal imbalance contributes to symptoms such as acne, hirsutism, oily skin, and androgenic alopecia. Another important contributor to PCOS is chronic low-grade inflammation. Women with PCOS often show elevated inflammatory biomarkers including C-reactive protein (CRP), interleukin-6 (IL-6), and tumour necrosis factor-alpha (TNF- α). These inflammatory processes worsen insulin resistance and further impair ovarian function (Mohammed *et al.*, 2024).

The Role of Genetics in PCOS

Genetic predisposition plays a major role in the development of PCOS. Studies show that 60–70% of affected women have a family history of the disorder, suggesting strong hereditary involvement. Several genes related to steroid hormone production, insulin signalling, and ovarian function have been implicated, including CYP17A1, CYP19A1, INSR, FSHR, and DENND1A (Dokras & Cooney, 2020). Genome-wide association studies (GWAS) have further identified multiple susceptibility associated with androgen excess and ovarian dysfunction. However, genetics alone do not determine the condition. Environmental factors such as unhealthy diet, physical inactivity, obesity, and chronic stress interact with genetic susceptibility and influence disease severity.

Common Symptoms

The clinical presentation of PCOS varies considerably among individuals, but menstrual irregularities remain one of the earliest and most common symptoms. Women may experience oligomenorrhea (infrequent periods), amenorrhea (absence of menstruation), or prolonged menstrual bleeding due to irregular ovulation. Approximately 70–80% of women with PCOS experience menstrual dysfunction (Teede *et al.*, 2023). Hyperandrogenism leads to visible symptoms such as hirsutism, acne, and hair thinning. Hirsutism, characterized by excessive hair growth in male-pattern areas such as the face and chest, affects nearly 65–75% of women with PCOS. Acne is also highly prevalent, occurring in approximately 40–85% of cases and often persisting into adulthood (Yildiz, 2025). Another characteristic feature is polycystic ovarian morphology, where ultrasound imaging reveals multiple small follicles arranged around the ovary in a “string of pearls” pattern. Importantly, these are immature follicles rather than true cysts (Cedars & Christ, 2023). Weight gain and abdominal obesity are also common manifestations. Excess adipose tissue contributes to inflammation and worsens insulin resistance, creating a vicious metabolic cycle. Many women with PCOS report difficulty losing weight despite regular diet and exercise, emphasizing the hormonal nature of the disorder. In addition to physical symptoms, PCOS significantly affects psychological well-being. Women with PCOS are at a two- to three-fold higher risk of depression and anxiety compared to the general population (Dokras & Cooney, 2020). Concerns related to infertility, body image, acne, and excessive hair growth often reduce self-esteem and social confidence.

Different Types of PCOS

Based on the Rotterdam diagnostic criteria, PCOS is classified into four phenotypes: Type A, Type B, Type C, and Type D. Type A, often called “classic PCOS,” is the most severe form and includes hyperandrogenism, ovulatory dysfunction, and polycystic ovaries. Women with this phenotype have the highest metabolic and reproductive risks (Zeng *et al.*, 2020). Type B

includes hormonal imbalance and irregular ovulation without polycystic ovaries, while Type C is considered a milder ovulatory form where menstrual cycles remain relatively regular despite androgen excess. Type D is the least severe form and is characterized by ovulatory dysfunction and polycystic ovaries without hyperandrogenism. Understanding these phenotypes is important as shown in Table 1, because symptoms, metabolic complications, and treatment responses differ between individuals. (Chaitanya *et al.*, 2026).

Table 1. Phenotypes of different types of PCOS

Phenotype	Ovulation	Androgens	Ovaries	Severity
A	Irregular	High	Polycystic	Severe
B	Irregular	High	Normal	Severe
C	Regular	High	Polycystic	Mild
D	Irregular	Normal	Polycystic	Mild

Diagnoses of PCOS

The Rotterdam Criteria (2003) remain the most widely accepted diagnostic guideline for PCOS. Diagnosis is confirmed when at least two of the following three features are present: irregular ovulation, hyperandrogenism, and polycystic ovaries on ultrasound (Teede *et al.*, 2023). Blood investigations commonly include testosterone, DHEAS, LH/FSH ratio, fasting glucose, insulin, HbA1c, lipid profile, and thyroid function tests. Recent international guidelines also recommend anti-Müllerian hormone (AMH) as an alternative diagnostic marker in adults. Because several disorders mimic PCOS, conditions such as hypothyroidism, hyperprolactinemia, congenital adrenal hyperplasia, Cushing's syndrome, and androgen-secreting tumors must be excluded during diagnosis (Alam *et al.*, 2024).

Table 2. Rotterdam diagnostic Criteria 2003

1. Irregular ovulation	Irregular, infrequent, or absent periods. < 9 periods/year, cycles >35 days, or no periods for 3+ months
2. High androgen signs	Clinical: Excess facial/body hair, severe acne, scalp hair thinning. Biochemical: High total/free testosterone, DHEAS, or androstenedione on blood test
3. Polycystic ovaries	12+ small follicles 2-9mm in each ovary OR ovarian volume >10mL on pelvic ultrasound

Nutritional Management of Polycystic Ovary Syndrome (PCOS)

Low Glycemic Index (GI) Diet

A low glycemic index (GI) diet is considered one of the most effective nutritional approaches for managing PCOS, helps to regulate blood glucose levels and improve insulin sensitivity. It exhibit insulin resistance (hyperinsulinemia) and increased androgen production. Consuming low-GI foods slows glucose absorption, prevents sudden spikes in blood sugar, and reduces insulin demand. Whole grains (oats, brown rice, millets (ragi, bajra), quinoa, and whole wheat) are preferred over refined cereals and processed foods. Fruits like apple, guava, pear, berries, and citrus fruits are beneficial due to their fiber and antioxidant content. Legumes including lentils, chickpeas, and green gram further help stabilize postprandial glucose response. (Teede *et al.*, 2023; Saeed *et al.*, 2025).

Balanced Macronutrient Distribution

Balanced intake of carbohydrates, proteins, and fats is essential for hormonal and metabolic regulation in PCOS. Complex carbohydrates should contribute approximately 45–50% of total energy intake, emphasizing high-fiber and minimally processed foods. Protein intake of about 20–25% helps improve satiety, stabilize blood glucose, and support lean body mass. Good protein sources include pulses, soy products, eggs, milk, curd, paneer, fish, and lean meat. Healthy fats should account for 25–30% of total calories, focusing mainly on monounsaturated and polyunsaturated fats. Nuts such as almonds and walnuts, seeds including flaxseeds and chia seeds, and oils such as olive oil and sesame oil are

recommended. Adequate intake of healthy fats helps reduce inflammation and improve reproductive hormone balance. (Di Lorenzo *et al.*, 2023).

High Fiber Intake

Dietary fiber plays an important role in improving insulin sensitivity and reducing metabolic complications associated with PCOS. High-fiber foods slow gastric emptying and carbohydrate absorption, thereby lowering postprandial blood glucose and insulin levels. Fiber also promotes satiety, which helps control appetite and reduce overeating. Whole grains, fruits with edible peels, vegetables, legumes, leafy greens, and seeds are excellent sources of soluble and insoluble fiber. Higher intake of dietary fiber often show improved lipid profiles, better glycemic control, reduced abdominal obesity, supports gut microbiota diversity, which is increasingly recognized for its role in hormonal regulation and inflammation control (Saeed *et al.*, 2025).

Anti-Inflammatory Dietary Pattern

PCOS is associated with chronic low-grade inflammation, which contributes to insulin resistance and ovarian dysfunction. Therefore, adopting an anti-inflammatory diet is highly beneficial. Omega-3 fatty acids found in fatty fish, flaxseeds, chia seeds, and walnuts help reduce inflammatory cytokines such as IL-6 and TNF- α . Antioxidant-rich foods including berries, pomegranate, spinach, moringa leaves, broccoli, tomatoes, and green tea help neutralize oxidative stress and improve cellular function. Herbs and spices such as turmeric, ginger, cinnamon, and garlic also possess anti-inflammatory properties that may support metabolic health. Research suggests that antioxidant-rich diets can reduce oxidative damage, improve ovulatory function, and decrease androgen levels in women with PCOS (Mohammed *et al.*, 2024).

Role of Protein-Rich Foods

Adequate protein intake is particularly important in PCOS because protein slows carbohydrate digestion and improves satiety hormones. Including protein in each meal helps maintain stable blood glucose levels and reduces excessive insulin secretion. High-quality protein sources such as eggs, fish, dairy products, soybeans, tofu, lentils, and chickpeas support muscle maintenance and metabolic activity. Protein-rich diets may also reduce cravings for sugary foods and support gradual weight reduction. Studies have shown that women with PCOS consuming moderate to high protein diets experience improvements in body composition and insulin sensitivity (Escobar-Morreale, 2022).

Importance of Healthy Fats

Healthy dietary fats contribute to endocrine regulation and reduce systemic inflammation in PCOS. Monounsaturated and polyunsaturated fatty acids improve lipid metabolism and insulin action. Omega-3 fatty acids are especially beneficial because they lower triglycerides, reduce inflammatory markers, and may improve ovulatory function. Foods such as walnuts, flaxseeds, sunflower seeds, fatty fish, and olive oil are recommended. In contrast, trans fats and excessive saturated fats found in fried foods, bakery products, fast foods, and processed snacks should be minimized because they worsen inflammation and insulin resistance (Jin & Xie, 2020).

Micronutrient Management

Several micronutrient deficiencies are commonly observed in women with PCOS and can worsen metabolic and reproductive dysfunction. Vitamin D deficiency is highly prevalent and is associated with insulin resistance, obesity, menstrual irregularities, and infertility. Dietary sources such as milk, curd, egg yolk, fortified foods, and fatty fish should be included along with safe sunlight exposure. Iron-rich foods including spinach, moringa leaves, lentils, dates, jaggery, and millets help prevent anemia, particularly in women experiencing irregular heavy bleeding. Calcium and magnesium support hormonal balance, nerve function, and glucose metabolism. Zinc and chromium also play important roles in insulin action and ovarian health. Nutritional correction of these deficiencies may improve ovulation, metabolic function, and overall quality of life in women with PCOS (Teede *et al.*, 2023).

Weight Management through Nutrition

Weight management is a major component of PCOS treatment because even modest weight loss can significantly improve hormonal and metabolic abnormalities. A reduction of 5–10% of body weight has been shown to improve insulin sensitivity, restore ovulation, reduce androgen levels, and improve fertility outcomes. Sustainable weight loss should focus on calorie control, portion moderation, regular meal timing, and increased intake of nutrient-dense foods rather than extreme dieting. Crash diets are discouraged because they may worsen hormonal imbalance and reduce metabolic rate. Combining balanced nutrition with regular physical activity produces the best long-term outcomes for women with PCOS (Forslund *et al.*, 2020).

Hydration and Meal Timing

Adequate hydration is important for maintaining metabolism, digestion, and hormonal balance. Women with PCOS are advised to consume approximately 2.5–3 liters of water daily depending on activity level and climate. Replacing sugary beverages with water, herbal teas, and unsweetened drinks helps reduce excess calorie intake and improves glycemic control. Meal timing also influences insulin regulation. Eating smaller, balanced meals at regular intervals may help maintain stable blood sugar levels and reduce cravings. Avoiding late-night overeating and prolonged fasting can further support metabolic stability (Saeed *et al.*, 2025).

Foods to Limit in PCOS

Certain dietary components worsen insulin resistance, inflammation, and hormonal imbalance in PCOS and should therefore be limited. Refined carbohydrates such as white bread, pastries, sweets, sugary cereals, and soft drinks rapidly increase blood glucose and insulin levels. Processed foods high in trans fats and sodium contribute to obesity and cardiovascular risk. Excess intake of saturated fats from fried foods and processed meats may worsen inflammatory responses. Highly processed snacks and fast foods also contain additives and preservatives that negatively affect metabolic health. Reducing these foods while emphasizing whole, minimally processed foods is associated with better hormonal and reproductive outcomes (Di Lorenzo *et al.*, 2023).

Conclusion

The global rise in PCOS highlights the urgent need for awareness, early screening, and preventive healthcare strategies. Despite its complexity, PCOS can be effectively managed through a multidisciplinary approach that combines medical care, nutritional intervention, physical activity, and psychological support. As research continues to uncover the genetic, inflammatory, and metabolic pathways involved in PCOS, future therapies may become increasingly personalized and targeted. Until then, education and lifestyle management remain the strongest tools in reducing the growing burden of this lifelong disorder.

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