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PCOS – The Importance of Diet, Physical Activity, and Other Non-Pharmacological Methods in Treatment

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KEYWORDS: PCOS, diet, physical activity, treatment, supplementation, probiotics

ABSTRACT

Purpose of research: PCOS is one of the most common endocrine disorders. It is estimated to affect about 5-10% of women of reproductive age. This paper aims to highlight the challenges faced by those with PCOS and to demonstrate the importance of non-pharmacological methods in treating this condition.

Methods: Databases such as PubMed, Medline, and ResearchGate were used.

Basic results: PCOS is associated with menstrual irregularities and leads to reduced fertility, while commonly occurring hyperandrogenism causes unpleasant changes in appearance, such as hair loss, hirsutism, and acne. Women with PCOS also have an increased risk of developing type 2 diabetes, hypertension, and certain cancers.

Conclusions: The first line of treatment for PCOS is lifestyle modification. Appropriate diet and weight loss aim to reduce inflammation, regulate the menstrual cycle, restore ovulation, and reduce the risk of cardiovascular disease and cancer. An important aspect is the intake of vitamins D and E, as well as inositol. Research shows that probiotics may also have a positive effect.

Keywords: PCOS, diet, physical activity, treatment, supplementation, probiotics

INTRODUCTION

The prevalence of polycystic ovary syndrome (PCOS) in women of reproductive age is estimated to be around 5-10%. PCOS is one of the most common endocrine disorders [1].

PCOS can manifest in various ways, including menstrual irregularities, acne, hirsutism, alopecia, or oily skin and hair. Women with this syndrome are observed to have a higher risk of developing type II diabetes, lipid disorders, or hypertension. Obesity is common, with its prevalence estimated at 33-88%. PCOS leads to ovulation disorders and consequently to reduced fertility [2]. It negatively impacts women's mental health. Fertility issues, hirsutism, obesity, and other appearance-related symptoms contribute to decreased self-esteem [3]. Anxiety and depressive disorders are common. There is also an increased risk of bipolar

disorder, eating disorders, obsessive-compulsive disorder, and reduced sexual satisfaction [4]. Additionally, PCOS increases the risk of endometrial, breast, and ovarian cancers [2].

PATHOPHYSIOLOGY

The cause of PCOS is not known; however, it appears that genetic, hormonal, and environmental factors influence the development of this disease. PCOS represents a complex issue. It often affects related individuals, suggesting a hereditary basis [2].

In approximately 60-80% of patients with PCOS, hyperandrogenism is observed. Androgens are produced under the influence of luteinizing hormone (LH) by theca cells in the ovaries and under the influence of adrenocorticotropic hormone in the adrenal glands. In women, there are five types of androgens, among which testosterone and dihydrotestosterone (DHT) exhibit the highest biological activity. DHT and testosterone directly bind to the androgen receptor, inducing biological effects. Hyperandrogenism leads to ovulation and menstrual disorders and causes changes in appearance such as acne, alopecia, and hirsutism. It also contributes to the development of obesity, type II diabetes, and hypertension [5].

Many women with PCOS also exhibit insulin resistance and secondary hyperinsulinemia. The etiology of insulin resistance in PCOS is not fully understood. It can occur not only in obese patients but also in those who are lean. Insulin influences the metabolism of fats, carbohydrates, and proteins. It also stimulates androgen production in the ovaries and decreases the synthesis of sex hormone-binding globulin (SHBG), which raises the level of free testosterone [2][6].

Patients have also been shown to have elevated levels of inflammatory mediators. This chronic inflammatory state may contribute to the increased cardiovascular risk in women with PCOS. Studies have demonstrated the mutual influence of inflammation, insulin resistance, hyperandrogenism, and obesity, but there are still many unknowns in this area [1][2].

Obesity, which is common in women with PCOS, also impacts reproductive disorders. Obesity impairs ovulation, hinders implantation, and is associated with a higher miscarriage rate. Obese women with PCOS often exhibit a more severe phenotype than lean women [7][8].

DIAGNOSTIC CRITERIA

The criteria used for diagnosing PCOS include:

- Rotterdam criteria
- National Institutes of Health criteria
- Androgen Excess and PCOS Society criteria

The Rotterdam criteria are the most commonly used. They require the fulfillment of two out of three conditions:

1. Clinical and/or biochemical hyperandrogenism.
2. Oligo-ovulation/lack of ovulation.
3. Polycystic ovarian morphology on ultrasound (at least one ovary with a volume > 10 ml and/or the presence of 12 or more follicles measuring 2 to 9 mm in diameter) [2][9].

PCOS phenotypes according to the Rotterdam criteria:

- Phenotype A: hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology on ultrasound.
- Phenotype B: hyperandrogenism and ovulatory dysfunction, but normal ovarian morphology on ultrasound.
- Phenotype C: hyperandrogenism and polycystic ovarian morphology on ultrasound, without ovulatory dysfunction.
- Phenotype D: ovulatory dysfunction and polycystic ovarian morphology on ultrasound, without evidence of hyperandrogenism [2][10].
-

TREATMENT OF PCOS

In this article we focus on non-pharmacological methods. The choice of therapy, its intensity and duration should be adapted individually. In overweight and obese patients, healthy eating habits, a low-calorie diet and physical activity adapted to the body's capacity are recommended, with measurable health benefits. Reducing insulin resistance (IR) has a positive effect on normalising androgen levels, which can result in spontaneous regulation of menstrual cycles. These are the cheapest and simplest non-pharmacological treatments [2].

International guidelines for PCOS include recommendations for treating symptoms such as irregular menstrual cycles, hirsutism and lack of ovulation. The first line of treatment is lifestyle modification - appropriate diet, physical activity, sleep and stress reduction to normalise hyperinsulinaemia [2][11].

Pharmacological treatment of PCOS includes the use of combined oral contraceptives (COCs), metformin and anti-androgens. Hormonal therapies are only considered when lifestyle modifications are unsuccessful. COCs are often used to regulate menstrual cycles, treat hirsutism and acne. Metformin helps to reduce insulin resistance and androgen levels. Anti-androgenic drugs such as spironolactone and finasteride are used to manage symptoms such as

hirsutism and acne. These methods are considered when lifestyle modifications do not produce sufficient results. However, they may be associated with side effects and contraindications [2].

Diet and nutrition

PCOS often coexists with obesity and other metabolic disorders. This is associated with increased androgen hormone activity, leading to increased fat accumulation in the abdominal region [12].

Appropriate diet and weight reduction aims to reduce inflammation, regulate the menstrual cycle, restore ovulation and, in addition, reduce the risk of cardiovascular events and tumours [2].

It is recommended to maintain a body weight to achieve a BMI (Body Mass Index) within normal limits; however, it has been shown that even a 5-10% reduction in body weight can be beneficial in terms of restoring the menstrual cycle, improving lipid parameters, carbohydrate metabolism and insulin profile [2][11].

The diet in PCOS should be optimally tailored to the needs of the individual patient, but the consumption of low-glycaemic-index foods is recommended, as proven in clinical trials. The glycaemic index is an indicator of the increase in glucose two hours after consumption of a product compared to a reference product, glucose [13][14].

- Products with a low glycaemic index (GI ≤ 55) cause a slow and moderate rise in blood glucose levels. They are more beneficial to health, especially for people with diabetes, insulin resistance or PCOS (polycystic ovary syndrome), as they help to keep blood sugar levels stable.
- Products with a medium glycaemic index (**GI 56-69)**: cause a moderate increase in blood glucose levels. They can be eaten in moderation, especially when combined with low-GI products, to keep blood sugar levels in balance.
- Products with a high glycaemic index (**GI ≥ 70)** cause a rapid and high rise in blood glucose levels. Consumption of such products can lead to insulin spikes, which is detrimental to people with metabolic problems [2][13]. Examples of low and high glycaemic index products are given in the table (Table 1).

Table 1. Examples of Products with Low and High Glycemic Index [2][13][14].

Category	Product	Glycemic Index
Low GI	Broccoli	15
	Chickpeas	28
	Apples	36
	Plain yogurt	35
Medium GI	Whole grain bread	65
	Basmati rice	50-58
	Corn	60
	Bananas	51-60
High GI	White bread	75
	Baked potatoes	85
	Watermelon	72
	Cornflakes	81

In addition, patients should eat balanced meals in terms of protein, carbohydrates and fats, ensure adequate hydration and avoid simple sugars, saturated fats or low-fibre products [14][15][16].

Ketogenic diet, which belongs to high fat diets, is no more effective in reducing body weight than a calorie-restricted diet and is therefore not routinely recommended in PCOS. In addition, it requires careful monitoring of the foods consumed and can have a negative impact on mental health. Despite the potential benefits of its short-term use in combination with calorie restriction, practical use requires further research [2][17][18].

Physical activity

Exercise plays a key role in reducing body weight and improving metabolic parameters. In addition, they affect the regulation of ovulation by acting on the hypothalamic-pituitarygonadal (HPG) axis, lowering insulin and androgen levels [16]. The American Heart Association

recommends regular moderate exercise of 150 min or intense exercise of 75 min per week [15][16][19].

Nutrients and supplementation

Excessive intake of saturated fatty acids, cholesterol and simple sugars, especially sucrose, negatively affects the cardiovascular system and may contribute to the development of diabetes among women with PCOS. In addition, most patients with this condition have an inadequate dietary supply of fibre, cobalamin, calcium, zinc and magnesium [2].

Vitamin D

Vitamin D deficiency influences the pathophysiology of PCOS by inducing insulin resistance, obesity and favouring the induction of an inflammatory response, although the exact mechanism of these processes remains unknown [2].

Vitamin D, particularly its active form calcitriol, regulates insulin receptor expression and enhances insulin sensitivity, both directly by activating PPAR-δ receptors and indirectly by regulating intracellular calcium levels in adipose and muscle tissue [12][15][20].

Studies have shown a correlation of the prevalence of PCOS and obesity and insulin resistance with lower 25-hydroxyvitamin D levels [2]. Improvements in biochemical parameters after vitamin D3 supplementation in women with PCOS, such as Creactive protein (hs-CRP) and oxidative stress markers such as MDA (malondialdehyde) or TAC (total antioxidant capacity) have been noted [2][21], but without significant effects on NO and total glutathione (GSH) levels or androgen metabolism [21][22].

In people with a deficiency, vitamin D3 supplementation is indicated. Dosages may vary depending on individual needs and level of deficiency, but doses of 1000-4000 IU per day are often recommended. It is also important to include adequate calcium intake to support the effects of vitamin D [23][24].

Vitamin E

Thanks to its antioxidant and anti-coagulant properties, the vitamin E may have a beneficial effect on the endometrium in women with infertility. Studies on vitamin E supplementation have confirmed its effects on lipid profile and insulin levels in women with PCOS.

Simultaneous supplementation of omega-3 fatty acids and vitamin E reduces lipoprotein gene expression, significantly decreases TGA, VLDL, LDL cholesterol levels and serum total cholesterol to HDL cholesterol ratio [2][25][26][27].

Inositol

Inositol has an effect on carbohydrate metabolism by lowering blood glucose levels. This occurs by limiting the absorption of glucose from the duodenum through competitive binding to glucose transporters. Glucose, on the other hand, may limit the cellular uptake of inositol, and hyperglycaemia and insulin resistance affect the ratio of inositol isomers in tissues [25].

Furthermore, sodium-glucose transporter inhibitors prevent the absorption of both glucose and inositol (Table 2) [2][24][25].

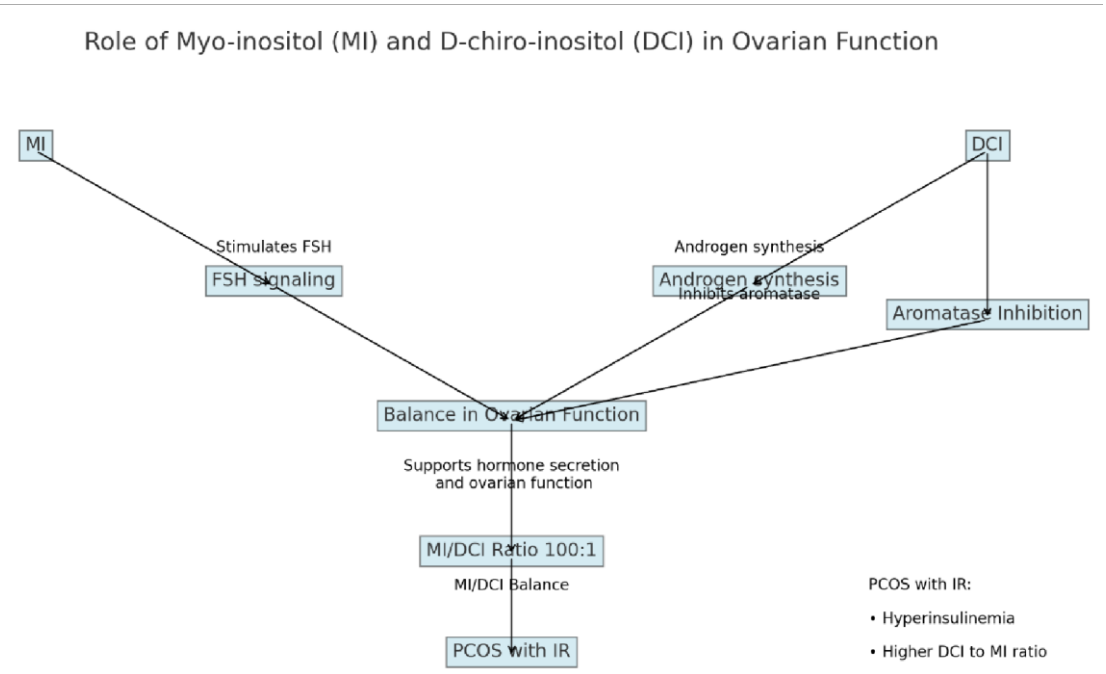

Table 2. diagram shows the role of myo-inositol (MI) and d-chiro-inositol (DCI) in ovarian function and the impact on hormonal regulation in the context of PCOS and insulin resistance (IR). MI stimulates FSH signalling, DCI participates in androgen synthesis and acts as an aromatase inhibitor. The balance between MI and DCI supports normal hormone secretion and ovarian function. The MI/DCI ratio in physiological follicular fluid is approximately 100:1.In patients with PCOS and IR, hyperinsulinaemia leads to a higher DCI to MI ratio, which affects endocrine disruption[2][25].

Studies confirm the positive effects of inositol on follicle development, hormonal regulation and glucose homeostasis, indicating its potential use in the treatment of PCOS [2][28][29].

Probiotics, prebiotics and synbiotics

According to the WHO, probiotics are live microorganisms that occur naturally in fermented foods. When consumed in adequate amounts, they exhibit antioxidant, antimicrobial and antiinflammatory effects, improve metabolic parameters, regulate intestinal flora and modulate the immune system.

Studies show that probiotics can positively influence the metabolic profile of women with PCOS. Chronic supplementation with probiotics such as L. acidophilus, L. casei and B. bifidum, L. rhamnosus L. delbrueckii and L. fermentum was found to significantly reduce body weight and BMI, improve glycaemic control and lipid profile [2][30].

Other studies have shown no significant effects on anthropometric indices, but have demonstrated improvements in glycaemic control, insulin levels and lipid metabolism, or a reduction in free androgens Prebiotics such as FOS, inulin, GOS and lactulose also have a positive effect on the composition of the gut microbiome and host health [2][31].

Alternative medicine

The following are a wide range of alternative medicine methods used to treat polycystic ovary syndrome (PCOS). Although many of these therapies show promising results, further research is needed to confirm their efficacy and safety [2].

Herbal medicine is a significant part of alternative medicine in the treatment of PCOS. Plants such as Cinnamomum verum (cinnamon), Terminalia chebula (Haritaki/Myrobalan), and many other herbs, show promise in regulating menstrual cycles, improving metabolic parameters, influencing hormonal balance and carbohydrate metabolism resulting in a reduction of PCOS symptoms [2][32].

Combining herbs with pharmacological drugs, such as Cimicifuga racemosa with clomiphene, shows synergistic potential, increasing the chances of improving fertility in PCOS patients. However, the results of such combinations are variable and require further research to establish optimal treatment protocols.

Herbs with anti-androgenic effects, such as Anethum graveolens (dill), Asparagus racemosus (wild asparagus) and Matricaria chamomilla (chamomile), may be helpful in reducing

testosterone levels and alleviating hirsutism. Although preliminary results are promising, more research is needed to fully understand their potential and mechanisms of action [32] (Table 3).

Table 3. Herbal medicine in the treatment of PCOS [2][32]

Herb	**Action**
Cinnamomum verum	Cinnamon, used in various forms (extract, powder, supplement), affects hormonal balance, carbohydrate metabolism, menstrual cycles, and lowers BMI and insulin levels.
Terminalia chebula	Haritaki/Myrobalan has antioxidant, antidiabetic, and anti-inflammatory effects, improves glucose and lipid metabolism, and protects against endothelial dysfunction.
Nigella sativa	Black cumin improves ovarian function, reduces insulin resistance, has antioxidant effects, regulates sex hormone levels, and may reduce inflammation.
Glycyrrhiza glabra	Licorice lowers blood sugar and lipid levels, contains glycyrrhizin with anti-inflammatory properties, and may improve carbohydrate metabolism.
Vitex agnus-castus	Regulates menstrual cycles, has effects similar to oral contraceptives with fewer side effects.
Others	**Trigonella foenum-graecum L., Flaxseed powder, Grifola frondosa, Unkei-to, Marjoram** - support regulation of menstrual cycles and fertility improvement.

Acupuncture and vagus nerve stimulation (VNS) are non-invasive methods that can support the treatment of PCOS by reducing inflammation, improving hormonal balance and alleviating depression [2][33][34] (Table 4).

Table 4. Alternative Medicine Methods for Treating PCOS [2][33][34].

Method	Description
Acupuncture	This method stimulates the vagus nerve to treat PCOS by reducing inflammation, improving hormonal balance, and alleviating depression.
Vagus Nerve Stimulation (VNS)	VNS modulates inflammatory responses and has therapeutic effects on conditions like epilepsy, rheumatoid arthritis, and diabetes associated with PCOS.
Transcutaneous Auricular Vagus Nerve Stimulation (taVNS)	A non-invasive technique involving ear acupuncture to stimulate the vagus nerve, improving mood, cognitive functions, and potentially treating PCOS-related symptoms.

CONCLUSIONS

PCOS affects approximately 5-10% of women of reproductive age. This condition manifests with symptoms such as menstrual irregularities, acne, hirsutism, hair loss, and oily skin and hair. Women with PCOS are at an increased risk for type II diabetes, lipid disorders, hypertension, and cancers of the endometrium, breast, and ovaries. The disease leads to reduced fertility and negatively impacts mental health. Lifestyle modification is the first line of treatment for PCOS. A proper diet and weight loss aim to reduce inflammation, regulate the menstrual cycle, restore ovulation, and reduce the risk of cardiovascular diseases and cancers. Obesity is common among women with PCOS. Physical activity plays a crucial role in weight reduction, improving metabolic parameters, and regulating ovulation. The American Heart Association recommends 150 minutes of moderate or 75 minutes of intense physical activity

per week. Maintaining a BMI within the normal range is advised, but even a 5-10% weight reduction can bring significant health benefits.

The diet should be tailored individually, emphasizing low-glycemic index foods. Excessive intake of saturated fatty acids, cholesterol, and simple sugars can negatively affect the cardiovascular system and increase the risk of diabetes. Adequate nutrient intake and supplementation are also important. Women with PCOS often have deficiencies in fiber, cobalamin, calcium, zinc, and magnesium. Proper vitamin intake is crucial. Vitamin D regulates the expression of insulin receptors and increases insulin sensitivity. Vitamin E supplementation affects insulin levels and improves the lipid profile, especially when combined with omega-3 fatty acids. Inositol improves carbohydrate metabolism by lowering blood glucose levels. It positively influences follicle development, hormonal regulation, and glucose homeostasis. Studies show that probiotics can also affect the metabolic profile of women with PCOS.

The treatment of PCOS also involves alternative medicine. Many of these therapies show promising results, but further research is needed to confirm their effectiveness and safety.

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