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CURRENT THERAPEUTIC APPROACHES IN THE MANAGEMENT OF POLYCYSTIC OVARY SYNDROME

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ABSTRACT

Introduction. Polycystic ovary syndrome (PCOS) is one of the most common endocrine disorders affecting women of reproductive age and is characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. The syndrome is frequently associated with metabolic disturbances such as insulin resistance, obesity, dyslipidemia, and chronic inflammation, which increase the risk of long-term cardiometabolic complications. Due to its complex and multifactorial pathophysiology, effective management of PCOS requires a comprehensive and individualized therapeutic approach.
Materials and methods. Relevant literature was identified through a structured search of PubMed and Google Scholar databases. The search included terms such as "PCOS treatment," "PCOS pharmacological treatment," and "PCOS alternative treatment," followed by more specific phrases related to diet, exercise, oral contraceptives, antiandrogens, metformin, GLP-1 receptor agonists, nutritional supplements, herbal medicine, and surgical treatment. The analysis primarily included systematic reviews, meta-analyses, and randomized controlled trials in accordance with Evidence-Based Medicine (EBM) principles.
Results. The reviewed evidence indicates that lifestyle modification, including weight reduction, dietary changes, and regular physical activity, remains the cornerstone of PCOS management and can significantly improve metabolic and reproductive outcomes. Pharmacological therapies such as combined oral contraceptive pills, antiandrogens, metformin, and GLP-1 receptor agonists effectively address menstrual irregularities, hyperandrogenism, and insulin resistance. In addition, nutritional supplementation and herbal medicine may provide supportive benefits by improving insulin sensitivity, reducing inflammation, and regulating hormonal balance. For patients with infertility who do not respond to pharmacological ovulation induction, laparoscopic ovarian drilling may be considered as a second-line treatment.
Conclusions. PCOS management requires a multidisciplinary and individualized approach combining lifestyle interventions, pharmacological therapy, and complementary treatments. Further high-quality clinical studies are needed to better evaluate emerging therapies and optimize long-term treatment strategies for women with PCOS.

KEYWORDS

Polycystic Ovary Syndrome, Hyperandrogenism, Pharmacological Treatment, Lifestyle Modification, Infertility

CITATION

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Introduction.

Polycystic ovary syndrome (PCOS) represents a prevalent endocrine disorder affecting women of reproductive age and is characterized by a heterogeneous clinical presentation. (Merviel et al., 2021; Burnik Papler et al., 2022). The syndrome is frequently accompanied by a variety of metabolic abnormalities, including insulin resistance, dyslipidemia, obesity, and chronic low-grade inflammation, which contribute not only to reproductive disturbances but also to long-term cardiometabolic risk (Calcaterra et al., 2024; Dokras et al., 2016). Because of its multifactorial nature and heterogeneous clinical presentation, PCOS represents a complex medical condition that requires a comprehensive and individualized therapeutic approach.

The pathophysiology of PCOS involves interactions between genetic predisposition, environmental factors, and metabolic disturbances. Insulin resistance plays a central role in the development and progression of the syndrome by promoting compensatory hyperinsulinemia, which stimulates ovarian androgen production and reduces hepatic synthesis of sex hormone-binding globulin (SHBG), leading to increased levels of circulating free androgens (Cena et al., 2020; Merviel et al., 2021). Elevated androgen concentrations contribute to many of the clinical manifestations of PCOS, including hirsutism, acne, and menstrual irregularities, while also interfering with normal follicular development and ovulation (Reiser et al., 2022; Armanini et al., 2022).

In addition to reproductive symptoms, women with PCOS are at increased risk of metabolic complications such as impaired glucose tolerance, type 2 diabetes mellitus, and cardiovascular disease (Saeed

et al., 2025; Gu et al., 2022). These metabolic disturbances often coexist with obesity and unfavorable lifestyle factors, further exacerbating hormonal imbalance and reproductive dysfunction (Calcaterra et al., 2024; Barrea et al., 2019). Moreover, PCOS is associated with psychological comorbidities, including anxiety, depression, and reduced quality of life, highlighting the broad health impact of the disorder (Cowan et al., 2023).

Given the complex and multifaceted nature of PCOS, its management requires a multidisciplinary therapeutic strategy aimed at addressing both metabolic and reproductive abnormalities. Lifestyle modification, including dietary changes, weight reduction, and increased physical activity, is widely recommended as the first-line intervention, particularly in women with overweight or obesity (Barrea et al., 2019; Kite et al., 2019). Pharmacological treatments are frequently used to manage specific clinical manifestations, such as menstrual irregularities, hyperandrogenic symptoms, and metabolic dysfunction. These include combined oral contraceptive pills, antiandrogen medications, insulin-sensitizing agents such as metformin, and newer therapeutic options like glucagon-like peptide-1 receptor agonists (Dokras et al., 2016; Saeed et al., 2025; Reiser et al., 2022).

In addition to conventional medical treatments, increasing attention has been directed toward complementary approaches, including nutritional supplementation and herbal medicine, which may target multiple aspects of PCOS pathophysiology such as insulin resistance, oxidative stress, inflammation, and hormonal imbalance (Saeed et al., 2025; Moini Jazani et al., 2019). Furthermore, in cases of infertility resistant to pharmacological ovulation induction, surgical interventions such as laparoscopic ovarian drilling may be considered as a second-line treatment option (Burnik Papler et al., 2022; Sirmans & Pate, 2013).

Given the wide range of therapeutic options available and the variability in clinical presentation among patients, evaluating the effectiveness and mechanisms of different treatment strategies remains an important area of research. Therefore, the aim of this study is to review current evidence regarding the effectiveness of lifestyle interventions, pharmacological therapies, nutritional supplementation, herbal medicine, and surgical treatment in the management of polycystic ovary syndrome.

Materials and methods.

The research method used was a review of the literature on PubMed and Google Scholar using the keywords: “PCOS treatment“, “PCOS pharmacological treatment”, ”PCOS alternative treatment“. On this basis, it was determined that the treatment methods for PCOS include: lifestyle modification, the use of hormonal contraception, antiandrogens, metformin, GLP-1 receptor agonists, supplements, and herbal remedies.

The literature review was then repeated using the phrases: “PCOS diet“, ”PCOS exercise“, “PCOS oral contraceptive pills”, ”PCOS metformin“, ”PCOS antiandrogens“, ”PCOS GLP-1 receptor agonists“, “PCOS nutritional supplements”, ”PCOS herbal medicine“, ”PCOS surgical treatment“. The assessment of the effectiveness of the listed methods was based primarily on systematic reviews, meta-analyses, and randomized controlled trials, which, according to the principles of Evidence-Based Medicine (EBM), constitute scientific evidence of the highest quality and reliability.

Results.

1. Lifestyle Modifications

Lifestyle modification represents the foundation of therapeutic strategies for women with polycystic ovary syndrome, particularly those with overweight, obesity, or metabolic dysfunction. PCOS is frequently associated with insulin resistance, dyslipidemia, adiposity, and chronic low-grade inflammation, which contribute not only to reproductive abnormalities but also to long-term cardiometabolic risk (Calcaterra et al., 2024; Dokras et al., 2016). Because conventional pharmacological therapies often target specific manifestations rather than the underlying metabolic pathology, lifestyle interventions aimed at weight reduction and metabolic improvement are widely recommended as first-line therapy (Barrea et al., 2019).

Weight Reduction and Diet Therapy

Weight loss is a cornerstone in the management of PCOS and has been shown to improve multiple clinical outcomes. Even modest weight reduction (5–10% of initial body weight) can restore ovulation, improve menstrual regularity, decrease circulating insulin and androgen levels, and reduce ovary volume and the severity of polycystic ovarian morphology (Calcaterra et al., 2024; Barrea et al., 2019). Weight loss also enhances fertility outcomes and the efficacy of fertility treatments such as ovulation induction (Calcaterra et al., 2024).

Dietary interventions are central to weight management in PCOS. A variety of dietary approaches have been studied, including low-calorie diets, low-glycemic-index diets, and Mediterranean-style diets. Low-glycemic-index diets may be particularly beneficial in PCOS because they help reduce postprandial glucose and insulin peaks, which are linked to insulin resistance and hyperandrogenism (Saeed et al., 2025). Mediterranean diets that emphasize whole grains, fruits, vegetables, lean proteins, and healthy fats have been associated with improvements in insulin sensitivity, inflammation, and lipid profiles, making them a promising long-term nutritional strategy in PCOS (Gu et al., 2022).

Caloric restriction remains the primary driver of weight loss regardless of the specific macronutrient composition. Hypocaloric diets achieve weight reduction through decreased energy intake, which in turn improves metabolic parameters and endocrine function in women with PCOS (Calcaterra et al., 2024). Evidence suggests that structured dietary guidance, ideally provided by trained nutrition professionals, leads to better adherence and more significant clinical benefits (Barrea et al., 2019).

Physical Activity and Exercise

Regular physical activity is another essential component of lifestyle modification in PCOS management. Exercise improves insulin sensitivity independently of weight loss, enhances glucose uptake by skeletal muscle, and contributes to overall metabolic health (Kite et al., 2019). Both aerobic and resistance training have demonstrated beneficial effects, with combined regimens often producing the greatest improvements in body composition, insulin action, and cardiovascular risk markers (Kite et al., 2019). Increased physical activity also positively influences psychological well-being, which is particularly relevant given the high prevalence of anxiety and depression in women with PCOS (Cowan et al., 2023).

Behavioral and Psychological Strategies

Lifestyle change often involves more than diet and exercise alone; behavioral support and psychological interventions can enhance motivation, adherence, and long-term success. Cognitive-behavioral therapy, motivational interviewing, and structured behavior modification programs have been shown to improve weight loss outcomes and quality of life in PCOS, addressing barriers such as emotional eating, stress, and body-image concerns (Cowan et al., 2023). Behavioral strategies that encourage goal setting, self-monitoring, and problem-solving have demonstrated added value when implemented alongside nutritional and physical activity interventions (Cowan et al., 2023).

Sleep and Chronobiology

Sleep quality and circadian rhythm regulation also play roles in metabolic health. Sleep disturbances and short sleep duration have been associated with increased insulin resistance, hormonal dysregulation, and weight gain, which are particularly detrimental in women with PCOS (Dokras et al., 2016). Lifestyle recommendations often include guidance on healthy sleep habits and stress management, which may positively influence insulin sensitivity, appetite regulation, and overall metabolic function.

Metabolic and Reproductive Effects

The beneficial effects of lifestyle modification extend beyond metabolic markers to reproductive outcomes. Weight loss and improved insulin sensitivity facilitate the restoration of regular ovulation and menstrual cycles in many women with PCOS (Barrea et al., 2019; Calcaterra et al., 2024). These changes are clinically significant, with evidence showing that women who achieve weight reduction are more likely to conceive naturally or respond favorably to fertility treatments. Additionally, improvements in lipid profiles and reductions in inflammation decrease long-term cardiometabolic risk, which is elevated in women with PCOS (Gu et al., 2022).

Implementation and Clinical Recommendations

Clinical guidelines for PCOS universally recognize lifestyle modification as a first-line therapy. A structured lifestyle program should ideally combine dietary counseling, personalized physical activity recommendations, behavioral support, and regular follow-up to reinforce adherence and monitor progress (Barrea et al., 2019). Individualization of lifestyle interventions is essential, considering factors such as baseline metabolic status, preferences, comorbidities, and psychosocial context.

Limitations and Challenges

Despite robust evidence supporting lifestyle approaches, implementation in real-world settings is often challenging. Barriers include limited access to health professionals with expertise in PCOS, socioeconomic factors, and difficulties in sustaining long-term behavior change. Adherence to diet and exercise regimens tends to decline over time, highlighting the need for ongoing support and innovative interventions that enhance motivation and engagement (Cowan et al., 2023).

2. Oral Contraceptive Pills

Combined oral contraceptive pills (COCPs) are among the most commonly prescribed pharmacological treatments in women with polycystic ovary syndrome. They are widely used to regulate menstrual cycles, reduce hyperandrogenic symptoms, and provide effective contraception in reproductive-aged women with PCOS (Dokras et al., 2016). PCOS is characterized by chronic anovulation, oligomenorrhea or amenorrhea, and clinical or biochemical hyperandrogenism; COCPs address several of these pathophysiological abnormalities through hormonal regulation (Witchel et al., 2019).

COCPs contain combinations of estrogen and progestin, which act by suppressing the hypothalamic-pituitary-ovarian axis, leading to inhibition of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) secretion. This suppresses ovarian androgen production and stabilizes endometrial growth (Dokras et al., 2016). Estrogen in COCPs increases hepatic synthesis of sex hormone-binding globulin (SHBG), thereby reducing the concentration of circulating free testosterone, which is a major contributor to clinical signs of hyperandrogenism (Witchel et al., 2019). Increased SHBG also decreases androgen bioavailability and helps alleviate symptoms such as hirsutism and acne (Rosa, 2021).

One of the primary clinical benefits of COCPs in PCOS is the restoration of more regular menstrual cycles. Women with PCOS frequently present with oligomenorrhea or amenorrhea due to chronic anovulation, which increases the risk of endometrial hyperplasia from unopposed estrogen exposure (Melin et al., 2023). By providing cyclic or continuous progestin exposure, COCPs induce regular withdrawal bleeding and reduce endometrial proliferation, thereby decreasing the risk of endometrial hyperplasia and carcinoma (Dokras et al., 2016).

In addition to menstrual regulation, COCPs are effective in managing dermatological manifestations of hyperandrogenism. Clinical studies demonstrate that COCPs reduce the severity of hirsutism and acne, likely due to both decreased ovarian androgen production and increased SHBG concentrations (Rosa, 2021). This effect is particularly beneficial because cutaneous symptoms are among the most distressing features of PCOS and can significantly impact quality of life (Witchel et al., 2019).

Different combinations of estrogen and progestin have varying antiandrogenic potentials. Progestins with lower androgenic activity, such as drospirenone, desogestrel, or cyproterone acetate, are often preferred in women with significant hyperandrogenic symptoms because they exhibit greater antiandrogenic effects (Rosa, 2021). Drospirenone, for example, has both antiandrogenic and antimineralocorticoid properties, which may offer additional benefits in reducing fluid retention and improving dermatological symptoms (Rosa, 2021).

Despite their widespread use, COCPs can have metabolic side effects that require clinical consideration. Some studies indicate that certain COCP formulations may negatively affect insulin sensitivity and lipid metabolism, although these effects vary depending on the hormonal components and dose (Dokras et al., 2016). Because insulin resistance and dyslipidemia are common features in PCOS, careful selection of pill formulation and monitoring of metabolic parameters are important in long-term management (Dokras et al., 2016).

COCPs are generally safe and well tolerated, but some adverse effects have been described. Common side effects include nausea, breast tenderness, headaches, and breakthrough bleeding, particularly during the initial months of use (Dokras et al., 2016). Rare but serious risks include venous thromboembolism, particularly in women with additional risk factors such as smoking or obesity; therefore, patient selection and counseling are essential (Dokras et al., 2016).

Another important consideration in the use of COCPs for PCOS is the timing of contraceptive use relative to reproductive goals. Because COCPs are contraceptive, they are not suitable for women actively seeking to become pregnant. In such cases, alternative ovulation induction therapies should be prioritized (Witchel et al., 2019).

In addition to their effects on reproductive and dermatological outcomes, COCPs may also influence long-term health in women with PCOS. Some studies suggest that COCPs may reduce the risk of endometrial cancer by normalizing menstrual cycles and limiting unopposed estrogen exposure (Melin et al., 2023). This is particularly relevant in PCOS, where chronic anovulation is associated with prolonged estrogen exposure and an increased risk of endometrial pathology (Melin et al., 2023).

However, evidence regarding the impact of COCPs on long-term metabolic outcomes, such as type 2 diabetes and cardiovascular disease risk in PCOS, remains mixed. Some research suggests potential adverse effects on glucose tolerance and lipid profiles with certain formulations, underscoring the need for individualized risk assessment and follow-up (Dokras et al., 2016).

In conclusion, combined oral contraceptive pills represent a cornerstone in the management of reproductive and hyperandrogenic symptoms in women with PCOS. By regulating menstrual cycles, reducing androgen bioavailability, and improving dermatological outcomes, COCPs provide significant clinical benefits. However, the selection of formulation and careful monitoring of metabolic and cardiovascular risk factors are essential to optimize therapeutic outcomes in this patient population (Dokras et al., 2016; Witchel et al., 2019; Rosa, 2021).

3. Antiandrogens

Hyperandrogenism is one of the key pathophysiological features of polycystic ovary syndrome and is responsible for many of its clinical manifestations, including hirsutism, acne, and androgenic alopecia (Reiser et al., 2022; Armanini et al., 2022). Elevated androgen levels in women with PCOS result from increased ovarian androgen production and altered endocrine regulation, which leads to excessive stimulation of androgen receptors in target tissues such as hair follicles and sebaceous glands (Reiser et al., 2022). Because these symptoms significantly affect quality of life, pharmacological agents that reduce androgen activity play an important role in the management of PCOS (Siddiqui et al., 2022).

Antiandrogens are medications that reduce the biological effects of androgens by either blocking androgen receptors or inhibiting androgen production (Armanini et al., 2022). These drugs are primarily used to treat clinical manifestations of hyperandrogenism rather than the underlying metabolic abnormalities associated with PCOS (Reiser et al., 2022). Antiandrogen therapy is typically recommended when symptoms such as hirsutism or acne persist despite treatment with combined oral contraceptives or other first-line therapies (Siddiqui et al., 2022).

One of the most commonly used antiandrogen medications in PCOS is spironolactone. Spironolactone is primarily an aldosterone antagonist but also exhibits antiandrogenic properties through competitive inhibition of androgen receptors and inhibition of 5-alpha-reductase, the enzyme responsible for converting testosterone into the more potent androgen dihydrotestosterone (DHT) (Armanini et al., 2022; Siddiqui et al., 2022). By blocking androgen action at target tissues, spironolactone can reduce excessive hair growth, acne, and other dermatological manifestations of hyperandrogenism in women with PCOS (Siddiqui et al., 2022).

Clinical studies have demonstrated that spironolactone is effective in reducing hirsutism in women with PCOS when administered at appropriate therapeutic doses (Armanini et al., 2022). The drug is generally well tolerated and widely used due to its relatively favorable safety profile and low cost (Armanini et al., 2022). However, spironolactone may cause side effects such as menstrual irregularities, dizziness, fatigue, and hypotension, particularly at higher doses (Armanini et al., 2022).

Another antiandrogen that has been studied in PCOS management is flutamide, a nonsteroidal androgen receptor antagonist originally developed for the treatment of prostate cancer (Rashid et al., 2022). Flutamide acts by competitively inhibiting the binding of androgens to androgen receptors in peripheral tissues, thereby preventing androgen-mediated biological effects (Rashid et al., 2022). Clinical studies have shown that flutamide can significantly improve hirsutism and reduce androgen levels in women with PCOS (Rashid et al., 2022).

Despite its therapeutic efficacy, the clinical use of flutamide is limited due to concerns regarding hepatotoxicity. Cases of elevated liver enzymes and severe liver injury have been reported during flutamide therapy, which necessitates careful monitoring of liver function during treatment (Rashid et al., 2022).

Finasteride is another antiandrogen that may be used in the treatment of hyperandrogenic symptoms associated with PCOS. Finasteride acts as a selective inhibitor of 5-alpha-reductase, thereby preventing the conversion of testosterone to dihydrotestosterone and reducing androgen activity in hair follicles and other target tissues (Armanini et al., 2022). This mechanism contributes to the reduction of hirsutism and androgenic alopecia in affected women (Armanini et al., 2022).

Several clinical trials have demonstrated that antiandrogens such as spironolactone, finasteride, and flutamide are effective in reducing hirsutism scores in women with PCOS (Armanini et al., 2022). Comparative studies suggest that these medications have similar efficacy in reducing androgen-related symptoms, although their safety profiles differ (Armanini et al., 2022).

Antiandrogen therapy is frequently combined with combined oral contraceptives in the treatment of PCOS. Oral contraceptives suppress ovarian androgen production and increase levels of sex hormone-binding globulin (SHBG), which reduces free circulating testosterone (Reiser et al., 2022). The combination of oral contraceptives with antiandrogens may enhance the reduction of hyperandrogenic symptoms and improve clinical outcomes (Siddiqui et al., 2022).

An important consideration in antiandrogen therapy is the potential teratogenic effect of these medications. Antiandrogens may interfere with normal male fetal development by blocking androgen activity, which makes reliable contraception essential for women receiving this treatment (Armanini et al., 2022). For this reason, antiandrogens are generally prescribed only in combination with effective contraceptive methods in women of reproductive age (Siddiqui et al., 2022).

Although antiandrogen therapy is effective in reducing clinical symptoms of hyperandrogenism, it does not directly address other important aspects of PCOS such as insulin resistance or metabolic dysfunction

(Reiser et al., 2022). Therefore, antiandrogens are usually used as part of a comprehensive treatment strategy that may also include lifestyle interventions, insulin-sensitizing medications, and reproductive therapies (Reiser et al., 2022; (Siddiqui et al., 2022).

In conclusion, antiandrogen medications represent an important therapeutic option for the management of hyperandrogenic symptoms in women with PCOS. Drugs such as spironolactone, flutamide, and finasteride can effectively reduce androgen activity and improve clinical manifestations including hirsutism, acne, and androgenic alopecia. However, because these medications do not address the underlying metabolic abnormalities of PCOS and may carry potential risks, their use should be individualized and carefully monitored as part of a comprehensive treatment approach (Reiser et al., 2022; Armanini et al., 2022; Siddiqui et al., 2022).

4. Metformin

Metformin is one of the most widely studied pharmacological agents used in the management of polycystic ovary syndrome, primarily due to its insulin-sensitizing properties and beneficial effects on metabolic and reproductive abnormalities associated with the disorder (Saeed et al., 2025). PCOS is frequently accompanied by insulin resistance and compensatory hyperinsulinemia, which contribute to hyperandrogenism, ovulatory dysfunction, and metabolic complications; therefore, treatments targeting insulin sensitivity have become an important component of PCOS therapy (Witchel et al., 2019).

Metformin is a biguanide drug traditionally used in the treatment of type 2 diabetes mellitus, but it has been increasingly utilized in PCOS management due to its ability to improve insulin resistance and glucose metabolism (Saeed et al., 2025). The primary molecular mechanism of metformin involves the activation of AMP-activated protein kinase (AMPK), which regulates cellular energy homeostasis and leads to decreased hepatic gluconeogenesis and increased peripheral glucose uptake (Saeed et al., 2025). Through AMPK activation, metformin improves insulin sensitivity and enhances glucose utilization in tissues such as skeletal muscle and adipose tissue (Saeed et al., 2025).

In addition to its metabolic effects, metformin exerts direct actions on ovarian function. Studies suggest that metformin can reduce ovarian androgen production by inhibiting key steroidogenic enzymes involved in androgen synthesis, which may contribute to the improvement of hyperandrogenism in women with PCOS (An et al., 2025). Long-term metformin therapy has also been associated with decreased activity of steroidogenic enzymes and reduced adrenal androgen response, further supporting its role in improving hormonal imbalance in PCOS (Saeed et al., 2025).

Clinical studies demonstrate that metformin treatment may improve several metabolic parameters in women with PCOS. These include reductions in body mass index (BMI), waist circumference, and circulating androgen levels, as well as improvements in lipid profiles (Rashid et al., 2022). A meta-analysis of randomized controlled trials reported that metformin significantly improved endocrine and metabolic markers such as testosterone, follicle-stimulating hormone (FSH), luteinizing hormone (LH), and low-density lipoprotein cholesterol in overweight women with PCOS (Kotlyar & Seifer, 2023).

Metformin therapy has also been associated with improvements in menstrual regularity and ovulation. By reducing insulin resistance and androgen levels, the drug may restore normal follicular development and improve ovulatory function in women with PCOS (Tso et al., 2020). As a result, metformin has been used in the management of anovulatory infertility related to PCOS, either alone or in combination with other treatments such as ovulation-inducing agents (Reiser et al., 2022).

Another important effect of metformin in PCOS is its impact on inflammation and oxidative stress. PCOS is increasingly recognized as a condition associated with chronic low-grade inflammation, characterized by elevated inflammatory markers such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α) (Saeed et al., 2025). Metformin has been shown to reduce the expression of inflammatory cytokines and suppress inflammatory signaling pathways such as PI3K-AKT-NF-κB, which may contribute to improved metabolic and reproductive outcomes (Saeed et al., 2025). Furthermore, the drug can reduce oxidative stress by decreasing reactive oxygen species levels and improving mitochondrial function (Saeed et al., 2025).

Emerging evidence also indicates that metformin may influence gut microbiota and intestinal metabolism. Activation of intestinal AMPK by metformin can modify the composition of gut microbiota and increase the production of beneficial metabolites, which may contribute to improved metabolic and ovarian function in PCOS (Melin et al., 2023).

In addition to metabolic and endocrine effects, metformin may improve endometrial function in women with PCOS. Studies have shown that metformin treatment can influence gene expression and DNA methylation

in the endometrium, including increased expression of genes related to insulin signaling and endometrial receptivity, suggesting a potential role in improving fertility outcomes (Reiser et al., 2022).

Despite its benefits, metformin is not considered a universal first-line therapy for all manifestations of PCOS. Current clinical recommendations suggest its use primarily in women with metabolic abnormalities, insulin resistance, or impaired glucose tolerance, often as an adjunct to lifestyle modification (Saeed et al., 2025). Nevertheless, due to its favorable safety profile and multiple mechanisms of action, metformin remains an important pharmacological option in the comprehensive management of PCOS (Witchel et al., 2019).

5. GLP-1 receptor agonists

Glucagon-like peptide-1 (GLP-1) is an incretin hormone secreted by intestinal L-cells that plays a key role in the regulation of glucose metabolism, appetite, and energy balance. GLP-1 receptor agonists (GLP-1RAs), originally developed for the treatment of type 2 diabetes mellitus, have recently attracted attention as a potential therapeutic option for patients with polycystic ovary syndrome, particularly those with obesity and insulin resistance (Cena et al., 2020; Reiser et al., 2022).

Insulin resistance is one of the central pathophysiological mechanisms in PCOS and occurs in a large proportion of affected women, regardless of body mass index, although it is more prevalent among overweight and obese individuals (Reiser et al., 2022). Hyperinsulinemia contributes to ovarian androgen overproduction and decreased sex hormone-binding globulin (SHBG) levels, leading to hyperandrogenism and reproductive dysfunction (Cena et al., 2020). Therefore, pharmacological strategies that improve insulin sensitivity and metabolic parameters may play an important role in PCOS management (Cena et al., 2020).

GLP-1 receptor agonists exert several metabolic effects that are beneficial in PCOS. These drugs stimulate glucose-dependent insulin secretion, suppress glucagon release, delay gastric emptying, and reduce appetite through central nervous system mechanisms (Reiser et al., 2022). Activation of GLP-1 receptors in the brain reduces hunger and energy intake, alters reward pathways associated with food consumption, and may decrease cravings for energy-dense foods (Reiser et al., 2022). As a result, GLP-1RAs promote significant weight loss and improvements in metabolic parameters (Cena et al., 2020).

Weight reduction is particularly important in PCOS, as obesity exacerbates insulin resistance, hyperandrogenism, and reproductive dysfunction. Clinical studies have demonstrated that treatment with GLP-1 receptor agonists leads to significant reductions in body weight, body mass index (BMI), waist circumference, and visceral fat mass in women with PCOS (Cena et al., 2020) (Rashid et al., 2022). In several randomized clinical trials, liraglutide therapy resulted in weight loss of approximately 3–5 kg over several months of treatment and significantly reduced waist circumference compared with placebo or metformin (Cena et al., 2020; Rashid et al., 2022).

In addition to improvements in anthropometric parameters, GLP-1 receptor agonists also have beneficial effects on metabolic and endocrine markers associated with PCOS. Studies have shown reductions in fasting insulin levels, improvements in insulin sensitivity indices, and favorable changes in lipid profiles following GLP-1RA therapy (Cena et al., 2020; Reiser et al., 2022). Moreover, treatment has been associated with decreased circulating androgen levels, including free testosterone, and increased SHBG concentrations, suggesting a potential role in reducing hyperandrogenism, (Cena et al., 2020; Reiser et al., 2022).

Some studies also report improvements in reproductive outcomes. For example, GLP-1RA therapy has been associated with improved menstrual regularity and ovulatory function in women with PCOS, which may be related to reductions in body weight, insulin resistance, and androgen levels (Cena et al., 2020; Reiser et al., 2022). In addition, treatment with liraglutide has been shown to increase SHBG levels and reduce free testosterone concentrations, further supporting its endocrine benefits (Reiser et al., 2022).

Another important aspect of GLP-1RA therapy in PCOS is its potential advantage compared with traditional treatments. Metformin remains one of the most widely used pharmacological therapies for insulin resistance in PCOS; however, several studies suggest that GLP-1 receptor agonists may be more effective in reducing body weight and improving certain metabolic parameters (Cena et al., 2020; Rashid et al., 2022). Combination therapy with GLP-1RAs and metformin has also been investigated and may provide additive benefits due to complementary mechanisms of action, including appetite suppression by GLP-1 and improved hepatic insulin sensitivity induced by metformin (Cena et al., 2020).

Despite promising results, the use of GLP-1 receptor agonists in PCOS still has some limitations. Most clinical trials have relatively small sample sizes and short follow-up periods, and long-term data on reproductive outcomes and safety remain limited (Rashid et al., 2022). Additionally, GLP-1RAs may cause

adverse effects such as nausea, vomiting, and gastrointestinal discomfort, which may limit treatment adherence in some patients (Reiser et al., 2022).

In summary, GLP-1 receptor agonists represent a promising therapeutic option for women with PCOS, particularly in those with obesity and insulin resistance. Their ability to promote weight loss, improve metabolic parameters, and reduce hyperandrogenism suggests that they may play an important role in the comprehensive management of PCOS. However, further large-scale randomized controlled trials are needed to clarify their long-term efficacy and safety in this patient population (Cena et al., 2020; Reiser et al., 2022; Rashid et al., 2022).

6. Nutritional Supplements

Nutritional supplementation has emerged as an important adjunctive strategy in the management of polycystic ovary syndrome. PCOS is a complex endocrine and metabolic disorder characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology, frequently accompanied by insulin resistance, obesity, dyslipidemia, and chronic low-grade inflammation (Merviel et al., 2021). Because conventional pharmacological therapies primarily target individual symptoms and may not fully address the metabolic and endocrine complexity of the disorder, nutritional supplements have gained increasing attention as supportive therapeutic options (Saeed et al., 2025).

Many nutritional supplements used in PCOS management exert their beneficial effects through modulation of insulin sensitivity, reduction of oxidative stress, improvement of lipid metabolism, and regulation of hormonal balance (Merviel et al., 2021). These mechanisms are particularly relevant because insulin resistance and hyperinsulinemia play a central role in the pathogenesis of PCOS by stimulating ovarian androgen production and decreasing the hepatic synthesis of sex hormone-binding globulin (SHBG), which leads to increased circulating free androgen levels (Merviel et al., 2021).

One of the most extensively studied nutritional supplements in PCOS is inositol, particularly myo-inositol and D-chiro-inositol. These compounds act as insulin sensitizers and participate in intracellular signaling pathways involved in glucose metabolism (Merviel et al., 2021). Several clinical studies have demonstrated that inositol supplementation can improve insulin sensitivity, reduce serum insulin levels, and promote ovulatory function in women with PCOS (Merviel et al., 2021). Furthermore, treatment with myo-inositol has been associated with improvements in hormonal profiles, including reductions in serum testosterone levels and normalization of menstrual cycles (Saeed et al., 2025).

Vitamin D is another nutritional factor that has been widely investigated in relation to PCOS. Vitamin D deficiency is common among women with PCOS and may contribute to metabolic and endocrine disturbances associated with the condition (Calcaterra et al., 2021). Evidence suggests that vitamin D supplementation may improve insulin resistance, lipid metabolism, and inflammatory markers in patients with PCOS (Calcaterra et al., 2021). Additionally, vitamin D may influence ovarian steroidogenesis and follicular development, potentially improving reproductive outcomes in affected women (Saeed et al., 2025).

Omega-3 fatty acids have also been studied for their potential role in PCOS management due to their anti-inflammatory and cardiometabolic effects. Supplementation with omega-3 fatty acids has been shown to improve lipid profiles, reduce triglyceride levels, and decrease markers of systemic inflammation (Saeed et al., 2025). These effects are particularly relevant because women with PCOS have an increased risk of cardiovascular disease and metabolic syndrome (Merviel et al., 2021).

Another compound of interest is N-acetylcysteine (NAC), which possesses antioxidant and insulin-sensitizing properties. NAC supplementation has been reported to improve insulin resistance, enhance ovulation rates, and reduce androgen levels in women with PCOS (Nordio et al., 2019). Some studies also suggest that NAC may improve fertility outcomes, particularly in women undergoing ovulation induction therapy (Nordio et al., 2019).

Resveratrol, a polyphenolic compound found in grapes and other plant sources, has also been investigated as a potential supplement for PCOS. Research indicates that resveratrol may reduce androgen production, improve insulin sensitivity, and exert anti-inflammatory and antioxidant effects (Saeed et al., 2025). Clinical studies have reported reductions in total testosterone and dehydroepiandrosterone sulfate (DHEAS) levels following resveratrol supplementation in women with PCOS (Saeed et al., 2025).

Coenzyme Q10 (CoQ10) is another nutritional supplement that has been evaluated in PCOS due to its role in mitochondrial function and oxidative stress reduction. Some studies suggest that CoQ10 supplementation may improve metabolic parameters, including fasting glucose levels and lipid profiles, in

women with PCOS (Rosa, 2021). Additionally, CoQ10 may contribute to improved antioxidant capacity and reduced oxidative stress, which are commonly elevated in PCOS (Rosa, 2021).

Melatonin has also been proposed as a potential therapeutic supplement in PCOS because of its role in regulating circadian rhythms and reproductive physiology. Studies indicate that melatonin may improve oocyte quality, reduce oxidative stress in ovarian tissue, and enhance reproductive outcomes in women with PCOS (Saeed et al., 2025).

Magnesium and zinc supplementation have also been investigated in the context of PCOS management. These micronutrients play important roles in glucose metabolism, insulin signaling, and antioxidant defense mechanisms (Bednarska & Siejka, 2017). Some studies suggest that supplementation with magnesium and zinc may contribute to improvements in insulin resistance and metabolic parameters in women with PCOS (Bednarska & Siejka, 2017).

In addition to individual supplements, combined nutritional interventions have been studied for their potential synergistic effects. For example, combinations of inositol, vitamin D, and other micronutrients may enhance improvements in metabolic and reproductive outcomes compared with single-nutrient supplementation (Saeed et al., 2025). Such combination therapies may target multiple aspects of PCOS pathophysiology simultaneously, including insulin resistance, oxidative stress, and hormonal imbalance (Saeed et al., 2025).

Despite the promising findings associated with nutritional supplementation in PCOS, the available evidence remains heterogeneous. Differences in study design, sample size, dosage, and duration of supplementation make it difficult to establish standardized recommendations for clinical practice (Alesi et al., 2021). Moreover, while many supplements appear to be safe and well tolerated, further high-quality randomized controlled trials are necessary to confirm their long-term efficacy and safety in women with PCOS (Alesi et al., 2021).

In conclusion, nutritional supplements represent a promising complementary approach in the management of PCOS. Various compounds, including inositols, vitamin D, omega-3 fatty acids, N-acetylcysteine, resveratrol, coenzyme Q10, and micronutrients such as magnesium and zinc, have demonstrated potential benefits for metabolic, hormonal, and reproductive outcomes. However, further well-designed clinical studies are required to determine optimal dosages, treatment duration, and long-term therapeutic effects of these supplements in women with PCOS (Saeed et al., 2025; Merviel et al., 2021).

7. Herbal Medicine

Herbal medicine has gained increasing attention as a complementary therapeutic approach in the management of polycystic ovary syndrome, particularly among patients seeking alternatives or adjuncts to conventional pharmacological treatments. PCOS is a complex endocrine disorder characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology, and it is frequently associated with metabolic disturbances such as insulin resistance, obesity, and dyslipidemia (Moini Jazani et al., 2019). Because conventional pharmacological therapies often target only specific symptoms and may be associated with adverse effects or contraindications, many women with PCOS turn to complementary therapies, including herbal medicine, as part of a holistic treatment strategy (Arentz et al., 2014).

Herbal medicine has a long history in traditional medical systems, including Traditional Chinese Medicine and traditional Persian medicine, where plant-based preparations have been used to treat gynecological disorders such as infertility, menstrual irregularities, and hormonal imbalance (Moini Jazani et al., 2019). Many herbal extracts contain biologically active compounds that may influence endocrine, metabolic, and inflammatory pathways involved in the pathogenesis of PCOS (Manouchehri et al., 2022). These phytochemicals may exert effects through modulation of steroidogenesis, improvement of insulin sensitivity, reduction of oxidative stress, and regulation of inflammatory processes (Chen et al., 2023).

Several herbal medicines have been investigated for their potential therapeutic effects in PCOS. Among the most commonly studied plants are *Vitex agnus-castus*, *Cimicifuga racemosa*, *Tribulus terrestris*, *Glycyrrhiza* species (licorice), *Paeonia lactiflora*, and *Cinnamomum cassia* (Arentz et al., 2014). Preclinical and clinical studies suggest that these herbal preparations may influence reproductive endocrinology by reducing luteinizing hormone levels, lowering testosterone concentrations, improving insulin metabolism, and promoting ovulation (Arentz et al., 2014).

Cinnamon (*Cinnamomum* species) is one of the most extensively studied herbal agents in PCOS. Clinical studies have demonstrated that cinnamon supplementation may improve insulin resistance, reduce fasting blood glucose levels, and improve lipid profiles in women with PCOS (Moini Jazani et al., 2019). In addition, cinnamon

administration has been associated with reductions in serum insulin levels and improvements in metabolic parameters such as cholesterol and triglyceride concentrations (Moini Jazani et al., 2019).

Another plant that has received considerable attention is *Vitex agnus-castus* (chasteberry), which has traditionally been used for menstrual disorders and infertility. The herb is believed to act on the hypothalamic–pituitary axis by modulating prolactin secretion and influencing gonadotropin release, which may contribute to improved ovulatory function and menstrual cycle regulation in women with PCOS (Arentz et al., 2014).

Tribulus terrestris is another herbal medicine that has been investigated for its potential reproductive benefits in PCOS. Experimental studies suggest that extracts from this plant may stimulate ovulation and improve ovarian function, possibly through modulation of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) activity (Arentz et al., 2014). Similarly, *Paeonia lactiflora*, particularly when combined with *Glycyrrhiza* species, has been reported to reduce androgen levels and improve hormonal balance in women with hyperandrogenic conditions (Arentz et al., 2014).

Licorice (*Glycyrrhiza* species) has demonstrated anti-androgenic properties and may contribute to the reduction of circulating testosterone levels in women with PCOS (Arentz et al., 2014). In addition to its endocrine effects, licorice may exert anti-inflammatory and metabolic benefits that could further support the management of PCOS symptoms (Manouchehri et al., 2022).

Berberine, a plant-derived alkaloid present in several medicinal herbs, has also been studied as a potential treatment for PCOS. Research suggests that berberine may improve insulin sensitivity, regulate glucose metabolism, and reduce lipid levels, which are key metabolic abnormalities observed in PCOS patients (Moini Jazani et al., 2019; Chen et al., 2023). Some clinical studies have suggested that berberine may have metabolic effects comparable to those of metformin, a commonly prescribed insulin-sensitizing medication (Moini Jazani et al., 2019).

In addition to individual herbs, combinations of herbal extracts have been investigated for their synergistic effects in PCOS management. For example, formulations combining cinnamon, licorice, *Paeonia lactiflora*, and other botanicals have demonstrated improvements in metabolic and hormonal parameters in some clinical studies (Moini Jazani et al., 2019). Such combinations may target multiple aspects of PCOS pathophysiology simultaneously, including insulin resistance, androgen excess, and chronic low-grade inflammation (Chen et al., 2023).

Herbal therapies may also influence reproductive outcomes in women with PCOS. Some clinical studies have reported improvements in ovulation rates, menstrual cycle regularity, and fertility following treatment with specific herbal medicines (Arentz et al., 2014). In certain cases, herbal therapies have shown comparable effects to conventional medications such as clomiphene citrate or bromocriptine in improving reproductive endocrine parameters (Arentz et al., 2014).

Despite promising findings, the evidence supporting the use of herbal medicine in PCOS remains heterogeneous. Many studies are limited by small sample sizes, differences in herbal preparations, and variability in treatment duration and outcome measures (Malik et al., 2023). Furthermore, standardization of herbal products and rigorous clinical trials are necessary to confirm their efficacy and safety in the long-term management of PCOS (Babhare et al., 2025).

In terms of safety, most studies report that herbal treatments are generally well tolerated and associated with relatively few adverse effects compared with conventional pharmacological therapies (Moini Jazani et al., 2019). However, some herbal compounds may interact with medications or produce mild gastrointestinal symptoms, emphasizing the importance of medical supervision when using herbal therapies (Manouchehri et al., 2022).

In conclusion, herbal medicine represents a promising complementary approach in the management of PCOS, with potential benefits for metabolic, endocrine, and reproductive outcomes. Various herbal agents, including cinnamon, berberine, licorice, *Vitex agnus-castus*, and *Tribulus terrestris*, have demonstrated potential therapeutic effects in both preclinical and clinical studies. Nevertheless, further high-quality randomized controlled trials are required to establish standardized treatment protocols and determine the long-term safety and efficacy of herbal therapies in women with PCOS (Malik et al., 2023; Babhare et al., 2025).

8. Ovarian Drilling

Laparoscopic ovarian drilling (LOD) is a surgical treatment used in the management of infertility in women with polycystic ovary syndrome, particularly in patients who are resistant to first-line pharmacological ovulation induction therapies such as clomiphene citrate or letrozole (Sirmans & Pate, 2013; Lebbi et al., 2015). PCOS is characterized by hyperandrogenism, chronic anovulation, and polycystic ovarian morphology, and infertility resulting from anovulation is one of the most common clinical manifestations of the disorder (Burnik Papler et al., 2022).

Laparoscopic ovarian drilling was developed as a minimally invasive alternative to earlier surgical techniques such as ovarian wedge resection, which had been associated with a high risk of postoperative adhesions and other complications (Sirmans & Pate, 2013). The procedure is typically performed using laparoscopy and involves creating multiple small punctures in the ovarian cortex using electrocautery or laser energy (Lebbi et al., 2015). During the procedure, several perforations are made in each ovary to destroy a portion of the androgen-producing ovarian stroma (Lebbi et al., 2015).

The therapeutic effect of ovarian drilling is primarily attributed to the reduction of ovarian androgen production and the subsequent normalization of endocrine function (Lebbi et al., 2015). By destroying androgen-producing tissue, the procedure decreases circulating androgen levels and reduces luteinizing hormone (LH) concentrations, which can help restore the normal hormonal environment necessary for follicular development and ovulation (Lebbi et al., 2015). Studies have shown that after LOD, levels of testosterone and LH decrease significantly, while follicle-stimulating hormone (FSH) levels may increase, leading to improved ovulatory function (Burnik Papler et al., 2022).

Another mechanism by which ovarian drilling may improve reproductive outcomes involves changes in intra-ovarian signaling and follicular dynamics. The destruction of part of the ovarian cortex may reduce the number of small antral follicles and decrease ovarian stromal thickness, which may facilitate the development of dominant follicles and ovulation (Lebbi et al., 2015). In addition, some studies suggest that LOD may improve endometrial receptivity by altering metabolic and hormonal signals within the reproductive tract (Lebbi et al., 2015).

Laparoscopic ovarian drilling has demonstrated effectiveness in restoring ovulation in women with anovulatory PCOS who do not respond to medical therapy. Clinical studies report high ovulation rates following the procedure, with ovulation occurring in a substantial proportion of treated patients (Sirmans & Pate, 2013). In some studies, ovulation rates after ovarian drilling have been reported to range between approximately 63% and 81% within several months following the procedure (Sirmans & Pate, 2013).

In addition to restoring ovulation, ovarian drilling may improve menstrual regularity and reduce clinical symptoms associated with hyperandrogenism. Research has shown that after LOD, many patients experience normalization of menstrual cycles as well as reductions in symptoms such as hirsutism and acne (Burnik Papler et al., 2022). These improvements are believed to result from the reduction of androgen levels and the restoration of hormonal balance following the surgical procedure (Burnik Papler et al., 2022).

Another important clinical outcome associated with ovarian drilling is improvement in pregnancy rates among women with PCOS-related infertility. Several studies have reported that many patients conceive naturally following the restoration of ovulation after the procedure (Sirmans & Pate, 2013). Some clinical investigations have demonstrated substantial pregnancy rates within the first year after surgery in women undergoing LOD for infertility related to PCOS (Sirmans & Pate, 2013; Waghmare & Shanoo, 2023).

Compared with pharmacological ovulation induction using gonadotropins, laparoscopic ovarian drilling offers certain advantages. One important benefit is a lower risk of multiple pregnancy, which is a common complication associated with gonadotropin therapy (Sirmans & Pate, 2013). In addition, ovarian drilling is associated with a reduced risk of ovarian hyperstimulation syndrome (OHSS), a potentially serious complication of fertility treatment (Sirmans & Pate, 2013).

Despite its benefits, ovarian drilling is not considered a first-line treatment for PCOS. Current clinical guidelines recommend pharmacological ovulation induction as the initial therapy for anovulatory infertility, with surgical interventions such as LOD reserved for patients who do not respond adequately to medical treatment (Burnik Papler et al., 2022). Therefore, ovarian drilling is generally considered a second-line therapeutic option in the management of infertility associated with PCOS (Burnik Papler et al., 2022).

Like any surgical procedure, laparoscopic ovarian drilling is associated with potential risks and complications. One of the main concerns is the formation of postoperative adhesions, which may negatively affect fertility outcomes (Sirmans & Pate, 2013). Additionally, excessive destruction of ovarian tissue during

the procedure may theoretically reduce ovarian reserve, although careful surgical technique can minimize this risk (Lebbi et al., 2015).

Another limitation of ovarian drilling is that its beneficial effects may not be permanent in all patients. Some women may experience recurrence of anovulation or hyperandrogenic symptoms over time, which may require additional medical treatment (Collée et al., 2021).

In conclusion, laparoscopic ovarian drilling represents an effective surgical option for women with PCOS-related infertility who are resistant to pharmacological ovulation induction. The procedure can restore ovulation, improve hormonal balance, and increase the likelihood of spontaneous pregnancy. However, because of potential surgical risks and the availability of effective pharmacological therapies, LOD is generally reserved for selected patients as a second-line treatment approach in the management of PCOS (Burnik Papler et al., 2022; Sirmans & Pate, 2013; Lebbi et al., 2015).

Discussion.

Polycystic ovary syndrome is a complex endocrine disorder with metabolic and reproductive consequences, which requires a multifaceted therapeutic approach (Merviel et al., 2021; Dokras et al., 2016). The findings of this review indicate that effective management of PCOS often involves a combination of lifestyle interventions, pharmacological therapies, complementary approaches, and, in selected cases, surgical treatment.

Lifestyle modification remains the first-line therapy, particularly in women with overweight or obesity. Evidence shows that weight reduction and improved dietary habits can enhance insulin sensitivity, decrease androgen levels, and restore ovulatory function (Barrea et al., 2019; Calcaterra et al., 2024). Regular physical activity further improves metabolic parameters and insulin sensitivity, highlighting the importance of sustainable behavioral changes in PCOS management (Kite et al., 2019).

Pharmacological treatments are primarily used to address specific clinical manifestations. Combined oral contraceptive pills are widely used to regulate menstrual cycles and reduce hyperandrogenic symptoms such as hirsutism and acne (Dokras et al., 2016; Witchel et al., 2019). Antiandrogen medications may be added in cases of persistent hyperandrogenic symptoms, although they do not directly address metabolic abnormalities (Reiser et al., 2022; Armanini et al., 2022).

Metformin remains one of the most widely studied agents targeting insulin resistance in PCOS and may improve metabolic parameters, hormonal balance, and ovulatory function (Saeed et al., 2025; Tso et al., 2020). More recently, GLP-1 receptor agonists have emerged as promising treatments for women with obesity and insulin resistance, as they promote weight loss and improve metabolic and endocrine outcomes (Cena et al., 2020; Reiser et al., 2022).

Complementary therapies such as nutritional supplements and herbal medicine have also gained attention. Compounds including inositols, vitamin D, omega-3 fatty acids, and plant-derived substances may improve metabolic and hormonal parameters; however, heterogeneity in available studies limits the development of standardized recommendations (Moini Jazani et al., 2019; Merviel et al., 2021; Alesi et al., 2021)

In cases of infertility resistant to pharmacological treatment, laparoscopic ovarian drilling may be considered as a second-line therapy. The procedure can reduce androgen production and restore ovulation in selected patients, although it carries surgical risks and is therefore reserved for specific clinical situations (Burnik Papler et al., 2022; Sirmans & Pate, 2013).

Overall, the heterogeneity of PCOS highlights the importance of individualized treatment strategies. Future research should focus on large-scale randomized controlled trials to better evaluate long-term outcomes and optimize therapeutic approaches for women with PCOS.

Conclusions

Polycystic ovary syndrome is a complex endocrine and metabolic disorder that requires a comprehensive and individualized therapeutic approach. Due to the multifactorial pathophysiology of the condition, effective management often involves a combination of lifestyle interventions, pharmacological therapies, complementary approaches, and, in selected cases, surgical treatment (Dokras et al., 2016; Merviel et al., 2021).

Lifestyle modification, including dietary changes, weight reduction, and increased physical activity, remains the foundation of PCOS management and can significantly improve metabolic parameters, insulin sensitivity, and reproductive function (Barrea et al., 2019; Calcaterra et al., 2024). Pharmacological therapies such as combined oral contraceptives, antiandrogens, metformin, and GLP-1 receptor agonists may effectively

address specific symptoms including menstrual irregularities, hyperandrogenism, and metabolic disturbances (Dokras et al., 2016; Reiser et al., 2022; Saeed et al., 2025).

In addition, complementary strategies including nutritional supplementation and herbal medicine show promising potential in improving metabolic, hormonal, and reproductive outcomes, although further high-quality studies are required to establish standardized therapeutic protocols (Merviel et al., 2021; Moini Jazani et al., 2019).

Surgical interventions such as laparoscopic ovarian drilling may be considered for women with infertility who do not respond to pharmacological ovulation induction, (Burnik Papler et al., 2022; Sirmans & Pate, 2013).

Overall, the management of PCOS should be tailored to individual patient characteristics, clinical presentation, and reproductive goals. Further large-scale randomized controlled trials are needed to better evaluate the long-term efficacy and safety of emerging therapeutic strategies and to optimize treatment approaches for women with PCOS.

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