Med Pregl 2024; LXXVII (9-12): 309-316. Novi Sad: septembar-decembar.

REVIEW ARTICLES
PREGLEDNI ČLANCI

REVIEW OF CURRENT THERAPEUTIC APPROACHES FOR POLYCYSTIC OVARY SYNDROME

PREGLED AKTUELNIH TERAPIJSKIH PRISTUPA U LEČENJU SINDROMA POLICISTIČNIH JAJNIKA

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Review article
Pregledni članak
UDK 618.11-006-08
https://doi.org/10.2298/MPNS2412309M

Abstract

Introduction. Polycystic ovary syndrome is a multifaceted endocrine disorder affecting 5-15% of women of reproductive age. This review aims to explore and synthesize current therapeutic strategies for managing polycystic ovary syndrome, emphasizing lifestyle modifications, pharmacological treatments, and emerging alternative therapies. A systematic literature search was conducted, focusing on randomized controlled trials, meta-analyses, and observational studies examining interventions that improve metabolic, reproductive, and psychological outcomes in women with polycystic ovary syndrome. **Current Therapeutic Strategies.** Lifestyle interventions, including weight management and regular exercise, are fundamental in enhancing insulin sensitivity and alleviating symptoms such as menstrual irregularities and hirsutism. Pharmacological treatments, including hormonal contraceptives, metformin, and anti-androgens, play a vital role in managing hyperandrogenism and promoting fertility. Additionally, emerging therapies, such as glucagon-like peptide-1 receptor agonists and herbal supplements, show potential in addressing metabolic dysfunction. Nutritional supplementation, particularly vitamin D, folic acid, and omega-3 fatty acids, has demonstrated benefits in improving both metabolic and reproductive outcomes. Complementary treatments, including acupuncture and herbal medicine, also hold promise but require further validation through robust clinical research. **Conclusion.** A personalized, multidisciplinary approach integrating lifestyle, pharmacological, and complementary therapies is essential for optimizing polycystic ovary syndrome management and improving patient outcomes.

Key words: Polycystic Ovary Syndrome; Insulin Resistance; Hyperandrogenism; Metformin; Inositol; Therapeutics

Sažetak

Uvod. Sindrom policističnih jajnika predstavlja složen endokrini poremećaj koji se javlja kod 5–15% žena u reproduktivnom periodu. Cilj rada je da istraži i objedini savremene terapijske pristupe u lečenju sindroma policističnih jajnika, sa posebnim fokusom na promene načina života, farmakološke tretmane i nove alternativne terapije. Sistematski pregled baza podataka obuhvatio je randomizovane kontrolisane studije, metaanalize i opservacione studije o lečenju sindroma policističnih jajnika. Odabrane studije bile su usmerene na intervencije koje imaju za cilj unapređenje metaboličkog stanja, plodnosti i mentalnog zdravlja kod žena sa sindromom policističnih jajnika. **Aktuelni terapijski pristupi u lečenju sindroma policističnih jajnika.** Promene načina života, poput regulacije telesne težine i redovne fizičke aktivnosti, ključne su za poboljšanje osetljivosti na insulin, kao i smanjenje simptoma poput neredovnih menstruacija i pojačane maljavosti (hirzutizam). Farmakološke strategije, uključujući hormonske kontraceptive, metformin i antiandrogene, igraju važnu ulogu u kontroli hiperandrogenizma i fertiliteta. Pored toga, inovativne terapije poput agonista receptora glukagonu sličnog peptida-1 receptora i biljnih dodataka pokazuju obećavajuće rezultate u tretiranju metaboličkih poremećaja. Suplementacija vitamina, posebno vitamina D i folne kiseline, kao i omega-3 masnih kiselina, donosi pozitivne efekte na metabolizam i plodnost. Alternativne terapije, kao što su akupunktura i biljni lekovi, takođe pokazuju potencijalne koristi, ali potrebna su dodatna istraživanja kako bi se potvrdila njihova efikasnost i bezbednost. **Zaključak.** U radu je naglašena važnost individualnog i integrisanog pristupa u lečenju sindroma policističnih jajnika, koji kombinuje promene načina života, farmakološke terapije i alternativne metode radi postizanja optimalnih ishoda za pacijentkinje.

Ključne reči: sindrom policističnih jajnika; insulinska rezistencija, hiperandrogenizam; metformin; inozitol; terapija

Introduction

Polycystic ovary syndrome (PCOS), also known as Stein-Leventhal syndrome, is a prevalent and complex endocrine disorder affecting 5-15% of women of reproductive age. First identified in 1935 through symptoms such as menstrual irregularities, infertility, obesity, and hirsutism, it was initially termed

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Abbreviations

PCOS – polycystic ovary syndrome
NIH – National Institutes of Health
FSH – follicle-stimulating hormone
IR – insulin resistance
IL – interleukin
BMI – body mass index
LDL – low-density lipoprotein
FINS – exercise improved fasting insulin
CBT – cognitive behavioral therapy
COCs – combined oral contraceptives
SHBG – sex hormone-binding globulin
GLP-1 – glucagon-like peptide 1
VNS – vagus nerve stimulatio
taVNS – transcutaneous auricular vagus nerve stimulation

"secondary amenorrhea with infertility, obesity, and male-pattern hair growth" before being renamed PCOS in 1960. Diagnostic criteria have evolved over time. The 1990 NIH consensus requiring infrequent ovulation, hyperandrogenism, and exclusion of similar disorders, while the widely used Rotterdam criteria (2003) require two of the following: hyperandrogenism, oligo/anovulation, and polycystic ovaries [1, 2]. Based on these criteria, four phenotypes have been recognized: (1) HOP – hyperandrogenism, ovulatory dysfunction, and polycystic ovaries; (2) HO – hyperandrogenism and ovulatory dysfunction; (3) HP – hyperandrogenism and polycystic ovaries; and (4) OP – ovulatory dysfunction and polycystic ovaries without hyperandrogenism. These phenotypes underscore the syndrome's heterogeneity, making management complex [3]. Beyond reproductive dysfunction, PCOS is a polygenic, multifactorial disorder with metabolic, cardiovascular, and psychological impacts. Approximately 70% of affected women experience infertility due to anovulation. Elevated androgens contribute to hirsutism, acne, and insulin resistance, which increase the risk of obesity and type 2 diabetes. Genetic, environmental, and lifestyle factors play significant roles; for example, prenatal androgen exposure may predispose individuals to PCOS. Hormonal imbalances lead to the development of multiple antral follicles, causing menstrual irregularities and reproductive complications [4–7]. PCOS also has a significant psychological impact. Women with the condition are at an increased risk of anxiety, depression, and other mental health disorders, often exacerbated by symptoms such as hirsutism, infertility, and obesity [8].

Etiology of PCOS

Polycystic Ovary Syndrome arises from a complex interplay of genetic predisposition, environmental factors, and lifestyle influences. While its exact cause remains unclear, prenatal exposure to excess androgens or environmental toxins has been implicated [9]. Genetic studies have identified multiple genes associated with hormonal imbalances, though further research is needed. Ovarian dysfunction is central to PCOS pathophysiology, but obesity significantly influences symptom severity. Enlarged subcutaneous adipocytes are associated with hyperandrogenism and visceral fat accumulation, reinforcing the link between obesity and hormonal dysregulation [3, 5, 6]. Theca cells in the ovaries overproduce androgens, while hormonal imbalances – including an elevated luteinizing hormone:FSH ratio, increased gonadotropin-releasing hormone pulse frequency, and low FSH – further disrupt follicular development, leading to ovulatory dysfunction and polycystic ovaries [10, 11].

Genetic Factors in PCOS

Genetics play a major role in PCOS. The condition has a higher prevalence in certain ethnic groups, such as Spanish, Native American, and Mexican women, and family history increases risk [12]. Davies et al. identified a link between PCOS and cardiovascular risk in family members, with mothers of PCOS patients having twice the risk of hypertension and fathers a fourfold increased risk of stroke. Genes such as *INSIG2*, *MC4R*, and *TCF7L2* have been associated with insulin resistance and weight gain, with the latter contributing to an average increase of 1.56 kg/m² per allele [13]. Fica et al. further identified biochemical defects contributing to insulin resistance, such as impaired insulin receptor function and reduced PI3K activity, linking PCOS to an increased risk of type 2 diabetes and cardiovascular disease [14].

Hyperinsulinemia and Insulin Resistance

Insulin resistance (IR) affects 50-70% of women with PCOS, regardless of body weight, due to post-receptor defects in insulin signaling. This leads to compensatory hyperinsulinemia, which stimulates theca cells to overproduce androgens, exacerbating symptoms such as hirsutism and acne. IR, combined with beta-cell dysfunction, elevates the risk of type 2 diabetes, hypertension, dyslipidemia, and cardiovascular diseases. Women with PCOS are also at increased risk for metabolic syndrome. Recent findings by Marotti et al. suggest that smoking further worsens cardiovascular risk in PCOS, highlighting the need for lifestyle interventions [14–16].

Role of Inflammation in PCOS

Chronic low-grade inflammation is increasingly recognized as a key factor in PCOS pathogenesis. Elevated inflammatory markers – C-reactive protein, ferritin, necrosis factor-alpha, interleukin (IL)-6, and

IL-18 – impair insulin receptor function, contributing to insulin resistance. Altered iron metabolism, characterized by increased ferritin and transferrin levels and the HP2/HP2 genotype of haptoglobin, reduces anti-inflammatory capacity and exacerbates inflammation. This iron overload may further aggravate insulin resistance, increasing the risk of metabolic and cardiovascular complications [16].

This review aims to provide an in-depth analysis of available treatment options for PCOS. It evaluates lifestyle interventions, pharmacological treatments, and alternative therapies such as acupuncture and herbal medicine. The effectiveness, safety, and applicability of these approaches are compared to offer a practical guide for healthcare providers and patients in selecting the most suitable treatment strategies. Additionally, this review highlights areas where further research is needed to optimize PCOS management.

Current Therapeutic Strategies for PCOS

The management of PCOS requires a personalized approach due to its heterogeneous presentation. Lifestyle modifications, pharmacological interventions, and emerging therapies are key components of treatment. Weight loss and increased physical activity significantly improve symptoms such as insulin resistance and menstrual irregularities. Pharmacotherapy includes hormonal contraceptives to regulate menstrual cycles and anti-androgens to reduce excess hair growth. Women seeking pregnancy may require fertility treatments such as clomiphene or assisted reproductive technologies. Additionally, alternative therapies like acupuncture and herbal medicine are being explored, though further research is needed to establish their efficacy [1].

Lifestyle Interventions

Current guidelines emphasize the importance of lifestyle modifications for all women with PCOS to maintain a healthy weight and improve metabolic and reproductive outcomes. For those with excess weight, a 5-10% weight loss through a daily energy deficit of 500-750 kcal is recommended [17]. A Cochrane review of 15 trials demonstrated that lifestyle interventions significantly reduce weight, body mass index (BMI), and reproductive markers such as free androgen index, testosterone, and hirsutism, while lowering total cholesterol, low-density lipoprotein (LDL) cholesterol, and fasting insulin levels [18]. The findings align with a meta-analysis by Domecq et al., who found that lifestyle changes lower fasting glucose and insulin levels as effectively as metformin. Evan a modest weight loss (2-5%) has been linked to improvements in ovulation and menstrual regularity, while losses exceeding 5% enhance conception rates and reduce ovarian volume [19]. However, Pasquali et al. reported that even with over 5% weight loss, only one-third of women experienced full recovery from PCOS, with central adiposity and severe hyperandrogenism contributing to poorer outcomes [20]. This underscores the need for targeting interventions addressing insulin resistance and fat distribution, even in the absence of significant weight loss.

The 2018 PCOS guidelines recommend at least 150 minutes of moderate or 75 minutes of vigorous exercise per week for weight gain prevention, at least 250 minutes of moderate or 150 minutes of vigorous exercise per week for weight loss and prevention of weight regain, as well as strength training twice a week and minimizing sedentary behavior [21].

A comprehensive review of 18 trials (27 studies) by the year 2017 found that exercise improves fasting insulin (FINS), insulin resistance (HOMA-IR), cholesterol (TC, LDL-C), triglycerides (TAG), body composition (fat percentage and waist circumference), and aerobic fitness (VO_2max) compared to controls. Aerobic exercise specifically improves BMI, waist circumference, body fat, FINS, HOMA-IR, TC, TAG, and VO_2max. Resistance training reduces waist circumference and improves body composition, although it may decrease high-density lipoprotein-C and increase BMI. Combined aerobic and resistance training showed no significant impact on these markers. Recent reviews have confirmed that vigorous aerobic exercise can improve insulin resistance, body composition, and cardiorespiratory fitness. High-intensity interval training may improve insulin resistance and BMI, though evidence is inconsistent. Resistance training improves body composition and strength, and may also benefit androgen levels, although more research is needed. The impact of exercise type on reproductive function remains unclear [17].

Beyond diet and physical activity, adequate sleep and stress management play critical roles in PCOS management. Poor sleep and high stress exacerbate insulin resistance, complicating further PCOS symptoms such as irregular menstrual cycles, acne, and hirsutism. Behavioral interventions that promote better sleep, hygiene, and stress reduction techniques, such as mindfulness or cognitive-behavioral therapy, are gaining recognition as essential adjuncts to PCOS treatment. While lifestyle modifications are critical, they may not always be sufficient for symptom control, particularly in cases where obesity or insulin resistance is more severe, necessitating the addition of pharmacological therapy. Women with PCOS have a higher risk of depression and anxiety and report significantly lower quality of life than those without the condi-

tion. A meta-analysis found that CBT significantly reduces anxiety symptoms and improves quality of life, particularly regarding hirsutism. Some evidence also suggests CBT enhances patient adherence to treatment and increases pregnancy rates. However, there is limited evidence on its impact on BMI, menstrual health, infertility, social functioning, weight, and emotional well-being. More randomized, double-blind trials with larger sample sizes and extended follow-up periods are needed to clarify these effects [22].

Medical treatment

Hormonal contraceptives

When lifestyle modifications alone fail to adequately manage PCOS symptoms, pharmacological interventions are introduced, with combined oral contraceptives (COCs) being the first-line treatment. COCs regulate menstrual cycles, reduce hirsutism and acne, and suppress gonadotropin secretion, leading to increased sex hormone-binding globulin (SHBG) levels and reduced free androgen concentrations. Higher SHBG levels lead to fewer circulating free androgens, minimizing their effects on the skin and hair follicles. COCs also act directly on the hypothalamic-pituitary-ovarian axis, which helps regulate ovulation and menstrual cycles. Although various COC formulations exist, no specific combination has proven superior for PCOS treatment. However, the World Health Organization recommends COCs containing 35 μg of estrogen and cyproterone acetate for severe acne and hirsutism, though these formulations carry a higher thromboembolic risk and are considered second-line options. Women with metabolic syndrome or severe insulin resistance may not be ideal candidates for COCs, as they may exacerbate cardiovascular risks. Beyond COCs, progestin-only therapies may be considered in women who cannot tolerate estrogen, although they are less effective for hirsutism and acne. Other hormonal therapies, including clomiphene citrate (a selective estrogen receptor modulator) and letrozole (an aromatase inhibitor), are commonly used for ovulation induction in women with PCOS who pursue pregnancy. While clomiphene has traditionally been the first-line therapy, recent studies indicate that letrozole may offer higher ovulation and pregnancy rates, with improved maternal and fetal outcomes. Furthermore, combining letrozole with metformin or clomiphene citrate with metformin has been shown to yield similar follicle development without anti-estrogenic effects on the endometrium. Notably, the letrozole-metformin combination resulted in a higher pregnancy rate after the third intrauterine insemination cycle, suggesting that metformin and letrozole enhance ovarian response in moderately obese PCOS women resistant to clomiphene citrate [2, 23–26].

Metformin's Role in PCOS Management

Metformin, an insulin sensitizer, is widely used to address insulin resistance, a key driver of PCOS pathophysiology. It reduces hepatic glucose production, enhances peripheral glucose uptake, and improves insulin sensitivity, leading to lower insulin and androgen levels and improved ovulatory function. Although metformin's effects on menstrual regulation are mild to moderate, its impact on insulin sensitivity and androgen reduction is more pronounced. Recent guidelines suggest that combining metformin with COCs may provide greater benefits, particularly in overweight or obese women with PCOS, by simultaneously improving hyperandrogenism and metabolic parameters. Metformin has also been shown to reduce anti-Müllerian hormone levels, a marker of ovarian dysfunction, indicating potential benefits for ovarian reserve and function. However, while metformin enhances metabolic and reproductive outcomes, it is less effective than COCs for treating acne and hirsutism. Common adverse effects include gastrointestinal disturbances (e.g., diarrhea, nausea, abdominal discomfort), which may limit tolerability in some patients. Contraindications include severe renal impairment and metabolic acidosis, necessitating careful patient selection. Emerging research explores metformin in combination with other agents, such as GLP-1 receptor agonists (e.g., liraglutide and semaglutide), which have shown promising effects on weight loss and insulin resistance, areas where metformin alone may be insufficient [10, 27–30].

Antiandrogens and Combination Therapies

Antiandrogens play a crucial role in managing hyperandrogenism in PCOS, particularly for symptoms such as hirsutism and acne. Spironolactone and flutamide function by blocking androgen receptors, reducing the effects of elevated androgen levels. Spironolactone is the most commonly prescribed due to its dual role as both an antiandrogen and a diuretic, which may help alleviate fluid retention in PCOS. However, potential adverse effects, including gynecomastia and hyperkalemia, necessitate regular monitoring. Another option, finasteride, a 5-alpha-reductase inhibitor, reduces the conversion of testosterone to dihydrotestosterone, a potent androgen implicated in hair growth and acne. While androgens are effective in symptom relief, they are frequently used in combination with COCs to enhance therapeutic outcomes. Despite their widespread use, high-

quality studies evaluating antiandrogens in PCOS remain limited, and further research is needed to establish their long-term safety profiles [31, 32].

Emerging Therapies: Semaglutide and Tirzepatide

Recent advances in PCOS treatment have focused on medications that target weight management and insulin sensitivity. Semaglutide, a GLP-1 receptor agonist, has demonstrated significant weight loss and metabolic benefits in women resistant to lifestyle interventions. In a study by Carmina and Longo, three months semaglutide therapy resulted in significant reductions in BMI, fasting glucose, insulin levels, and HOMA-IR (a marker of insulin resistance). Notably, nearly 80% of obese women with PCOS achieved at least a 5% weight loss, leading to improved insulin sensitivity and glucose regulation. Compared to metformin, semaglutide exhibited superior efficacy with minimal side effects. Another promising agent, tirzepatide, recently Food and Drug Administration-approved for diabetes management, is being explored for PCOS treatment. Tirzepatide acts via a dual mechanism, targeting glucose-dependent insulinotropic polypeptide (GIP) and GLP-1 receptors, resulting in substantial weight loss and improved insulin sensitivity. Additionally, tirzepatide has been associated with fewer gastrointestinal side effects compared to traditional GLP-1 receptor agonists. However, further clinical trials in PCOS populations are needed to confirm its effectiveness and safety in this context [33, 34].

Surgical Approaches

For PCOS patients unresponsive to first-line infertility treatments such as clomiphene citrate or gonadotropins, surgical interventions like ovarian wedge resection and laparoscopic ovarian drilling present viable alternatives. Clomiphene resistance affects approximately 15–25% of anovulatory patients, necessitating alternative strategies. Ovarian wedge resection, first described by Stein and Leventhal in 1935, initially demonstrated pregnancy rates of 81–87%. However, concerns regarding postoperative adhesion led to a decline in its use after the 1960s, as medical therapies improved. Between 1935 and 1983, the cumulative pregnancy rate following resection was 59%. Modern surgical advancements, including microlaser and laparoscopic electrocautery drilling, have improved pregnancy rates to 60-65%, though adhesion rates remained highly variable (19-86%).To mitigate adhesion risk, minimally invasive techniques that preserve ovarian stroma have been developed. One promising approach involves vertical resection near the utero-ovarian ligament after exteriorizing the ovary, achieving adhesion rates as low as 11% and pregnancy success rates of up to 90%. Despite its historical decline, ovarian wedge resection – particularly via mini-laparotomy – remains a valuable option for women unresponsive to standard ovulation induction. It offers high fertility success rates, short hospitalization, and reduced adhesion risk [25, 35–38].

Nutrient Deficiencies and Complementary Therapies in PCOS

Women with PCOS frequently exhibit deficiencies in essential vitamins and minerals, which may contribute to both psychological symptoms (depression and anxiety) and physiological disturbances (insulin resistance, infertility, metabolic dysfunction). Nutrient supplementation, when integrated with lifestyle and pharmacological interventions, may enhance symptom management and long-term outcomes [39].

Vitamin D enhances insulin sensitivity, particularly at low daily doses, and may improve pancreatic beta-cell function. While its role in glycemic control is well-documented, its effects on lipid profile, androgen levels, and body weight remain inconclusive and require further research [40, 41].

Inositols, particularly Myo-inositol and D-chiro-inositol, play a key role in insulin signaling and glucose metabolism in ovarian tissue. Supplementation has been associated with reduced fasting insulin, improved ovulatory function, regularized menstrual cycles, lower testosterone levels, and increased sex SHBG, making them beneficial for both reproductive and metabolic symptoms of PCOS [23, 42, 43].

Folic acid (Vitamin B9), essential for methylation and DNA synthesis, has been shown to reduce elevated homocysteine levels, a known cardiovascular risk factor in PCOS. Additionally, it may support glycemic control and reduce oxidative stress, particularly in overweight or obese women [44].

Omega-3 fatty acids, particularly EPA and DHA, pose anti-inflammatory and insulin-sensitizing properties, contributing to improved lipid profiles, reduced triglycerides, and enhanced insulin sensitivity. However, their impact on weight loss and androgen levels appears limited, suggesting their primary role in metabolic management rather than reproductive outcomes [45].

Probiotics have emerged as a promising complementary therapy due to their ability to improve gut microbiota diversity, often reduced in women with PCOS. Supplementation has been associated with improved insulin sensitivity, reduced inflammation, and lower oxidative stress markers, although long-term effects on hormonal balance and metabolic outcomes remain to be fully established. Additional supplements such as alpha-lipoic acid, selenium, zinc,

magnesium, and coenzyme Q10 have shown promise in improving glycemic control, reducing oxidative stress, enhancing mitochondrial function, and lowering androgen levels. While these findings are encouraging, large-scale randomized controlled trials are necessary to confirm their long-term safety and efficacy in PCOS management [39, 46, 47].

Alternative Medicine for PCOS

Cinnamomum verum (cinnamon), especially when combined with *Glycyrrhiza spp.* and *Paeonia lactiflora*, has been associated with reductions in BMI, insulin levels, and cholesterol. However, its effects on fasting glucose and testosterone appear minimal. *Lagerstroemia speciosa* and *Cinnamomum burmannii* have demonstrated significant BMI reduction over six months. *Terminalia chebula* (Haritaki) improves glucose and lipid metabolism, possesses antioxidant and anti-inflammatory properties, and may aid in insulin resistance (IR) prevention. Other herbs like *Trigonella foenum-graecum* (Fenugreek), *Vitex agnus-castus* (Chasteberry), and *Cimicifuga racemosa* (Black Cohosh) may contribute to menstrual regularity and fertility enhancement. *Nigella sativa* (Black Cumin) has shown positive effects on ovarian function and IR in animal models. *Cimicifuga racemosa,* when combined with clomiphene, may improve fertility outcomes. Berberine, either alone or in combination with metformin, has been shown to enhance glucose metabolism. While data on anti-androgenic effects remain limited, herbs like *Anethum graveolens* (Dill) and *Matricaria chamomilla* (Chamomile) have been suggested to reduce testosterone and alleviate hirsutism symptoms [2, 48, 49].

Acupuncture also emerged asa potential adjunct therapy for PCOS management. Vagus nerve stimulation (VNS), a form of acupuncture, may help modulate inflammation by inhibiting pro-inflammatory cytokines. VNS has demonstrated therapeutic effects in conditions such as diabetes, epilepsy, and autoimmune disorders by influencing the hypothalamic-pituitary-adrenal axis, thereby enhancing cortisol release and insulin metabolism. A non-invasive variant, transcutaneous auricular vagus nerve stimulation (taVNS), specifically targets the ear and has shown benefits in improving mood and cognitive function, particularly in treatment-resistant depression, which is commonly observed in PCOS patients. While taVNS has been linked to enhanced emotional well-being and alertness, its direct impact on PCOS symptoms requires further clinical investigation [2, 50].

Conclusion

Polycystic ovary syndrome requires a personalized, multidisciplinary treatment approach due its complex metabolic, reproductive, and psychological manifestations. Lifestyle modifications, including weight management and increased physical activity, remain first-line interventions, offering substantial improvements in insulin sensitivity and hormonal balance. Pharmacological therapies, such as hormonal contraceptives, metformin, and antiandrogens, play a pivotal role, particularly when lifestyle changes alone prove insufficient. Emerging medications, including glucagon-like peptide-1 receptor agonists, offer promising metabolic benefits, especially in obese women with polycystic ovary syndrome.

Complementary therapies, including herbal medicine and acupuncture, are gaining recognition as adjunct treatments. Herbal agents like Cinnamomum verum, Nigella sativa, and Terminalia chebula show potential metabolic and reproductive benefits, while acupuncture and vagus nerve stimulation may aid in inflammation regulation and mood stabilization. Despite these advances, further high-quality research is required to establish the long-term efficacy and safety of alternative treatments in polycystic ovary syndrome.

Mowing forward, an individualized treatment plan incorporating lifestyle changes, pharmacotherapy, and complementary therapies remains the most effective strategy for managing the complex symptoms of polycystic ovary syndrome. Continued research and evidence-based guidelines will be essential to refining therapeutic approaches and improving patient outcomes.

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Rad je primljen 2. II 2025.
Recenziran 17. III 2025.
Prihvaćen za štampu 29. III 2025.
BIBLID.0025-8105:(2024):LXXVII:9-10:309-316.

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