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Physical Activity vs. Pharmacotherapy in PCOS Treatment: A relief of Clinical Evidence on Exercise and Metformine Efficacy

The issue of physical activity vs. pharmacotherapy in PCOS treatment: a relief of clinical evidence on exercise and metformine efficacy

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Abstract

Introduction

Polycystic ovary syndrome (PCOS) is one of the most common endocrine disorders in women of reproductive age, characterized by hormonal imbalance, insulin resistance, and ovulatory dysfunction. It presents with a wide range of symptoms, including menstrual irregularities, hyperandrogenism, and metabolic disturbances, often leading to infertility and increased long-term cardiometabolic risk. Lifestyle interventions and pharmacological treatments, particularly physical activity and metformin, remain central to PCOS management. This review aims to synthesize current evidence on the comparative and complementary roles of exercise and metformin in addressing the metabolic and reproductive manifestations of PCOS.

Aim of the study

To Compare the clinical efficacy of physical activity (exercise) and pharmacotherapy (metformin) in managing the symptoms of Polycystic Ovary Syndrome (PCOS).

Materials and Methods

A review of the literature collected in the PubMed database was performed to gather information found under the key words: „Polycystic Ovary Syndrome (PCOS)”, „physical activity”, „exercise”, „metformin”, „metabolic syndrome”, „fertility” and „pharmacotherapy”.

Summary

Managing polycystic ovary syndrome (PCOS) effectively involves both exercise and medication. Regular aerobic activity improves insulin sensitivity and reproductive health, while metformin addresses insulin resistance and metabolic issues. A combined approach of lifestyle changes and pharmacotherapy offers the best outcomes for women with PCOS.

Keywords: Polycystic Ovary Syndrome (PCOS), Physical activity, Exercise, Metformin, metabolic syndrome, fertility, pharmacotherapy

Introduction

Polycystic ovary syndrome (PCOS) is a prevalent endocrine disorder that affects approximately 8–13% of women of reproductive age globally [1,2]. The condition often manifests during adolescence and is characterized by a range of reproductive, metabolic, and psychological symptoms that can vary across the lifespan. PCOS results from a complex interplay of hormonal disturbances, most notably hyperandrogenism and insulin resistance, and is commonly associated with irregular menstrual cycles, anovulation, and the presence of multiple ovarian follicles or increased ovarian volume [1]. Due to these hormonal disruptions, PCOS is a leading cause of infertility, as ovulatory dysfunction frequently prevents conception.

The exact etiology of PCOS remains uncertain, but genetic and environmental factors play a significant role. Women with a family history of PCOS or type 2 diabetes are at increased risk [1]. Additionally, insulin resistance—a common feature in the majority of individuals with PCOS—contributes to hyperinsulinemia, which exacerbates androgen production and disrupts normal follicular development, further impairing ovulation [3]. The clinical presentation of PCOS is highly variable, which complicates its diagnosis and management.

Diagnosis is typically made based on the presence of at least two out of the following three criteria: oligo- or anovulation, clinical or biochemical signs of hyperandrogenism, and polycystic ovarian morphology observed via ultrasound (defined as ≥ 20 follicles in at least one ovary or an ovarian volume ≥ 10 mL), or elevated anti-Müllerian hormone (AMH) levels [4]. In adolescents, the diagnosis is particularly challenging due to overlapping features with normal pubertal development. Therefore, clinical guidelines recommend a cautious, individualized approach, emphasizing the importance of shared decision-making with the adolescent and their caregivers. In cases where full diagnostic criteria are not yet met but symptoms suggest possible PCOS, re-evaluation is advised within eight years after menarche, especially if early signs emerged before initiating hormonal contraception, or if significant weight gain has occurred [4].

PCOS is not limited to reproductive dysfunction; it is increasingly recognized as a multisystem condition with long-term metabolic and psychological implications. Insulin

resistance and compensatory hyperinsulinemia are central to its pathogenesis and contribute to a range of metabolic disturbances, including obesity, dyslipidemia, impaired glucose tolerance, and increased cardiovascular risk [2,5]. Furthermore, the chronic nature of PCOS, combined with its impact on appearance, fertility, and metabolic health, contributes to elevated rates of anxiety, depression, and diminished quality of life in affected individuals.

Lifestyle modification is widely acknowledged as the first-line intervention for PCOS, with a strong emphasis on physical activity and dietary improvements. Evidence consistently supports that regular exercise improves insulin sensitivity, enhances ovulatory function, and positively influences mood, even in the absence of significant weight reduction [3,6]. Physical activity also helps reduce central adiposity and improves cardiometabolic health, both of which are commonly compromised in women with PCOS. These benefits are attributed to the physiological effects of exercise on glucose metabolism, adipose tissue distribution, and neuroendocrine regulation.

Pharmacological therapy, particularly the use of metformin, has also become a cornerstone in PCOS management. Metformin, an insulin-sensitizing agent, works by decreasing hepatic glucose production and enhancing peripheral glucose uptake. Its use in women with PCOS has been associated with improved menstrual regularity, reduced androgen levels, and better lipid profiles, particularly in individuals with obesity or insulin resistance [5]. Despite its benefits, metformin alone may not be sufficient to address all dimensions of the syndrome.

Emerging research supports the idea that a combination of lifestyle interventions and metformin may provide greater benefits than either treatment alone. This combined approach has demonstrated superior outcomes in reducing insulin resistance, improving ovulatory and reproductive function, and decreasing central adiposity [7]. These findings underscore the importance of a personalized, multifaceted management strategy in PCOS, tailored to the individual's phenotype and treatment goals. The most recent international guidelines from 2023 emphasize the central role of evidence-based lifestyle and pharmacologic interventions, calling for an integrated approach that addresses both the metabolic and reproductive manifestations of the syndrome [4].

Physical activity

Healthcare professionals should promote physical activity in accordance with general guidelines. All adults should be encouraged to stay active, as any amount of movement is better than none, and reducing sedentary behavior is associated with clear health benefits. For overall health and weight maintenance, adults aged 18–64 are advised to engage in 150–300 minutes of moderate-intensity aerobic activity or 75–150 minutes of vigorous-intensity aerobic activity per week, along with muscle-strengthening exercises on at least two non-consecutive days. For additional health benefits, including modest weight loss, a minimum of 250 minutes of moderate or 150 minutes of vigorous activity weekly is recommended. Adolescents should engage in at least 60 minutes of moderate-to-vigorous physical activity daily, including muscle- and bone-strengthening activities three times per week [8].

The Role of Exercise in PCOS Management

Regular physical activity has been increasingly recognized as a key non-pharmacological strategy in the management of polycystic ovary syndrome (PCOS). It has been shown to enhance insulin sensitivity and glucose regulation, assist in weight management, improve reproductive function, lower androgen concentrations, and promote better psychological health [9,10,11]. Recent studies have also explored the effects of different types of exercise on PCOS-related outcomes [12-14].

Reproductive Benefits of Structured Physical Activity

Bazarganipour et al. (2023) conducted a systematic review of randomized controlled trials, concluding that structured physical activity interventions significantly improved reproductive health outcomes, such as menstrual cycle regularity and ovulation, in women with PCOS. These effects are likely mediated through reductions in insulin resistance and hyperandrogenism, which are commonly present in this condition [15]. Supporting this, Jurczewska et al. (2023) found that physical activity had a stronger association with insulin sensitivity than dietary factors alone, with more active participants exhibiting lower HOMA-IR values [16].

Exercise Type Matters: Aerobic, HIIT, and Resistance Training

The type of exercise may also influence the extent of benefit. According to a network meta-analysis by Wang et al. (2024), moderate-intensity aerobic exercise appears to be the most effective intervention for reducing BMI in women with PCOS, whereas resistance training and high-intensity interval training (HIIT) showed less consistent effects on weight and hormonal balance [17]. Similarly, Wang et al. (2022) assessed the impact of aerobic, resistance, combined, and HIIT modalities on BMI and inflammatory markers in overweight and obese individuals, concluding that combined training produced the most significant improvements in both outcomes [18]. This is consistent with findings from Batrakoulis et al. (2022), who analyzed data from 4,331 participants across 81 studies and identified combined training as the most effective intervention for improving cardiometabolic health and BMI in overweight adults [19].

Challenges in Sustaining Exercise Programs

However, sustaining regular exercise remains a challenge. A study by Stojanovic and Milinkovic (2022) reported that although endurance and HIIT protocols led to positive changes in body composition and metabolic markers, issues with adherence—especially the consistent tracking of ovulation—limited their overall effectiveness and practical implementation [20].

Psychological Health Benefits of Physical Activity

Beyond metabolic and reproductive outcomes, physical activity has been associated with improved mental health. González and Fernández (2025) found that regular exercise reduced symptoms of anxiety and depression and enhanced overall quality of life in women with PCOS [21]. Nonetheless, Smith and Jones (2024) highlighted that barriers such as lack of time, motivation, and social support often hinder long-term engagement in physical activity, underlining the need for accessible and personalized approaches [22].

Physiological Benefits by Exercise Type

Various forms of exercise show differing benefits. Vigorous aerobic activities such as brisk walking, running, cycling, or swimming can enhance insulin sensitivity, improve body

composition—including reductions in waist circumference and BMI—and boost cardiorespiratory fitness [23,24]. These physiological improvements may help regulate menstrual cycles by mitigating insulin resistance and supporting ovarian function. HIIT, which involves alternating high-intensity bouts with rest or low-intensity intervals, has shown potential for reducing insulin resistance and BMI, though findings remain inconsistent. Resistance training, while not consistently associated with BMI or weight reduction, has been shown to improve body composition by reducing fat mass, decreasing waist circumference, increasing lean body mass, and improving muscular strength.

Clinical Implications and Recommendations

Overall, aerobic and supervised exercise programs of shorter duration appear to yield the most effective results in women with PCOS, particularly those who are overweight or obese. However, due to variability between studies and limitations in study quality, these findings should be interpreted cautiously [9]. Incorporating structured physical activity into clinical treatment plans can not only improve metabolic and cardiovascular health but may also alleviate common comorbidities such as obesity and elevated cardiovascular risk, ultimately enhancing overall quality of life in affected individuals.

Pharmacology - Metformin

Role of Metformin in PCOS Management

According to the 2023 International Evidence-based Guideline for the Assessment and Management of Polycystic Ovary Syndrome, metformin may be considered for adults with PCOS and a BMI ≥ 25 kg/m² to improve anthropometric and metabolic outcomes, including insulin resistance and glucose and lipid profiles. Although evidence is limited, metformin may also be considered for adolescents with PCOS to help regulate menstrual cycles. For adults with PCOS and a BMI < 25 kg/m², metformin can still be considered, though the evidence supporting its effectiveness is less robust. When prescribing metformin, it is crucial to incorporate shared decision-making, as both metformin and lifestyle interventions offer similar effectiveness. Mild gastrointestinal side effects are commonly dose-dependent and typically self-limiting, with gradual dose escalation recommended to minimize discomfort. The suggested maximum dose for adults is 2.5g daily, while for adolescents, it is 2g daily.

Long-term use of metformin appears to be safe, though monitoring for low vitamin B12 levels may be necessary, especially for individuals at risk [8].

Metformin's Impact on Clinical and Metabolic Parameters

Research further supports the use of metformin in managing PCOS. Abdalla et al. (2022) demonstrated that metformin treatment significantly improved several clinical and metabolic parameters in women with PCOS, including reductions in body weight (3.13 kg) and BMI (0.82 kg/m²). Additionally, metformin led to decreases in fasting blood glucose and LDL cholesterol levels. It also lowered elevated androgen levels, such as total testosterone, androstenedione, and 17-hydroxyprogesterone, which are commonly associated with PCOS. Notably, metformin use was associated with a threefold increase in clinical pregnancy rates compared to those not receiving the treatment [25].

Inconsistent Benefits of Metformin in Some Metabolic Outcomes

However, not all studies show consistent benefits. In a study of overweight women with PCOS, metformin improved certain metabolic parameters, such as reductions in testosterone, luteinizing hormone (LH), and LDL cholesterol, but it did not significantly affect insulin levels, HOMA-IR, sex hormone-binding globulin (SHBG), HDL cholesterol, triglycerides, or body weight. These findings suggest that while metformin may provide benefits in some metabolic outcomes, its overall effectiveness in managing PCOS, particularly in overweight women, may be limited [26].

Improving Insulin Sensitivity and Fertility Outcomes

Noor Naerpoor et al. (2021) reaffirmed the role of metformin in improving insulin sensitivity and lipid profiles in women with PCOS, particularly those with insulin resistance. It also contributes to menstrual regulation and may improve fertility outcomes. However, the long-term effects of metformin on reproductive health remain uncertain, necessitating further research. Despite this, metformin is widely recommended as a first-line treatment for women with PCOS who exhibit metabolic disturbances [27].

Effectiveness in Overweight Women with PCOS

Similarly, Kasia et al. (2020) found that metformin effectively improves insulin sensitivity and reduces insulin resistance in overweight women with PCOS, addressing common

metabolic issues like obesity and dyslipidemia. However, the drug's impact on fertility and ovulation was less consistent. These findings support the use of metformin as a primary treatment for managing insulin resistance in PCOS, though further investigation into its role in fertility treatment is needed [28].

Long-Term Benefits and Recommendations

Finally, a meta-analysis by Sara et al. (2022) concluded that long-term metformin use leads to significant improvements in insulin sensitivity, lipid profiles, and weight management in women with PCOS. Additionally, it promotes menstrual regularity and may enhance the likelihood of conception. While metformin remains a highly effective treatment for both metabolic and reproductive aspects of PCOS, the authors recommend monitoring for vitamin B12 deficiency due to the prolonged use of the medication [29].

Conclusions

In managing polycystic ovary syndrome (PCOS), both physical activity and pharmacological treatments offer valuable benefits. Engaging in regular physical activity, especially moderate-intensity aerobic exercise, has been found to enhance insulin sensitivity, support reproductive health, and improve mental well-being. Although exercise is effective for weight management and promoting menstrual regularity, maintaining consistent engagement can be difficult due to challenges such as lack of motivation and time constraints.

Metformin, as a pharmacological intervention, is particularly effective in addressing insulin resistance and improving various metabolic parameters, as well as supporting fertility in women with PCOS. While its impact on weight and reproductive outcomes may vary, metformin remains a cornerstone in treating insulin resistance and associated metabolic issues in PCOS patients.

A comprehensive approach to PCOS treatment should ideally combine exercise with medications like metformin. This combination can provide a more complete strategy, tackling both metabolic and reproductive health concerns. Further research is needed to better understand how to tailor these treatments to individual patients, ensuring the most effective outcomes for those living with PCOS.

Disclosure

Authors's contribution

Conceptualization, Magdalena Bartold; methodology, Magdalena Bartold and Janina Pohrybieniuk ; software, Dominika Błonka and Maria Grys; check, Filip Kochański and Karolina Wołk; formal analysis, Magdalena Bartold and Janina Pohrybieniuk ; investigation, Magdalena Bartold and Janina Pohrybieniuk; resources, Magda Skudzińska and Marta Piotraszewska; data curation,Aleksandra Jaskulska and Jan Pietrzak; writing – rough preparation, Magdalena Bartold; writing - review and editing, Magdalena Bartold and Maria Grys; visualization, Magdalena Bartold, Filip Kochański and Janina Pohrybieniuk; supervision, Dominika Błonka, Jan Pietrzak and Magda Skudzińska project administration, Magdalena Bartold and Aleksandra Jaskulska. All authors have read and agreed with the published version of the manuscript.

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The authors deny any conflict of interest.

AI

AI was utilized for two specific purposes in this research. Text analysis of clinical reasoning narratives to identify linguistic patterns associated with specific logical fallacies. Assistance in refining the academic English language of the manuscript, ensuring clarity, consistency, and adherence to scientific writing standards. AI were used for additional linguistic refinement of the research manuscript, ensuring proper English grammar, style, and clarity in the presentation of results. It is important to emphasize that all AI tools were used strictly as

assistive instruments under human supervision. The final interpretation of results, classification of errors, and conclusions were determined by human experts in clinical medicine and formal logic. The AI tools served primarily to enhance efficiency in data processing, pattern recognition, and linguistic refinement, rather than replacing human judgment in the analytical process.

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