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The Impact of Physical Activity on Metabolic, Hormonal, and Psychological Profiles in Women with Polycystic Ovary Syndrome (PCOS): A Review of Current Evidence

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ABTRACT

Background. Polycystic Ovary Syndrome (PCOS) is a complex endocrine disorder significantly impacting metabolic and psychological well-being. Physical activity is a cornerstone of non-pharmacological therapy, improving insulin sensitivity, lipid profiles, and body composition.

Aim. This review aims to synthesize current evidence regarding the role of physical activity in PCOS management, focusing on cardiometabolic parameters, mental health, and reproductive functions.

Material and Methods. An analysis of literature, including meta-analyses and systematic reviews, was conducted to evaluate the impact of various exercise modalities and "dosage" on patient health.

Results and Discussion. Regular exercise significantly improves fasting glucose, cholesterol, and blood pressure while reducing inflammatory markers. High-Intensity Interval Training (HIIT) is more effective in reducing hyperandrogenism and visceral adiposity than moderate-intensity exercise. Physical activity alleviates anxiety and depression, though psychological barriers like negative body image may hinder adherence. While exercise promotes ovulation restoration (in up to 50% of patients), data remain heterogeneous. A research gap exists regarding PCOS in women with a normal BMI.

Conclusions. Physical activity is a fundamental component of PCOS therapy, improving insulin sensitivity and ovulatory function independently of weight loss. Greatest efficacy is observed in high-intensity programs (min. 150 minutes/week). Success depends on individualized training and systemic psychological support. Further standardized research is needed to refine recommendations for different PCOS phenotypes.

Keywords: PCOS, Activity and Health, Insulin resistance, female Reproductive endocrinology, High-intensity interval training (HIIT)

Introduction

Polycystic ovary syndrome (PCOS) is one of the most common endocrine disorders in women of reproductive age [1,2]. In clinical practice, the diagnosis of PCOS most often refers to the Rotterdam criteria, according to which at least two of the following three features are required: (1) oligo- or anovulation manifested by menstrual irregularities, (2) clinical and/or biochemical signs of hyperandrogenism, and (3) polycystic ovarian morphology on ultrasound-after excluding other conditions with similar presentations [3]. PCOS is a condition that extends beyond the reproductive sphere and often coexists with metabolic disturbances, which may

affect overall health. In parallel, the importance of mental health is increasingly emphasized-some women experience reduced quality of life, higher levels of stress, and a greater prevalence of anxiety and depressive symptoms, which constitutes an important context for planning therapeutic management [4–6].

From a practical perspective, PCOS is not a homogeneous condition, as reflected in the identification of clinical phenotypes within the Rotterdam criteria (phenotypes A–D). Consequently, a different configuration of syndrome features may predominate in individual patients: in some women, hyperandrogenic features are most pronounced; in others, ovulatory dysfunction and menstrual irregularities; and in still others, polycystic ovarian morphology on ultrasound [7,8]. This clinical variability translates into differing health needs and therapeutic priorities. Importantly, regardless of the predominant symptom profile, a subset of women presents with marked metabolic disturbances; however, their severity and pattern may also vary-from predominant insulin resistance and abnormalities of carbohydrate metabolism to more pronounced lipid disturbances, increased visceral adiposity, and other components of cardiometabolic risk. In some patients, the metabolic component may be less apparent in routine screening tests [9,10]. In clinical and sports practice, this means that effective management should not be limited solely to "normalizing the menstrual cycle" but should pursue a broader goal: improving overall health, including cardiometabolic profile, physical fitness, and day-to-day functioning.

Physical activity and structured exercise training play a key role in non-pharmacological management in women with PCOS. Exercise may influence core mechanisms related to PCOS pathophysiology, particularly insulin sensitivity, glucose and lipid metabolism, cardiovascular parameters, and body composition [11]. In recent years, there has also been growing interest in the effects of physical activity on domains beyond metabolic parameters, such as well-being, psychological symptoms, and quality of life [12]. Despite the increasing number of studies, findings remain partly heterogeneous due to differences in study populations and exercise protocols, which hinders the direct translation of evidence into practical recommendations and underscores the need for further, better-standardized research.

The aim of this review is to organize and synthesize current evidence on the role of physical activity in women with PCOS, with particular emphasis on the areas supported by the largest body of data and their practical implications for exercise planning and for supporting overall health.

Methodology

A comprehensive literature search was conducted to identify relevant studies examining the impact of physical activity on the metabolic, hormonal, and psychological profiles of women with Polycystic Ovary Syndrome (PCOS). The primary databases used for this search were PubMed and Scopus. To enhance the completeness of the review, additional searches were performed using major publishing platforms, including Springer, Frontiers, Elsevier, and Google Scholar.

The search strategy employed a combination of MeSH terms and keywords relevant to the topic, including: “polycystic ovary syndrome”, “PCOS”, “physical activity”, “exercise”, “high-intensity interval training”, “HIIT”, “insulin resistance”, “fertility”, “ovulation”, “mental health”, and “cardiometabolic risk”. Boolean operators (AND, OR) were used to refine the search and ensure adequate sensitivity and specificity in identifying studies related to various exercise modalities and their physiological "dosage."

The time frame for the literature search covered publications from 2004 to 2026, with a particular emphasis on the most recent evidence-based guidelines and meta-analyses published in the last four years (2022–2026). Both original research articles, systematic reviews, and meta-analyses were included. Studies conducted solely on animal models were excluded to maintain focus on clinical human outcomes. Additional exclusion criteria included articles not published in English or Polish, non-peer-reviewed sources, and studies not aligned with the scope of cardiometabolic, reproductive, or psychological health in the context of PCOS. The final selection was based on the relevance of the content to the interplay between exercise intensity, insulin sensitivity, and the management of different PCOS phenotypes.

Table 1. Study selection process and literature analysis according to PRISMA guidelines.

Stage	Description	Number of Records
Identification	Records identified via PubMed, Scopus, and publishing platforms (Springer, Frontiers, Elsevier, Google	**118**
Screening	Records screened for initial relevance based on title and abstract	**118**

Excluded	Records excluded after removing duplicates, non-English/Polish sources, and non-peer-reviewed articles	**42**
Eligibility	Full-text articles assessed for alignment with the review's scope (PCOS and physical activity focus)	**76**
Final Selection	Total studies analyzed and included in the review	**37**

Clinical Characteristics and Pathophysiology of Polycystic Ovary Syndrome (PCOS)

Polycystic Ovary Syndrome (PCOS) is a complex endocrine-metabolic disorder with a multifactorial etiology. Contemporary diagnostics are based on the Rotterdam Criteria, which require the presence of at least two of the following three features: oligo-ovulation or anovulation, clinical or biochemical signs of hyperandrogenism, and polycystic ovarian morphology on ultrasound examination [1-3].

The application of these criteria allows for the identification of four main clinical phenotypes (A–D), which differ in terms of symptom severity and metabolic risk [13,14]:

- Phenotype A (Classical): all three criteria are present (hyperandrogenism, anovulation, PCO on ultrasound); it is associated with the highest risk of insulin resistance.
- Phenotype B (Non-PCO): hyperandrogenism and anovulation, but without morphological changes on ultrasound.
- Phenotype C (Ovulatory): hyperandrogenism and PCO on ultrasound, with preserved ovulatory cycles.
- Phenotype D (Non-androgenic): anovulation and PCO on ultrasound, with normal androgen levels.

A key element of PCOS pathophysiology, particularly in the classical phenotypes, is insulin resistance (IR) and the accompanying hyperinsulinemia [15]. This mechanism drives hormonal disturbances through two primary pathways:

1. Direct ovarian stimulation: Excess insulin acts synergistically with luteinizing hormone (LH), stimulating ovarian theca cells to overproduce androgens [15,16]. This leads to premature follicle atresia, inhibition of follicle maturation, and the absence of a dominant follicle [15,16].

2. Impact on the liver and hormone bioavailability: Hyperinsulinemia inhibits the hepatic synthesis of SHBG (sex hormone-binding globulin) [15,16]. A decrease in SHBG concentration results in an increase in the free, biologically active fraction of testosterone in the blood, which directly exacerbates clinical symptoms such as hirsutism or acne [15,16].

Additionally, patients often exhibit chronic low-grade inflammation and dyslipidemia, which significantly increases cardiovascular risk. Understanding this heterogeneity and complexity of the syndrome is essential for evaluating how physical activity-by improving tissue insulin sensitivity, increasing SHBG production, and modulating the hormonal axis-can effectively modify the clinical course of individual phenotypes [17].

Table 2. Clinical and Metabolic Characteristics of PCOS Phenotypes [13-14].

Phenotype	**Androgen Status**	**Ovulatory Function**	**Ovarian Morphology (USG)**	**Metabolic Risk Profile**
Phenotype A (Classical)	Hyperandrogenism (Clinical/Biochemical)	Oligo-amenorrhea (Chronic Anovulation)	PCOM Present (Polycystic Appearance)	Highest Risk (Severe IR and Obesity)
Phenotype B (Essential)	Hyperandrogenism (Clinical/Biochemical)	Oligo-amenorrhea (Chronic Anovulation)	Normal Morphology (No PCO findings)	High Risk (Significant metabolic impact)
Phenotype C (Ovulatory)	Hyperandrogenism (Clinical/Biochemical)	Regular Cycles (Normal Ovulation)	PCOM Present (Polycystic Appearance)	Moderate Risk (Mainly androgen-driven)
Phenotype D (Non-Androgenic)	Normal Androgens (No Hyperandrogenism)	Oligo-amenorrhea (Chronic Anovulation)	PCOM Present (Polycystic Appearance)	Lowest Risk (Often lean/normal BMI)

The Impact of Physical Activity on Metabolic and Cardiometabolic Parameters in Women with PCOS

Physical activity is one of the fundamental pillars of non-pharmacological treatment for polycystic ovary syndrome (PCOS), resulting from its direct impact on frequently coexisting metabolic disorders and elevated cardiovascular risk in patients. Regular movement is recognized as an effective method for improving overall health; however, therapeutic effectiveness largely depends on measurable changes in the body's physiology [18,19]. Integrated clinical data analyses confirm that systematic physical exercise exerts a statistically positive effect on a wide range of health indicators, such as lowering fasting glucose levels, total cholesterol, and systolic blood pressure. Furthermore, a reduction in inflammatory markers, such as C-reactive protein (CRP), is observed, alongside beneficial changes in the hormonal profile, manifested by a decrease in total testosterone levels and an increase in sex hormone-binding globulin (SHBG) concentration [20,21].

The impact of activity on the lipid profile and body composition is of particular importance. Meta-analyses show that exercise leads to a significant reduction in waist circumference and the regulation of fasting insulin levels, which directly translates into a reduction in cardiometabolic risk [18]. It is worth emphasizing that insulin resistance affects from 50% to as many as 90% of women with PCOS, regardless of their body mass index (BMI), although excess adipose tissue exacerbates these disorders [22]. However, it should be noted that in many analyses, the effects obtained are relatively small, and their statistical significance can be variable depending on the selection of the study group. This underscores the need to design more rigorous studies that precisely separate the impact of activity itself from dietary interventions, which currently constitutes one of the major challenges in the literature on the subject [23].

Training Modalities and Exercise "Dosage" in PCOS

The selection of an appropriate form of activity and its intensity is crucial for optimizing health outcomes in women with PCOS. Evidence indicates that patients should perform a minimum of 120 minutes of vigorous-intensity exercise per week to achieve measurable improvements in insulin resistance, body composition, and physical fitness. Shorter interventions may be insufficient to induce lasting adaptive changes in the cardiovascular system and muscle metabolism [24]. The 2023 International Evidence-based Guidelines specify that women with PCOS should aim for at least 150 minutes of moderate-intensity activity per

week or 75 minutes of high-intensity activity, combined with resistance training twice a week [22].

Contemporary research places significant emphasis on comparing different modalities, such as High-Intensity Interval Training (HIIT) and strength training. While both forms are beneficial, a 12-week HIIT program demonstrates greater efficacy in reducing serum testosterone levels and decreasing body fat percentage [25]. Furthermore, intensive exercise protocols correlate with a better metabolic profile even in cases where the total energy expenditure (number of calories burned) remains at a similar level to lower-load training. This suggests that the high-intensity stimulus itself is key to improving tissue sensitivity to insulin [26].

Maintaining regularity (adherence) remains a practical challenge. Studies suggest that variable-intensity workouts may be better tolerated by patients, who often struggle with psychological barriers and low self-confidence regarding physical exertion [26]. Further search for optimal protocols aims to clarify how to differentiate exercise dosage depending on the specific PCOS phenotype to maximize cardiometabolic benefits while simultaneously supporting psychological well-being and quality of life.

The Impact of Physical Activity on Mental Health and Quality of Life in Women with PCOS

Beyond its metabolic manifestations, Polycystic Ovary Syndrome is associated with a significantly elevated risk of psychological disorders, which constitutes a critical element of comprehensive patient care. Epidemiological studies indicate that depression and anxiety occur much more frequently in young women with PCOS than in their healthy peers, a finding confirmed by numerous meta-analyses [27]. The pathophysiology of these disorders is multifactorial and encompasses biological mechanisms—such as chronic inflammation, insulin resistance, and hypothalamic-pituitary-adrenal (HPA) axis dysfunction—as well as psychosocial factors resulting from the clinical symptoms of the syndrome, such as hirsutism or obesity [28].

The introduction of regular physical activity proves to be an effective method for alleviating these burdens. Scientific evidence suggests that women with PCOS who adhere to international recommendations regarding exercise volume report lower levels of anxiety and depressive symptoms compared to those leading a sedentary lifestyle [29,30]. The mechanism of this impact is complex; physical exertion not only stimulates the secretion of mood-

enhancing neurotransmitters but, importantly, restores a sense of agency and control over one's body, which is crucial in the process of accepting physical changes induced by PCOS [31].

Structured training programs also translate into measurable improvements in quality of life (QoL), as measured by specialized questionnaires such as the PCOSQ. The greatest benefits are observed in domains related to self-esteem, weight regulation, and emotional stability [30]. Notably, the psychological impact of physical activity is not limited solely to high-intensity training; moderate-intensity exercise also demonstrates potential in reducing psychological stress by lowering sympathetic nervous system activity [32].

However, it is important to note that low self-confidence and physical barriers resulting from excess adipose tissue can hinder regular participation in exercise. From a practical perspective, a significant issue remains the fact that patients often perceive barriers to activity as outweighing its potential benefits [33]. The most serious obstacles include not only limited access to infrastructure, costs, or lack of time, but primarily psychological factors such as negative body image and a lack of social support, particularly from family. Additionally, neutral expectations regarding the effects of exercise are noticeable among patients; many express doubt in the effectiveness of exercise as a method for reducing fatigue. This suggests that for a real improvement in quality of life in this group, simply promoting activity is insufficient [33]. Educational initiatives must go hand in hand with professional mental health support (addressing depressive symptoms) and systemic mitigation of barriers that hinder the initiation and maintenance of regular activity. Therefore, modern therapeutic protocols, including HIIT-type training, are evaluated not only for their metabolic efficacy but also for their acceptability and impact on improving overall well-being [26]. Ultimately, optimizing exercise intensity may provide key support in cardiometabolic treatment while serving as a vital tool in the prevention of mood disorders in this patient group [22].

The Impact of Physical Activity on Hormonal Profile and Reproductive Functions

Contemporary scientific literature suggests a potential, though not yet fully understood, role of physical activity in modulating fertility in women with Polycystic Ovary Syndrome. According to a systematic review by Hakimi and Cameron, the relationship between exercise and ovulation takes a U-shaped form, meaning that both a sedentary lifestyle and extreme overtraining can lead to anovulation [34]. The authors indicate that in overweight women, moderate to high-intensity exercise (30–60 minutes per day) promotes the restoration of ovulation; however, exceeding 60 minutes of vigorous exercise, especially in individuals with

a low BMI, drastically increases the risk of infertility resulting from energy deficit. They also highlight a significant research gap regarding the impact of sport on women with PCOS and a normal BMI, noting that previous interventions have focused too heavily on weight loss itself rather than specific training parameters [34].

Conversely, a study by Shetty et al. suggests that exercise is one of the most effective methods for supporting infertility treatment in this patient group. According to the authors, regular training can lead to the resumption of ovulation and improved cycle regularity in approximately 50% of women by inducing favorable changes in testosterone and androstenedione levels and reducing insulin resistance. Additionally, weight loss induced by movement can lower the amplitude of luteinizing hormone (LH) pulses, facilitating the normalization of the hormonal profile necessary for conception [35].

Further reports suggest that to achieve reproductive benefits in women with PCOS, moderate aerobic exercise may be insufficient, with high-intensity aerobic and resistance training showing a greater impact. It is emphasized that maximal improvement in hyperandrogenism may only appear after approximately 50 hours of cumulative high-intensity exercise. Crucially, these studies indicate that exercise increases the chances of conception through mechanisms independent of weight loss, offering hope for improved fertility even in the absence of measurable changes on the scale [36].

Despite these findings, other analyses point out that the overall impact of physical activity on reproductive functions remains unclear and requires further verification [18,37]. These doubts are confirmed by a meta-analysis published in the journal Medicine, which indicates high heterogeneity in results concerning the menstrual cycle and fertility. The researchers noted low-certainty evidence regarding the impact of exercise on sex hormones and emphasized that currently available data are too limited to unequivocally assess the effectiveness of physical interventions in improving major health parameters in PCOS [37].

Discussion

The analysis of the collected body of evidence confirms that physical activity constitutes a key component of the non-pharmacological management of polycystic ovary syndrome (PCOS), although its effectiveness is closely dependent on the modality and intensity of exercise [18,19]. The findings indicate multidirectional metabolic benefits, including improved insulin sensitivity, which is fundamental in the management of a condition affecting between 50% and 90% of patients [22]. An important point of debate in the literature remains the choice

of the optimal training protocol. Although traditional recommendations focus on 150 minutes of moderate physical activity [22], more recent evidence suggests that high-intensity forms of exercise, such as high-intensity interval training (HIIT), demonstrate greater effectiveness in reducing testosterone levels and visceral adipose tissue. This supports the hypothesis that, for improving hormonal and metabolic profiles, the key factor is a strong physiological stimulus rather than merely total energy expenditure [25,26].

In the area of fertility, physical activity demonstrates significant therapeutic potential, and some literature reports suggest that regular training may contribute to the restoration of ovulation in up to half of the studied patients. This effect is likely associated with reductions in testosterone and androstenedione levels as well as beneficial modulation of luteinizing hormone (LH) pulse amplitude, which may facilitate cycle normalization independently of weight loss itself. Nevertheless, the considerable heterogeneity of available data and the risk of ovulatory disorders associated with extreme physical exertion and low BMI mean that the impact of physical activity on reproductive function remains a subject of scientific debate. Psychological barriers also represent an extremely important aspect. Although physical activity alleviates symptoms of anxiety and depression, negative body image and low self-confidence constitute real obstacles to the implementation of therapeutic recommendations, suggesting the need to combine exercise prescriptions with professional psychological support [29–33].

Particular attention should also be paid to the clearly identifiable research gaps that limit the ability to formulate fully precise clinical guidelines. First, the current literature almost completely lacks studies focusing on the effects of sport on ovulation and hormonal parameters in patients with PCOS who have a normal body weight, i.e., those with a normal BMI. Existing interventions have disproportionately focused on weight loss, which in many cases makes it difficult to reliably assess the benefits of physical activity itself as an independent therapeutic factor. Moreover, as demonstrated by meta-analyses, current findings regarding reproductive function are characterized by substantial heterogeneity, resulting largely from the lack of standardization in training programs used in the studied groups.

Therefore, there is an urgent need for studies that will clarify how specific training parameters (such as type and intensity) can support weight reduction while simultaneously improving hormonal function independently. It is necessary to develop standardized exercise protocols that will allow for precise determination of the minimal dose of physical activity required to optimize metabolic and reproductive health. Only a full understanding of these relationships will enable physicians and therapists to move from general recommendations

toward personalized lifestyle medicine, effectively combining weight management with targeted physical activity tailored to the needs of women with PCOS.

Conclusions

Physical activity constitutes a cornerstone of non-pharmacological therapy for PCOS, effectively improving insulin sensitivity and cardiometabolic parameters. Training programs of high intensity, such as High-Intensity Interval Training (HIIT), performed for a minimum of 150 minutes per week, demonstrate the greatest efficacy in optimizing the hormonal profile. Regular physical activity promotes the restoration of ovulation through direct modulation of the hypothalamic–pituitary–ovarian (HPO) axis, thereby providing significant support for fertility independently of weight loss alone.

However, the effectiveness of these interventions depends on addressing the psychological well-being of patients and mitigating barriers related to body image and self-acceptance. Despite the well-documented benefits, further research is required to determine precise exercise dosing, particularly among women with a normal body mass index (BMI).

Disclosure

Author's contribution

Conceptualization: J.Frączek; methodology: P. Górka, Sz.Domagała; software: W. Kądziołka ; check: K. Borówka, N. Kawka; formal analysis: J.Frączek, P. Tymińska ; investigation: P. Górka, W. Kądziołka; resources:N. Kawka, K. Borówka; writing-rough preparation : Sz. Domagała ; writing –review and editing: J.Frączek; visualization: P. Tymińska; supervisionK. Borówka; project administration: P. Górka

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