

Systematic Review

A Comparison between Diet, Exercise, and Combined Intervention in Women with Polycystic Ovarian Syndrome (A Systematic Review for The Anthropometric, Metabolic, Psychological, and Hormonal Parameters)

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Abstract

Introduction: Lifestyle changes are first-line treatments for Polycystic Ovary Syndrome (PCOS), but the comparative efficacy of various modalities remains unclear.

Objective: This systematic review compares the effects of diet (D), exercise (E), and combined interventions (ED) on PCOS manifestations.

Methods: A systematic search of PubMed, ScienceDirect, and Springer (2021–2025) identified 9 RCTs involving 418 women. Outcomes included anthropometric, metabolic, psychological, and hormonal parameters.

Results: Dietary intervention (D) produced the greatest improvements in insulin sensitivity (HOMA-IR, fasting glucose), lipid profiles (TC, LDL, TG), and hormonal balance (SHBG, LH). Combined therapy (ED) was most effective for reducing BMI and increasing HDL. Conversely, exercise alone (E) was most effective at reducing depression and anxiety scores. No significant changes were observed in WHR or FSH.

Discussion: Diet serves as a metabolic anchor by addressing hyperinsulinemia, while exercise catalyzes mental health benefits. The synergy of ED optimizes body composition and cardiovascular health.

Conclusion: PCOS management should be personalized, prioritizing diet for metabolic control and exercise for psychological well-being. A combined approach offers the most comprehensive benefits for body composition and long-term health.

Keywords: Diet; exercise; PCOS

Perbandingan antara Diet, Olahraga, dan Intervensi Kombinasi pada Wanita dengan Sindrom Ovarium Polikistik (Sebuah Tinjauan Sistematis terhadap Parameter Antropometri, Metabolik, Psikologis, dan Hormonal)

Abstrak

Pendahuluan: Perubahan gaya hidup merupakan lini pertama pengobatan *Polycystic Ovary Syndrome* (PCOS), namun efektivitas perbandingan berbagai modalitas masih belum jelas.

Tujuan: Tinjauan sistematis ini membandingkan dampak diet (D), olahraga (E), dan intervensi kombinasi (ED) terhadap manifestasi PCOS.

Metode: Tinjauan sistematis pada PubMed, ScienceDirect, dan Springer (2021 – 2025) mengidentifikasi 9 studi RCT yang melibatkan 418 wanita. Parameter yang diukur meliputi antropometri, metabolik, psikologis, dan hormonal.

Hasil: Intervensi diet (D) memberikan perbaikan terbesar pada sensitivitas insulin (HOMA-IR, glukosa puasa), profil lipid (TC, LDL, TG), dan keseimbangan hormonal (SHBG, LH). Terapi kombinasi (ED) paling efektif untuk penurunan BMI dan peningkatan HDL. Sebaliknya, olahraga mandiri (E) menunjukkan efikasi tertinggi dalam mengurangi skor depresi dan kecemasan. Tidak ditemukan perubahan signifikan pada WHR atau FSH pada semua kelompok.

Diskusi: Diet berperan sebagai jangkar metabolik dalam mengatasi hiperinsulinemia, sementara olahraga berfungsi sebagai katalis kesehatan mental. Sinergi ED mengoptimalkan komposisi tubuh dan kesehatan kardiovaskular.

Kesimpulan: Penatalaksanaan PCOS harus dipersonalisasi; memprioritaskan diet untuk kontrol metabolik dan olahraga untuk kesejahteraan psikologis. Pendekatan kombinasi menawarkan manfaat paling komprehensif bagi komposisi tubuh dan kesehatan jangka panjang.

Kata Kunci: Diet; olahraga; PCOS

Introduction

Polycystic ovary syndrome (PCOS) is a common yet complex endocrine disorder that affects up to 10% of women during their reproductive years.¹ While global estimates from the WHO (2024) suggest that PCOS affects 6–13% of the female reproductive-age population, there remains a significant diagnostic challenge, with approximately 70% of affected individuals unaware of their condition.² It is diagnosed using the Rotterdam Criteria, which require 2 of 3: (1) Oligo-anovulation/Irregular Periods: Infrequent (e.g., cycles > 35 days apart) or absent menstrual periods, indicating irregular ovulation; (2) Hyperandrogenism (clinical: signs such as excess facial/body hair (hirsutism), severe acne, or male-pattern baldness, and/or biochemical: blood tests showing high levels of male hormones like testosterone); (3) Polycystic Ovarian Morphology (PCOM): identified via ultrasound, showing 12–20+ small follicles on at least one ovary or an increased ovarian volume (>10 mL).^{3,4}

The pathophysiology of PCOS is complex and multifactorial. It involves interactions among hormonal imbalances,⁵ metabolic disturbances,⁶ and anthropometric changes,⁶ all of which contribute to a significant psychological impact.^{7,8} Common imbalances include elevated androgens, irregular ovulation, and insulin resistance, which can disrupt the menstrual cycle and lead to symptoms such as hirsutism and acne.⁹ The metabolic disturbances of PCOS are closely linked to insulin resistance, in which the body's cells do not respond effectively to insulin. This increases the risk of type 2 diabetes, high cholesterol, and cardiovascular disease over time. It is also associated with weight changes, particularly increased central adiposity, although not all women with PCOS are overweight.¹⁰

Lifestyle changes are recommended

as first-line interventions for managing PCOS.¹¹ Diet and exercise are two crucial areas that must be addressed.¹² A diet low in refined carbohydrates can help regulate blood sugar levels and improve insulin sensitivity.¹² Routine physical activity, particularly a combination of aerobic and resistance training, is instrumental in enhancing insulin sensitivity, decreasing adiposity, and strengthening cardiovascular health in women with PCOS.¹³ In addition to conventional training, complementary modalities, including yoga, acupuncture, and naturopathy, offer further support by stabilizing endocrine profiles, restoring menstrual regularity, and reducing psychiatric symptoms such as stress and anxiety.¹⁴

Diet and exercise have been shown to improve the manifestations of PCOS. However, no studies have compared the effectiveness of diet and exercise alone versus a combined intervention. Previous research has focused more on demonstrating the effectiveness of each intervention, diet, and exercise when used alone. This systematic review aims to evaluate and compare the efficacy of diet, exercise, and the combined intervention on anthropometric, metabolic, psychological, and hormonal outcomes in women diagnosed with PCOS.

Method

Study Design

The review focuses exclusively on Randomized Controlled Trials (RCTs) to ensure high-quality evidence and minimize bias when comparing the three intervention modalities. We have 4 stages of study: identifying the research topic and formulating research questions, searching for relevant literature, conducting critical analysis, and extracting data. In identifying the literature, we used the PICO (Population, Intervention, Comparison, and Outcome) criteria. The population for this review was women of

reproductive age diagnosed with PCOS using the Rotterdam Criteria. The intervention was diet or exercise alone. The comparison was a combined intervention. The outcomes were BMI, waist circumference, waist-to-hip ratio, fat mass, fasting glucose, HOMA-IR, insulin, total cholesterol, LDL, HDL, triglycerides, depression, anxiety, and total distress score.

Based on the PICO framework above, the research topic and question can be summarized as follows: “Which intervention modality (diet, exercise, or combined) is more effective in improving PCOS manifestations in female patients diagnosed with PCOS?” Databases searched included PubMed, Science Direct, Oxford Academy, and Springer from January 2021 to December 2025, using the Boolean operator (“Polycystic Ovary Syndrome” OR “Polycystic Ovarian Syndrome”) AND (“Exercise” OR “Exercises”) AND (“Dietary” OR “Diet” OR “Diets”). The studies were then analyzed using the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) Flowchart.

Population and Sample

The population in this study comprises all articles from the specified databases (PubMed, ScienceDirect, Oxford Academy, and Springer) published between January 2021 and December 15, 2025, that discuss the effectiveness of dietary, exercise, or combined interventions in patients with PCOS.

The inclusion criteria in this study were randomized controlled trial studies assessing women of reproductive age diagnosed with PCOS using the Rotterdam Criteria. The exclusion criteria were: use of medication therapy that affects carbohydrate or lipid metabolism (oral contraceptive pills, insulin-sensitizers, antiepileptics, antipsychotics, and statins) within the past 6 months; pregnancy or lactation; and other diseases (such as congenital adrenal hyperplasia,

Cushing syndrome, androgen-secreting tumors, hyperprolactinemia, diabetes, thyroid diseases, and severe cardiovascular, gastrointestinal, kidney, and liver diseases).

Outcomes

The outcomes of this study were anthropometric, metabolic, psychological, and hormonal. The anthropometric measures included mean body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and fat mass (FM). The metabolic measures consisted of the mean of fasting glucose (GF), HOMA-IR, insulin, total cholesterol (TC), LDL, HDL, and triglycerides. The psychological measures consisted of the mean of: depression score (DS), anxiety score (AS), and total distress score (TDS). The hormonal measures consisted of the mean of total testosterone (TT), SHBG, LH, and FSH.

Operational Definition

The definition of diet in this study is a nutritional intervention for patients, such as calorie restriction, a ketogenic diet, or a Mediterranean diet. It can be a strict or moderate diet. Meanwhile, the definition of exercise in this study is physical activity of moderate to high intensity. Those interventions were carried out regularly for at least 8 weeks.

Data Analysis

The data analysis in this systematic review used descriptive methods, presenting the research results coherently and the relationships between the variables studied in narrative form. Articles that met the inclusion criteria were assessed and grouped by author, year, number of patients involved, interventions, and findings. The interventions will be described as diet (D), exercise (E),

combined intervention (ED), and control (C). The research results will show which intervention yields the greatest improvement.

Result
Study Selection

Study selection was conducted across five databases: PubMed, ScienceDirect, Oxford Academy, and Springer, with searches conducted from January 2021 to December 15, 2025. Keywords were adjusted using Boolean operators and synonyms, different spellings, and word forms/variants using Medical Subject Headings (MeSH). The selected keywords yielded 1.469 articles. These articles consisted of 102 articles from PubMed, 702 from Science Direct, 0 from Oxford Academy, and 665 from Springer.

All retrieved articles underwent a duplicate selection process. This process was conducted using the Mendeley application, and 55 duplicate articles were removed. The remaining 1.414 articles passed the duplicate

selection process and were then selected for their titles and abstracts' appropriateness to the research topic. A total of 1.296 articles were excluded during the abstract selection. Eligibility was assessed by reading 114 full articles and evaluating their suitability. The eligibility selection excluded 77 articles because they were review articles or did not discuss diet and/or exercise interventions in women with PCOS. The final result was 9 articles, which proceeded to the data extraction and synthesis stages.

Study Characteristics

A total of 9 articles met the requirements for this systematic review. All of the studies were in English and used a randomized controlled trial design. The years of the studies varied: 2021 (2 articles), 2022 (1 article), 2023 (4 articles), and 2024 (1 article). The total number of participants across those studies was 418.

Study Results

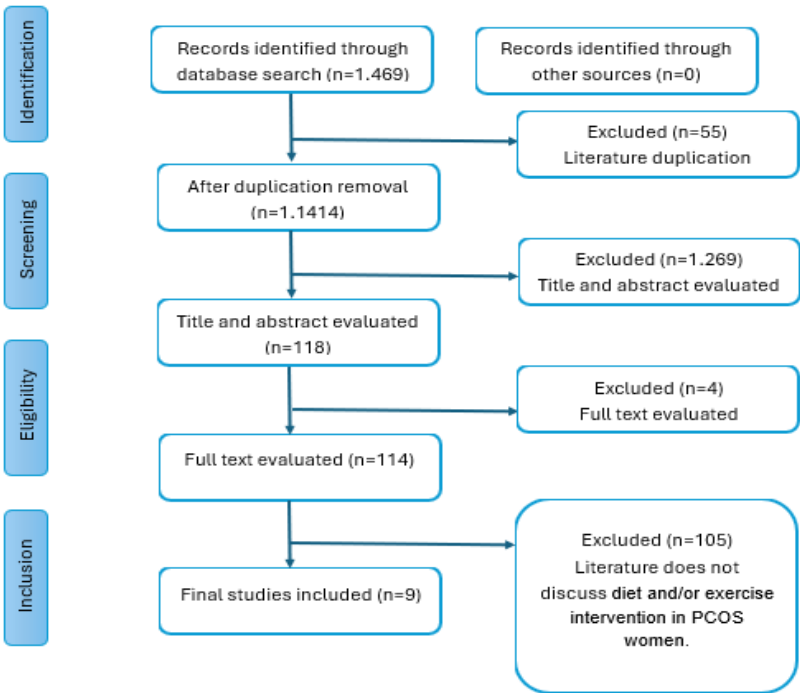


Figure 1 PRISMA Flowchart Result

The results of the literature search, conducted systematically using keywords, yielded 9 articles. Regarding anthropometrics, we found that BMI showed the greatest improvements in the ED group. WC showed the greatest improvements in the D group. There were no improvements in WHR across any group. Fat mass showed the greatest improvements only

in the D group.

The metabolic parameters on GF show the greatest improvements in the D group. HOMA-IR shows the greatest improvements in the D group. Insulin shows the greatest improvement in the D group. TC shows the greatest improvements in the D group. LDL shows the greatest improvement in the D

Table 1 Anthropometric result

Parameters		ED	E	D	C
BMI (kg/m ²) ^{17, 19, 21, 22, 23}	Before	25.9	34.4	32.2	30.9
	After	22.2	33.7	30	29
WC (cm) ^{16, 22, 23}	Before	87.4	nr	101.3	86.9
	After	84.5	nr	95.8	85.1
WHR ^{17, 19, 20}	Before	nr	0.87	0.89	0.87
	After	nr	0.83	0.88	0.87
FM (kg)	Before	nr	40.7	35.5	33.7
	After	nr	40.4	31.1	33.9

ED: exercise band diet, E: exercise, D: diet, C: control. BMI: body mass index, WC: waist circumference, WHR: waist to hip ratio, FM: fat mass

Table 2 Metabolic Result

Parameters		ED	E	D	C
GF (mg/dl) ^{15, 16, 17, 18, 19, 22}	Before	92.8	92.2	90.5	91.3
	After	91	94.5	87.1	92.0
HOMA-IR ^{15, 17, 18, 19, 21, 22}	Before	3.5	3.9	4.2	6.0
	After	3.3	3.7	2.7	5.7
Insulin (mU/mL) ^{15, 16, 17, 18, 19, 20, 21, 22}	Before	17.6	17.1	18.4	14.0
	After	16.6	16.6	12.9	13.4
TC (mg/dl) ^{16, 17, 18, 19, 21, 22}	Before	85.6	171	187.2	141.9
	After	81.1	164	169.3	141.6
LDL (mg/dl) ^{16, 17, 18, 19, 21, 22}	Before	58.1	104	114.8	92.5
	After	53.9	95	102.9	89.9
HDL (mg/dl) ^{16, 18, 19, 21}	Before	17	38.2	48.5	33.4
	After	16.8	38	52.1	33.4
Triglycerid (mg/dl) ^{16, 17, 21,}	Before	24.5	151.1	152.2	96.5
	After	22.2	149.1	126.5	92.8

ED: exercise band diet, E: exercise, D: diet, C: control. GS: glucose fasting, HOMA-IR: homeostasis model assessment of insulin resistance, TC: total cholesterol, LDL: low density lipoprotein, HDL: high density lipoprotein

Table 3 Psychology Result

	Parameters	ED	E	D	C
DS ²⁰	Before	nr	5.8	3.6	Nr
	After	nr	4.5	4.4	Nr
AS ²⁰	Before	nr	5.8	6.8	Nr
	After	nr	3.1	5.8	Nr
TD ²⁰	Before	nr	8.2	21.9	0.87
	After	nr	5.3	17.5	0.875

ED: exercise band diet, E: exercise, D: diet, C: control. DS: depression score, AS: anxiety score, TD: total distress, nr: not reported

Tabel 4 Hormonal result

	Parameters	ED	E	D	C
TT (ng/mL) ^{17, 18, 19, 21}	Before	nr	nr	0.6	0.6
	After	nr	nr	0.5	0.4
SHBG (nmol/L) ^{17, 19}	Before	nr	nr	25.6	26.6
	After	nr	nr	29.5	26.6
LH (mIU/mL) ^{17, 18}	Before	nr	nr	11.6	Nr
	After	nr	nr	10.2	Nr
FSH (mIU/mL) ^{17, 18}	Before	nr	nr	4.7	Nr
	After	nr	nr	4.9	Nr

ED: exercise band diet, E: exercise, D: diet, C: control, TT: total testosterone, SHBG: sex hormone binding globulin, LH: leutinizing hormone, FSH: follicle-stimulating hormone

Table 5 Summary of The Greatest Improvement

Parameters	ED	E	D	C
<i>Anthropometric</i>				
BMI				
WC				
WHR				
FM				
<i>Metabolic</i>				
GF				
HOMA-IR				
Insulin				
TC				
LDL				
HDL				
Triglycerid				
<i>Psychologic</i>				
DS				
AS				
TD				
<i>Hormonal</i>				
TT				
SHBG				
LH				
FSH				

ED: exercise band diet, E: exercise, D: diet, C: control. BMI: body mass index, WC: waist circumference, WHR: waist to hip ratio, FM: fat mass, HOMA-IR: homeostasis model assessment of insulin resistance, TC: total cholesterol, LDL: low density lipoprotein, HDL: high density lipoprotein, DS: depression score, AS: anxiety score, TD: total distress, TT: total testosterone, SHBG: sex hormone binding globulin, LH: leutinizing hormone, FSH: follicle-stimulating hormone.

group. HDL shows the greatest improvements in the ED group. Triglycerides show the greatest improvements in the D group.

The psychological DS score showed the greatest improvement in the E group. The anxiety score showed the greatest improvement in the E group. The TD score showed the greatest improvement in the D group.

The TT parameters showed the greatest improvement in the C group. The SHBG parameters showed the greatest improvement in the D group. The LH parameters showed the greatest improvement in the D group. There was no improvement in the FSH group.

Discussion

The primary objective of this study was to evaluate and compare the efficacy of diet (D), exercise (E), and combined interventions (ED) in addressing the multifaceted symptoms of Polycystic Ovarian Syndrome (PCOS). Our findings indicate that while all lifestyle modifications yield benefits, dietary intervention (D) appears to be the most influential factor in improving metabolic and hormonal profiles, whereas exercise (E) is paramount for psychological well-being.

Metabolic and Hormonal Superiority of Diet

Our results demonstrate that the diet-only group achieved the greatest improvements in insulin-sensitivity markers (HOMA-IR, fasting glucose, and insulin) and lipid profiles (TC, LDL, TG). This aligns with recent findings by Cowan et al. (2023), who noted that caloric restriction or low-glycemic-index diets directly address the primary driver of PCOS: hyperinsulinemia. By reducing the insulin load, dietary changes effectively lower androgen production in theca cells.²⁴

Furthermore, the significant increase in SHBG and decrease in LH within the

diet group align with the 2023 International Evidence-based Guideline for PCOS.²⁵ Increased SHBG reduces the bioavailability of free testosterone, which is essential for managing clinical symptoms such as hirsutism and acne.

The Synergistic Effect of Combined Interventions (ED)

While the diet excelled in metabolic markers, the ED group showed greater reductions in BMI and higher HDL levels. This suggests a synergistic mechanism: diet facilitates a caloric deficit, while exercise prevents the decline in resting metabolic rate often associated with weight loss.

Exercise as a Mental Health Catalyst

A striking finding in our study was that exercise alone (E) produced the greatest improvements in depression and anxiety scores. Women with PCOS are disproportionately affected by psychological distress. Regular physical activity modulates the hypothalamic-pituitary-adrenal (HPA) axis. It increases endorphin levels, providing a mood-boosting effect that dietary restriction, which can sometimes be perceived as a stressor, may not offer.

The Testosterone Paradox and Non-Responsive Markers

The finding that Total Testosterone (TT) improved most in the control group is unexpected. It may reflect “study-entry bias,” in which control-group participants spontaneously adopt healthier habits after diagnosis. Alternatively, the high variability of testosterone levels in PCOS patients requires large sample sizes and standardized testing times (early follicular phase) to achieve accuracy, which may have limited the 9 studies reviewed. The lack of improvement in WHR and FSH suggests that these parameters may require longer intervention

durations (over 6 months) to show significant structural or endocrine shifts.

Limitations and Future Directions

This study is limited by the relatively small number of RCTs (n=9) that directly compare all three arms. Heterogeneity in dietary (e.g., Ketogenic vs. Mediterranean) and exercise (e.g., HIIT vs. Resistance training) approaches across the literature makes it difficult to prescribe a protocol.

In conclusion, this study demonstrates that dietary modifications, exercise, and combined interventions (ED) yield significant clinical benefits for women with Polycystic Ovarian Syndrome (PCOS). Our comparative analysis shows that dietary intervention (D) yields the most comprehensive improvements in metabolic and hormonal profiles, particularly in insulin sensitivity, lipid levels (TC, LDL, TG), and regulation of LH and SHBG.

While diet is a cornerstone of metabolic recovery, combined therapy (ED) remains the most effective strategy for optimizing body composition (BMI) and cardiovascular health (HDL). Furthermore, exercise (E) is the primary driver of improved psychological well-being, specifically by reducing depression and anxiety.

Despite these positive outcomes, the lack of significant changes in WHR and FSH suggests that certain parameters may require longer or more specialized interventions. The limited number of available RCTs and the high degree of heterogeneity in intervention protocols underscore that a “one-size-fits-all” approach may be insufficient. Therefore, clinical management of PCOS should be personalized to the patient’s specific needs, prioritizing diet for metabolic control and exercise for mental health. Future research with larger, standardized cohorts is essential to establish definitive clinical guidelines and optimize long-term health outcomes for

women with PCOS.

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