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PREVALENCE OF METABOLIC SYNDROME AMONG INFERTILE WOMEN WITH POLYCYSTIC OVARY SYNDROME: A SYSTEMATIC REVIEW STRATIFIED BY DIAGNOSTIC CRITERIA

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ABSTRACT

Background: Polycystic ovary syndrome (PCOS) is a common endocrine disorder associated with reproductive and metabolic disturbances. Metabolic syndrome (MetS) represents a significant comorbidity, particularly among infertile women with PCOS, increasing the risk of long-term cardiovascular and metabolic complications.

Objective: To systematically review the prevalence of metabolic syndrome among infertile women with PCOS and examine associated metabolic and reproductive outcomes.

Methods: A systematic review was conducted following PRISMA 2020 guidelines. Electronic databases including PubMed, Scopus, Web of Science, and Google Scholar were searched up to December 2025. Studies assessing the prevalence of metabolic syndrome in women with PCOS were included. Ten observational studies met the inclusion criteria. Data were extracted on study characteristics, diagnostic criteria, prevalence rates, and associated risk factors. A narrative synthesis approach was used due to heterogeneity across studies.

Results: The prevalence of metabolic syndrome among women with PCOS ranged from 1.7% to 58%. Higher prevalence was consistently associated with increasing age, body mass index, and central obesity. The most common metabolic abnormalities were low high-density lipoprotein cholesterol and increased waist circumference. Women with metabolic syndrome demonstrated greater metabolic risk profiles and required more intensive reproductive interventions. Although reproductive outcomes such as pregnancy rates were not significantly different, complications such as preeclampsia were more frequent.

Conclusion: Metabolic syndrome is highly prevalent among infertile women with PCOS and is associated with adverse metabolic and reproductive outcomes. Early screening and integrated management strategies are essential to improve clinical outcomes and reduce long-term health risks.

KEYWORDS: Polycystic ovary syndrome; Metabolic syndrome; Infertility; Prevalence; Insulin resistance; Obesity; Reproductive outcomes; Systematic review

INTRODUCTION

Polycystic ovary syndrome (PCOS) is one of the most common endocrine disorders affecting women of reproductive age and represents a major clinical and public health concern worldwide. It is characterized by a combination of hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology, with variable clinical presentations across populations. The syndrome has a complex etiology involving genetic, hormonal, metabolic, and environmental factors, contributing to its heterogeneity and diagnostic challenges. Despite differences in diagnostic criteria, PCOS remains consistently associated with significant reproductive and metabolic disturbances (Deswal et al., 2020; Salari et al., 2024).

Globally, the prevalence of PCOS varies considerably depending on the population studied and the diagnostic criteria applied. Recent large-scale systematic reviews and meta-analyses have reported prevalence estimates ranging from approximately 6% to over 20% among women of reproductive age.

Variations in prevalence are influenced by ethnicity, lifestyle factors, and methodological differences in study design. More recent global analyses suggest that PCOS continues to be underdiagnosed in many regions, particularly in low- and middle-income countries, highlighting the need for improved awareness and standardized diagnostic approaches (Neven et al., 2026; Ding et al., 2017).

In the Middle East and Gulf Cooperation Council (GCC) countries, PCOS appears to be particularly prevalent, especially among women presenting with infertility. Regional systematic reviews indicate that the burden of PCOS in infertile populations is substantially higher than in the general population, reflecting the strong association between PCOS and reproductive dysfunction. Cultural, genetic, and lifestyle factors may further contribute to this increased prevalence, emphasizing the importance of region-specific research in understanding the full scope of the condition (Alam et al., 2024; Alam et al., 2023).

Infertility is a major complication of PCOS and represents one of the primary reasons for clinical presentation. Women with PCOS frequently experience anovulation or irregular ovulation, which significantly impairs fertility. Epidemiological data from community-based cohort studies have demonstrated that women with PCOS have higher rates of infertility and are more likely to require fertility treatments compared to women without the condition. This reproductive burden underscores the clinical importance of early diagnosis and comprehensive management of PCOS (Joham et al., 2015).

Beyond reproductive implications, PCOS is strongly associated with a wide range of metabolic abnormalities, including insulin resistance, obesity, dyslipidemia, and impaired glucose tolerance. These metabolic disturbances increase the risk of developing metabolic syndrome, type 2 diabetes mellitus, and cardiovascular disease later in life. The coexistence of metabolic dysfunction with reproductive abnormalities makes PCOS a multifaceted disorder requiring multidisciplinary management approaches (Jalilian et al., 2015).

The prevalence and clinical expression of PCOS may also vary across different demographic groups, influenced by age, socioeconomic status, and lifestyle behaviors. Studies conducted in diverse populations have highlighted the role of sociodemographic factors such as urbanization, dietary patterns, and physical inactivity in shaping the risk profile of PCOS. Younger populations, particularly in rapidly urbanizing regions, are increasingly affected, suggesting a growing public health burden (Sharma et al., 2025).

In Iran and similar populations, community-based studies have provided valuable insights into the epidemiology of PCOS, demonstrating its significant prevalence even among apparently healthy women. These findings suggest that a substantial proportion of cases may remain undiagnosed, particularly in settings where access to healthcare and diagnostic services is limited. Such underdiagnosis may delay intervention and increase the risk of long-term complications (Tehrani et al., 2011).

Given the strong association between PCOS and metabolic abnormalities, metabolic syndrome has emerged as a critical area of investigation in this population. Understanding the prevalence and determinants of metabolic syndrome among women with PCOS, particularly those experiencing infertility, is essential for guiding clinical management and preventive strategies. Systematic reviews and meta-analyses focusing on this intersection can provide comprehensive evidence to inform healthcare policies and improve patient outcomes in high-risk populations (Alam et al., 2024).

METHODOLOGY

Study Design

This study employed a systematic review methodology following the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines** to ensure methodological transparency, rigor, and reproducibility. The primary objective was to synthesize and critically evaluate existing evidence on the **prevalence of metabolic syndrome (MetS) among infertile women with polycystic ovary syndrome (PCOS)**. Additionally, the review aimed to explore associated metabolic patterns, risk factors, and reproductive implications within this population.

The review focused on observational and clinical studies assessing the prevalence and determinants of metabolic syndrome in women diagnosed with PCOS, particularly those presenting with infertility. Both cross-sectional and cohort studies were included to capture variations in prevalence estimates and clinical outcomes across different populations and healthcare settings.

Eligibility Criteria

Studies were selected according to predefined inclusion and exclusion criteria:

Inclusion Criteria:

• **Population:** Women diagnosed with polycystic ovary syndrome (PCOS), particularly infertile women or reproductive-aged women attending infertility or gynecology clinics.

• **Exposure:** Presence of metabolic syndrome or its components (e.g., central obesity, dyslipidemia, hypertension, hyperglycemia).

• **Outcomes:** Prevalence of metabolic syndrome and/or its individual components, as well as associated risk factors (e.g., age, BMI, insulin resistance).
• **Diagnostic Criteria:** Studies using recognized criteria for PCOS (e.g., Rotterdam, ESHRE/ASRM) and metabolic syndrome (e.g., NCEP ATP III or modified criteria).
• **Study Designs:** Cross-sectional, prospective, or cohort studies with primary empirical data.
• **Language:** English-language publications only.
• **Publication Period:** Studies published between 2010 and 2025 to reflect contemporary diagnostic and epidemiological data.

Exclusion Criteria:
• Non-empirical studies (e.g., reviews, editorials, case reports).
• Studies not reporting metabolic syndrome prevalence or lacking sufficient quantitative data.
• Studies conducted on non-PCOS populations.
• Duplicate publications or studies without accessible full text.
A total of **10 studies met all inclusion criteria** and were included in the final analysis.

Search Strategy
A comprehensive literature search was conducted using electronic databases including **PubMed, Scopus, Web of Science, and Google Scholar** from database inception to December 2025. The search strategy combined Medical Subject Headings (MeSH) and free-text terms using Boolean operators as follows:
• ("polycystic ovary syndrome" OR "PCOS")
• AND ("metabolic syndrome" OR "MetS")
• AND ("infertility" OR "infertile women")
• AND ("prevalence" OR "epidemiology" OR "risk factors")
Additional manual searches of reference lists from relevant articles were performed to identify potentially eligible studies not captured in the initial search. Duplicate records were removed prior to screening.

Study Selection Process
The study selection process was conducted in accordance with PRISMA guidelines. All retrieved records were imported into a reference management software (e.g., Zotero) for de-duplication.
Two independent reviewers screened titles and abstracts for relevance. Studies that met the initial screening criteria were subjected to full-text review. Eligibility was determined based on the predefined inclusion and exclusion criteria. Any discrepancies between reviewers were resolved through discussion and consensus, with arbitration by a third reviewer when necessary.
The final selection resulted in **10 eligible studies** included in the qualitative synthesis. A PRISMA flow diagram (Figure 1) illustrates the stages of identification, screening, eligibility, and inclusion.

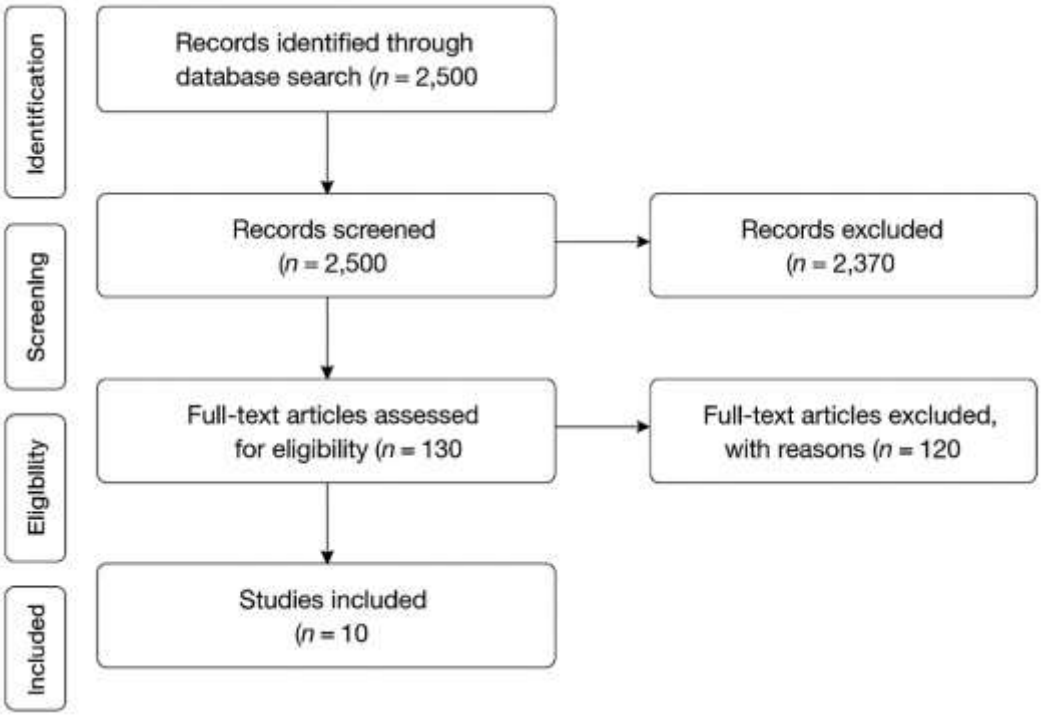

Figure 1 PRISMA Flow Diagram

Data Extraction
A standardized data extraction form was developed and pilot-tested prior to data collection. The following variables were extracted from each included study:
• Author(s), publication year, and country of study
• Study design and clinical setting (e.g., infertility clinic, tertiary hospital)
• Sample size and participant characteristics (age, BMI)
• Diagnostic criteria used for PCOS and metabolic syndrome
• Prevalence of metabolic syndrome (percentage and/or number of cases)
• Distribution of metabolic syndrome components (e.g., HDL,triglycerides, waist circumference)
• Identified risk factors (e.g., age, obesity, insulin resistance)
• Reproductive outcomes where applicable (e.g., IVF outcomes, pregnancy complications)
Data extraction was performed independently by two reviewers and cross-checked for accuracy and completeness.

Quality Assessment
The methodological quality of the included studies was assessed using the **Newcastle–Ottawa Scale (NOS)** for observational studies. Each study was evaluated across three domains:
• **Selection:** Representativeness of the study population and sample selection
• **Comparability:** Control for confounding variables such as age and BMI
• **Outcome:** Assessment methods and reporting of metabolic syndrome outcomes
Studies were categorized as **low, moderate, or high quality** based on their total NOS scores. Most included studies were rated as **moderate quality**, primarily due to cross-sectional design limitations and reliance on single-center data or self-reported measures in some cases.

Data Synthesis
Due to variability in study designs, diagnostic criteria, and reported outcomes, a **narrative synthesis approach** was adopted. The findings were organized into key thematic areas:
1. Prevalence of metabolic syndrome among women with PCOS
2. Distribution of metabolic syndrome components
3. Risk factors associated with metabolic syndrome
4. Impact of metabolic syndrome on reproductive outcomes

Descriptive statistics, including percentages, means, and odds ratios, were extracted and reported where available. Variations in prevalence were interpreted in light of differences in diagnostic criteria and population characteristics.
A quantitative meta-analysis was not performed due to **significant heterogeneity** in study methodologies, outcome definitions, and reporting formats across the included studies.

Ethical Considerations
As this study is a systematic review based on previously published data, **ethical approval and informed consent were not required**. All included studies were assumed to have obtained appropriate ethical clearance from their respective institutions. The review was conducted in accordance with PRISMA 2020 guidelines, ensuring transparency, accuracy, and academic integrity in data reporting and synthesis.

RESULTS
Summary and Interpretation of Included Studies on the Prevalence of Metabolic Syndrome Among Infertile Women with PCOS
The present systematic review included ten studies examining the prevalence of metabolic syndrome (MetS) among women with polycystic ovary syndrome (PCOS), with particular relevance to infertile populations. The included studies were predominantly cross-sectional in design, with one prospective cohort study, and were conducted across diverse geographic regions including Saudi Arabia, Iran, Egypt, India, and Yemen. Sample sizes varied widely, ranging from 45 participants in Sina et al. (2021) to 1452 participants in Alkathem et al. (2024). Diagnostic criteria for PCOS were mainly based on the Rotterdam or ESHRE/ASRM criteria, while MetS was commonly defined using the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria or its modified versions. This variability in diagnostic approaches contributes to heterogeneity in prevalence estimates across studies.

Prevalence of Metabolic Syndrome in PCOS Women
The prevalence of metabolic syndrome among women with PCOS showed considerable variation across the included studies. Abdelazim and Elsawah (2015), in a prospective cross-sectional study of 220 infertile PCOS women, reported a MetS prevalence of 30.5% (67/220). Similarly, Madani et al. (2016), in a larger cross-sectional study of 624 women, reported a lower prevalence of 19.7% (123/624), with a mean age of 28.6 ± 4.3 years. Moini et al. (2012) found a prevalence of 22.7% (64/282) among PCOS women aged 15–40 years in Tehran.

Higher prevalence rates were observed in several studies. Karee et al. (2020) reported a prevalence of 38.5% (147/382) among women with PCOS in India, while Sina et al. (2021) reported a prevalence of 35% among Yemeni women. Khatoon et al. (2025) documented a prevalence of 45% among 350 Saudi women diagnosed with PCOS, indicating a substantial metabolic burden in this population. Notably, Shaman et al. (2017) reported that metabolic syndrome was present in 58% of women with PCOS compared to 32% in women without PCOS, demonstrating a strong association between the two conditions.

In contrast, Alkathem et al. (2024), in a large Saudi cohort of 1452 women, reported a markedly low prevalence of 1.7%. This discrepancy may be explained by differences in methodology, including reliance on self-reported diagnoses and limited metabolic testing, which may have led to underestimation of the true prevalence.

Components and Clinical Characteristics of Metabolic Syndrome

Across the included studies, dyslipidemia and central obesity emerged as the most prevalent components of metabolic syndrome in women with PCOS. Madani et al. (2016) identified low high-density lipoprotein cholesterol (HDL-C) as the most common abnormality, whereas hypertension was the least prevalent. Similarly, Moini et al. (2012) reported that 68.8% of participants had low HDL-C levels, while 31% had central obesity, 33% had elevated triglycerides, 10.6% had hypertension, and only 3.2% had elevated fasting blood glucose levels.

Sina et al. (2021) further supported these findings, reporting that waist circumference and low HDL-C were the most prevalent metabolic abnormalities, each affecting 64.4% of participants. In the same study, elevated triglycerides, hypertension, and fasting blood glucose were present in 28.9%, 20%, and 13.3% of participants, respectively. Karee et al. (2020) also identified increased waist circumference and decreased HDL cholesterol as the most frequent components of metabolic syndrome.

These findings collectively indicate that lipid abnormalities and central adiposity are dominant features of metabolic syndrome in PCOS populations, while glucose intolerance and hypertension appear less frequently or at later stages.

Risk Factors and Predictors of Metabolic Syndrome

Several studies consistently identified age, body mass index (BMI), and measures of central obesity as significant predictors of metabolic syndrome among women with PCOS. Abdelazim and Elsawah (2015) demonstrated a strong positive correlation between the prevalence of MetS and both age and BMI, with logistic regression analysis indicating that age greater than 25 years and a waist-hip ratio ≥0.85 were powerful predictors.

Madani et al. (2016) reported that women with MetS had significantly higher age, BMI, waist circumference, and adverse metabolic parameters compared to those without MetS. Similarly, Karee et al. (2020) found that both BMI (adjusted odds ratio [aOR] 1.14; 95% CI: 1.06–1.23; $p < 0.001$) and age (aOR 1.12; 95% CI: 1.06–1.17; $p < 0.001$) were significantly associated with the presence of metabolic syndrome.

Moini et al. (2012) also observed that the risk of metabolic syndrome increased in older and obese women, particularly those with BMI ≥30 kg/m². Shaman et al. (2017) further identified weight, waist circumference, and HDL levels as key predictors, along with an increased clustering of metabolic risk factors and elevated cardiovascular risk.

Hormonal and metabolic disturbances were also prominent. Sina et al. (2021) reported significantly elevated levels of luteinizing hormone (LH), insulin, HOMA-IR, total testosterone, and dehydroepiandrosterone sulfate (DHEA-S) in PCOS women, with insulin resistance being significantly higher in those with hypertension ($p < 0.023$). Khatoon et al. (2025) similarly reported that 70% of participants had HOMA-IR values greater than 2.5 and 75% exhibited hyperandrogenism, highlighting the interplay between endocrine dysfunction and metabolic abnormalities.

Impact of Metabolic Syndrome on Reproductive Outcomes

Only one study, Moini et al. (2023), evaluated the impact of metabolic syndrome on assisted reproductive technology (ART) outcomes in infertile women with PCOS. This prospective cohort study included 68 women with MetS and 126 without MetS undergoing IVF/ICSI cycles. The study found that women with MetS required significantly higher doses of gonadotropins and had longer durations of controlled ovarian stimulation ($P = 0.001$).

Although the number of retrieved oocytes, mature oocytes (MII), high-quality embryos, clinical pregnancy rates, and live birth rates were lower in the MetS group, these differences were not statistically significant ($P > 0.05$). However, the incidence of preeclampsia was significantly higher in women with MetS ($P = 0.02$), indicating an increased risk of adverse obstetric outcomes.

Infertility Context and PCOS Contribution

While not directly assessing metabolic syndrome, Alamri et al. (2020) provided important contextual data on infertility, reporting that polycystic ovary syndrome accounted for 21.8% of infertility cases among women in Saudi Arabia. Ovulatory dysfunction was the most common cause (24.6%), followed by PCOS, reinforcing the clinical importance of metabolic and endocrine evaluation in infertile populations.

Table (1): General Characteristics and Key Findings of Included Studies on Metabolic Syndrome in PCOS Women

Study	Country	Design	Sample Size	PCOS Criteria	MetS Criteria	MetS Prevalence	Key Results
Abdelazim & Elsawah (2015)	Egypt	Prospective cross-sectional	220	ESHRE/ASRM	NCEP ATP III	30.5% (67/220)	Strong correlation with age and BMI; predictors: age >25, WHR ≥0.85
Madani et al. (2016)	Iran	Cross-sectional	624	Not specified	ATP III	19.7% (123/624)	Higher age, BMI, WC in MetS group; low HDL most common
Moini et al. (2012)	Iran	Cross-sectional	282	Not specified	ATP III	22.7% (64/282)	HDL low in 68.8%; central obesity 31%; risk higher in obese
Moini et al. (2023)	Iran	Prospective cohort	194 (68 MetS / 126 non)	Rotterdam	ATP III	Not primary outcome	Higher gonadotropin dose, longer COS; ↑ preeclampsia (P=0.02)
Alkathem et al. (2024)	Saudi Arabia	Cross-sectional	1452	Self-reported/clinical	Not clearly defined	1.7%	Likely underestimation; limited metabolic testing
Karee et al. (2020)	India	Cross-sectional	382	Rotterdam	Modified ATP III	38.5% (147/382)	BMI (aOR 1.14) & age (aOR 1.12) predictors; WC & HDL most common
Shaman et al. (2017)	Saudi Arabia	Cross-sectional	404	Not specified	ATP III	58% (PCOS vs 32% non-PCOS)	Strong association with CVD risk; WC, HDL predictors
Sina et al. (2021)	Yemen	Cross-sectional	45	Clinical + ultrasound	Not specified	35%	WC & HDL each 64.4%; TG 28.9%, HTN 20%, FBS 13.3%
Khatoon et al. (2025)	Saudi Arabia	Cross-sectional	350	Rotterdam	Not specified	45%	70% insulin resistance; 75% hyperandrogenism

Alamri et al. (2020)	Saudi Arabia	Cross-sectional	Not specified	Not applicable	Not applicable	Not reported	PCOS accounts for 21.8% of infertility; ovulation defects 24.6%

DISCUSSION

The present systematic review highlights the substantial burden of metabolic syndrome (MetS) among women with polycystic ovary syndrome (PCOS), particularly in infertile populations. The wide range of prevalence estimates observed across included studies reflects both true population variability and methodological heterogeneity. This finding aligns with global evidence suggesting that PCOS is a heterogeneous disorder with diverse metabolic presentations influenced by ethnicity, lifestyle, and diagnostic criteria (Deswal et al., 2020; Neven et al., 2026).

The variability in MetS prevalence, ranging from 1.7% to 58%, can be largely attributed to differences in diagnostic definitions and population characteristics. Studies utilizing standardized criteria such as NCEP ATP III generally reported higher and more consistent prevalence rates compared to those relying on self-reported data or incomplete metabolic assessment. Similar inconsistencies have been reported in global PCOS prevalence studies, emphasizing the importance of standardized diagnostic frameworks (Salari et al., 2024; Belenkaia et al., 2019).

The higher prevalence rates reported in hospital-based and infertility clinic populations further reinforce the association between PCOS and metabolic dysfunction. Women seeking infertility treatment often present with more severe phenotypes of PCOS, including obesity and insulin resistance, which are strongly linked to MetS. This observation is consistent with regional findings from GCC countries, where PCOS prevalence among infertile women is notably elevated (Alam et al., 2024; Alam et al., 2023).

Age and obesity emerged as the most consistent predictors of metabolic syndrome across the included studies. These findings are supported by epidemiological evidence indicating that metabolic risk increases progressively with age and body mass index (BMI) in women with PCOS. Obesity exacerbates insulin resistance and hormonal imbalance, thereby amplifying metabolic disturbances (Jalilian et al., 2015; Sharma et al., 2025).

Central obesity, as reflected by increased waist circumference and waist-hip ratio, was identified as a key determinant of metabolic syndrome. This is particularly important given the role of visceral adiposity in driving insulin resistance and systemic inflammation. Previous studies have similarly emphasized the central role of abdominal obesity in the pathophysiology of PCOS-related metabolic complications (Escobar-Morreale, 2018; Karkera et al., 2023).

Dyslipidemia, particularly low high-density lipoprotein cholesterol (HDL-C), was the most frequently reported metabolic abnormality across studies. This pattern is consistent with existing literature demonstrating altered lipid metabolism in PCOS, which contributes to increased cardiovascular risk. Ethnic variations in lipid profiles have also been reported, further influencing the prevalence of specific MetS components (Ding et al., 2017; Shaman et al., 2017).

Insulin resistance was another central feature observed in women with PCOS and metabolic syndrome. Elevated insulin levels and increased HOMA-IR values were consistently associated with MetS, reinforcing the role of insulin resistance as a core pathophysiological mechanism. This aligns with evidence highlighting insulin resistance as a unifying factor linking reproductive and metabolic dysfunction in PCOS (Dokras et al., 2025).

The hormonal disturbances observed in PCOS, including elevated androgen levels, further contribute to metabolic abnormalities. Hyperandrogenism has been shown to worsen insulin resistance and promote abdominal fat accumulation, thereby increasing the risk of metabolic syndrome. These interactions underscore the complex interplay between endocrine and metabolic pathways in PCOS (Karkera et al., 2023; Escobar-Morreale, 2018).

The findings of this review also highlight the clinical implications of metabolic syndrome on reproductive outcomes. Although some studies reported non-significant differences in pregnancy rates, women with MetS required higher doses of gonadotropins and longer stimulation periods during assisted reproductive treatments. This suggests reduced ovarian responsiveness and increased treatment burden (Moini et al., 2023).

Additionally, the increased incidence of obstetric complications, particularly preeclampsia, among women with metabolic syndrome underscores the importance of metabolic health in pregnancy outcomes. These findings are consistent with broader evidence linking metabolic dysfunction to adverse maternal and fetal outcomes (Dokras et al., 2025).

The relationship between PCOS and infertility is well-established, with ovulatory dysfunction being a primary contributing factor. Studies have shown that PCOS accounts for a significant proportion of infertility cases, particularly in Middle Eastern populations. This reinforces the need to address both reproductive and metabolic aspects in clinical management (Alamri et al., 2020; Joham et al., 2015).

Geographical and ethnic variations observed across studies further emphasize the influence of environmental and genetic factors on the expression of PCOS and metabolic syndrome. Differences in lifestyle, dietary habits, and healthcare access may contribute to these variations, highlighting the need for region-specific research and interventions (Tehrani et al., 2011; Ding et al., 2017).

Despite the valuable insights provided, the predominance of cross-sectional study designs limits the ability to establish causal relationships between PCOS and metabolic syndrome. Longitudinal studies are needed to better understand the temporal progression of metabolic abnormalities and their impact on reproductive health outcomes (Deswal et al., 2020).

Overall, the findings of this review underscore the importance of early screening and comprehensive management of metabolic syndrome in women with PCOS. Integrating metabolic assessment into routine infertility evaluation may improve both reproductive and long-term health outcomes. Future research should focus on standardized diagnostic criteria and large-scale prospective studies to enhance the quality of evidence in this field (Neven et al., 2026; Salari et al., 2024).

CONCLUSION

Metabolic syndrome is a highly prevalent and clinically significant comorbidity among women with polycystic ovary syndrome, particularly in those experiencing infertility. The evidence demonstrates substantial variability in prevalence; however, the consistent association with obesity, insulin resistance, and dyslipidemia highlights the need for early identification and targeted intervention. Addressing metabolic abnormalities is essential not only for improving reproductive outcomes but also for reducing long-term cardiovascular and metabolic risks.

The integration of metabolic screening into routine clinical management of PCOS is strongly recommended. A multidisciplinary approach involving endocrinologists, gynecologists, and nutrition specialists is crucial for optimizing patient outcomes. Future research should aim to standardize diagnostic criteria and explore effective interventions to mitigate the impact of metabolic syndrome in this high-risk population.

Limitations

This systematic review has several limitations that should be considered when interpreting the findings. First, the majority of included studies were cross-sectional in design, limiting the ability to establish causal relationships between PCOS and metabolic syndrome. Second, there was significant heterogeneity in diagnostic criteria used for both PCOS and metabolic syndrome, which may have contributed to the wide variation in prevalence estimates. Third, most studies were conducted in single-center or hospital-based settings, potentially limiting the generalizability of the findings to broader populations. Additionally, some studies relied on self-reported data or lacked comprehensive metabolic assessment, which may have led to underestimation or misclassification of metabolic syndrome. Finally, the absence of meta-analysis due to methodological heterogeneity restricts the ability to provide pooled prevalence estimates.

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