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POLYCYSTIC OVARY SYNDROME (PCOS): DIAGNOSIS, PATHOPHYSIOLOGY AND CONTEMPORARY THERAPEUTIC APPROACHES

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ABSTRACT

Polycystic Ovary Syndrome (PCOS) is a common endocrine disorder impacting reproductive-aged women, manifesting through hormonal imbalances, metabolic irregularities, and reproductive health issues. It is one of the leading causes of infertility, also contributing significantly to various metabolic and psychological conditions. Effective management of PCOS depends on early and accurate diagnosis, a comprehensive understanding of it's underlying mechanisms, and the application of individualized treatment strategies.

Aim of the Study: This study seeks to consolidate existing knowledge on PCOS, outline diagnostic criteria, examine pathophysiological mechanisms, and evaluate both conventional and modern therapeutic approaches. This study aims to promote improved health outcomes and care strategies for women with PCOS by examining recent research findings.

Materials and Methods: A systematic review of scientific literature was conducted through PubMed, Google Scholar, and other databases, focusing on diagnostic advancements, insights into pathophysiology, and innovative therapeutic methods for PCOS. Only studies published from 2019 onwards were included to ensure the use of the most recent data and developments in the field.

Results: Although research has advanced, PCOS remains a complex condition with significant diagnostic and therapeutic challenges. Recent studies propose innovative diagnostic and treatment approaches that offer clinicians alternative options for cases that do not respond to standard management methods.

Conclusions: PCOS continues to present a significant challenge in women's health. Ongoing research into diagnostic techniques and treatment options enriches current guidelines, facilitates the creation of standardized protocols, and supports more timely and effective management strategies tailored to individual needs.

Keywords: Polycystic Ovary Syndrome, diagnosis, pathophysiology, treatment, infertility, women's health, metabolic dysfunction.

INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is one of the most common endocrine disorders, affecting approximately 5-10% of women of reproductive age globally [3]. PCOS is characterized by hormonal imbalances, including elevated androgen levels, menstrual irregularities, and the presence of polycystic ovaries, though the presentation can vary widely among individuals. The disorder is also associated with metabolic

complications such as insulin resistance, obesity, and an increased risk of type 2 diabetes and cardiovascular disease [12, 14]. Furthermore, PCOS is a leading cause of infertility in women, contributing to physical, emotional, and psychological burdens [5, 14]. Despite the prevalence of PCOS, its exact etiology remains unclear, involving complex interactions between genetic and environmental factors. The diagnosis and management of PCOS are further complicated by these varied presentations and comorbidities [17].

METHODS

A systematic review of scientific and medical literature was conducted using the PubMed and Google Scholar databases. The search focused on the following keywords: Polycystic Ovary Syndrome AND diagnosis AND pathophysiology AND treatment AND infertility AND women's health AND metabolic dysfunction.. Inclusion criteria included studies on PCOS diagnosis and treatment, randomized controlled trials, clinical trials, and reviews, with full-text availability in English. Only studies published from 2019 onwards were included to ensure the use of the most recent data and developments in the field. This review aims to present updated data on PCOS, covering diagnostic criteria, pathophysiological insights, and contemporary treatment options. Recent scientific findings and clinical practices directed at improving the health and quality of life of PCOS patients were analyzed.

RESULTS AND DISCUSSION

The diversity and complexity of approaches to PCOS diagnosis and management underscore the ongoing challenges clinicians face in effectively addressing this syndrome. Research into the mechanisms and varied presentations of PCOS supports the development of more accurate diagnostic criteria and personalized treatment strategies. A comprehensive understanding of risk factors, including genetic predispositions and lifestyle influences, allows clinicians to better identify high-risk patients, enabling early intervention and improved therapeutic outcomes.

DEFINITON

Polycystic Ovary Syndrome (PCOS) is recognized as one of the most prevalent endocrine disorders among women of reproductive age, characterized by a constellation of hormonal imbalances, metabolic abnormalities, and reproductive health issues [5, 17]. The evolution of diagnostic criteria over the years has led to the establishment of three primary frameworks - each emphasizing different aspects of the syndrome [25, 33] - **NIH Criteria (1990), Rotterdam Criteria (2003), AE-PCOS Society Criteria (2006).**

These diagnostic frameworks underscore the heterogeneity and complexity of PCOS. Consequently, individual assessment is essential, as many women meet some—but not all—criteria, reflecting the syndrome's broad clinical spectrum [8, 13]. **These criteria will be presented in the later stages of the study.**

EPIDEMIOLOGY

PCOS affects an estimated 5–10% of women globally, with prevalence varying considerably depending on the criteria used. [6, 13] Studies indicate that prevalence estimates are generally higher when using the Rotterdam criteria, as they cover a wider spectrum of phenotypes by including PCOM as a diagnostic marker. [13, 36] The condition's prevalence is shaped by genetic, environmental, and lifestyle factors, contributing to regional variations. [15, 26]

IMPACT OF PCOS ON QUALITY OF LIFE AND LONG-TERM HEALTH

PCOS significantly impacts the quality of life for affected women, influencing physical, emotional, and psychological well-being. Common symptoms, including hirsutism, acne, and menstrual irregularities, often contribute to decreased self-esteem, body image issues, and social withdrawal. [1, 5] Additionally, PCOS is associated with heightened risks for several long-term health conditions:

Metabolic and Cardiovascular Health: Women with PCOS face an increased likelihood of developing metabolic syndrome, type 2 diabetes, and cardiovascular diseases. These risks persist across the lifespan, underscoring the need for early diagnosis and ongoing monitoring to manage metabolic health and prevent complications. [19, 20]

Mental Health: Studies reveal a higher incidence of mood disorders, particularly anxiety and depression, among women with PCOS. The chronic nature of the syndrome, along with visible symptoms like hirsutism and acne, contributes to psychological distress. Additionally, PCOS-related fertility challenges further exacerbate mental health concerns, highlighting the need for a multidisciplinary approach that includes mental health support. [1]

Reproductive Health and Cancer Risk: Long-term anovulation associated with PCOS elevates the risk of

endometrial hyperplasia, which can progress to endometrial cancer if left unmanaged. This risk underlines the importance of timely diagnosis, regular gynecological evaluations, and intervention strategies to prevent malignant transformation in high-risk individuals. [16, 29]

PCOS is thus a multifaceted health condition with implications that extend beyond reproductive health. It necessitates a comprehensive, individualized approach to diagnosis, continuous monitoring, and management that addresses both immediate symptoms and long-term health risks. [8, 28]

PATHOPHYSIOLOGY OF PCOS

HORMONAL MECHANISMS

Polycystic Ovary Syndrome (PCOS) is driven by a multifactorial hormonal dysregulation that disrupts the hypothalamic-pituitary-ovarian (HPO) axis, resulting in elevated androgen levels, insulin resistance, and altered gonadotropin release. [30, 35] Hyperandrogenism, characterized by excess levels of testosterone and other androgens, is a defining feature of PCOS and is exacerbated by an imbalance in luteinizing hormone (LH) and follicle-stimulating hormone (FSH). [35] This hormonal imbalance stimulates ovarian theca cells to increase androgen production, restricting normal follicular maturation and frequently leading to the development of multiple ovarian cysts, a characteristic sign of PCOS. [15]

Excess LH promotes androgen synthesis in the ovaries, while a concurrent deficiency in FSH inhibits the maturation of follicles, resulting in chronic anovulation. [11] Additionally, elevated levels of anti-Müllerian hormone (AMH), secreted by small antral follicles, contribute to reduced follicular responsiveness to FSH, thereby maitaining anovulatory cycles and enhancing the cycle of hyperandrogenism and impaired folliculogenesis. Elevated AMH levels, while often observed in PCOS, also underscore the multifaceted nature of hormonal dysregulation in this syndrome. [30]

INSULIN RESISTANCE AND METABOLIC DISORDERS

Insulin resistance (IR) is a significant feature in approximately 50–70% of PCOS cases, independent of body weight, leading to compensatory hyperinsulinemia. Elevated insulin levels further exacerbate androgen production by ovarian theca cells and decrease hepatic production of sex hormone-binding globulin (SHBG), thereby increasing levels of free testosterone. This exacerbates hyperandrogenic symptoms and increases the risk for type 2 diabetes mellitus and cardiovascular complications. [23, 30]

Metabolically, PCOS is associated with dyslipidemia, marked by elevated levels of low-density lipoprotein (LDL) and triglycerides, alongside reduced high-density lipoprotein (HDL) cholesterol. [14, 29] Central obesity and chronic low-grade inflammation frequently observed in PCOS patients create a pro-inflammatory state, which, in turn, supports both androgen excess and insulin resistance, establishing a self-reinforcing cycle of endocrine and metabolic dysregulation. This interplay of metabolic disturbances highlights the need for comprehensive metabolic monitoring in PCOS management. [29, 31]

GENETIC AND EPIGENETIC THEORIES

Genetic predisposition, coupled with epigenetic modifications, are emerging as important contributors to the pathogenesis of PCOS. Numerous genes involved in androgen synthesis, insulin signaling, and HPO axis regulation have been implicated in PCOS. [12] Epigenetic changes, often modulated by environmental factors such as diet, stress, and prenatal androgen exposure, influence gene expression, contributing to the phenotypic diversity seen in PCOS. [12] This intricate interaction between genetic susceptibility and environmental triggers underscores the heterogeneous nature of PCOS and supports ongoing research into targeted and personalized therapeutic strategies. [24]

CLINICAL SYMPTOMS OF PCOS

HORMONAL SYMPTOMS

The hormonal imbalances characteristic of PCOS result in a spectrum of symptoms primarily impacting reproductive health. Chronic anovulation often manifests as irregular menstrual cycles, with many patients experiencing oligomenorrhea or amenorrhea. [25, 28] Hyperandrogenism contributes to symptoms such as hirsutism (excessive hair growth on areas such as the face, chest, and back), acne, and androgenic alopecia (hair thinning on the scalp), all of which can significantly affect quality of life and psychological well-being. [25, 35] The interplay between elevated androgen levels and chronic anovulation increases the risk of endometrial hyperplasia, and, over time, may elevate the risk of endometrial carcinoma due to prolonged estrogen exposure without progesterone opposition, especially in women with prolonged anovulatory cycles. [16, 21]

METABOLIC SYMPTOMS

PCOS presents substantial metabolic challenges, particularly insulin resistance, which exacerbates hyperinsulinemia and contributes to abdominal obesity frequently observed in PCOS patients. This central adiposity intensifies insulin resistance, raising the risk of type 2 diabetes and cardiovascular diseases. [7, 14] Dyslipidemia, often seen in PCOS patients, is characterized by high LDL and low HDL cholesterol levels, further compounding cardiovascular risk. These metabolic irregularities necessitate vigilant monitoring to address long-term health implications effectively. [11, 29]

PSYCHOLOGICAL SYMPTOMS

The impact of PCOS extends beyond physical symptoms to include significant psychological challenges. The visible manifestations of hyperandrogenism, such as hirsutism, acne, and alopecia, can negatively influence body image and self-esteem. The chronic and unpredictable nature of PCOS symptoms is linked to higher rates of mood disorders, including depression and anxiety. The psychological burden is compounded by fertility-related concerns and the metabolic complications associated with the syndrome, underscoring the importance of including mental health support in the comprehensive management of PCOS patients. [1, 9, 26] Addressing these psychological aspects through counseling and support groups can enhance quality of life and improve outcomes for those living with PCOS. [1, 9]

DIAGNOSIS OF PCOS

Diagnosis of Polycystic Ovary Syndrome (PCOS) relies on three primary sets of diagnostic criteria, each with a different emphasis on symptoms and diagnostic markers:

NIH Criteria (1990): Defined by the National Institutes of Health (NIH), these criteria require the presence of both oligo-anovulation (irregular or absent ovulation) and hyperandrogenism (clinical or biochemical signs of androgen excess, such as hirsutism or elevated testosterone levels). The NIH criteria exclude other potential causes of hyperandrogenism, such as thyroid dysfunction or hyperprolactinemia, but do not consider polycystic ovarian morphology (PCOM) as a diagnostic requirement. This set of criteria is relatively stringent, focusing on reproductive and hormonal symptoms. [8, 33]

Rotterdam Criteria (2003): Accepted by the European Society for Human Reproduction and Embryology (ESHRE) and the American Society for Reproductive Medicine (ASRM), these criteria are broader in scope. To diagnose PCOS, the Rotterdam criteria require the presence of at least two out of three features: hyperandrogenism, oligo-anovulation, or polycystic ovaries observed on ultrasound imaging (≥12 follicles per ovary or an ovarian volume >10 mL). This approach allows for the identification of four phenotypes, meaning that patients with various combinations of symptoms may still meet the criteria for a PCOS diagnosis. [17, 25]

AE-PCOS Criteria (2006): Developed by the Androgen Excess and PCOS Society, these criteria emphasize androgen excess by requiring hyperandrogenism alongside either oligo-anovulation or polycystic ovarian morphology. The AE-PCOS criteria narrow the diagnostic scope by focusing more specifically on androgen-related features and exclude some of the metabolic aspects that are more prominent in the Rotterdam criteria. [25, 30]

Table 1. "Comparison of Diagnostic Criteria for Polycystic Ovary Syndrome (PCOS): NIH, Rotterdam, and AE-PCOS"

	NIH Criteria (1990)	Rotterdam Criteria (2003)	AE-PCOS Criteria (2006)
Key Diagnostic Requirements	Requires both: 1) Oligo-anovulation (irregular or absent ovulation) AND 2) Hyperandrogenism (clinical or biochemical signs, e.g., hirsutism or elevated testosterone levels). Excludes polycystic ovarian morphology	Any two of three features required: 1) Hyperandrogenism, 2) Oligo-anovulation, 3) Polycystic ovarian morphology (≥12 follicles per ovary or ovarian volume >10 mL) on ultrasound. Allows diagnosis across four phenotypes based	Requires: 1) Hyperandrogenism, COMBINED WITH EITHER 2) Oligo-anovulation OR 3) Polycystic ovarian morphology. Focuses on androgen excess as a defining feature, excluding broader metabolic features recognized in the Rotterdam criteria.

	(PCOM) and other potential causes of hyperandrogenism, such as thyroid dysfunction or hyperprolactinemia.	on varied symptom presentations.	
Symptoms Emphasized	Focuses strictly on oligo-anovulation and hyperandrogenism (e.g., hirsutism, elevated testosterone) without considering PCOM or metabolic factors.	Recognizes a broader set of symptoms: androgen excess, ovulatory dysfunction, and polycystic ovarian appearance on ultrasound imaging. Allows for combinations that present diverse PCOS phenotypes.	Prioritizes androgen-related symptoms in conjunction with either ovulatory issues or PCOM, reducing focus on metabolic symptoms.
Imaging Requirements	Imaging for polycystic ovarian morphology not required.	Ultrasound imaging to confirm polycystic ovaries (≥12 follicles per ovary or ovarian volume >10 mL) is one of the three diagnostic features, but not mandatory if other symptoms are present.	Includes polycystic ovarian morphology as an option, with emphasis placed on the presence of hyperandrogenism rather than imaging alone.
Metabolic Considerations	No consideration of metabolic symptoms or complications (e.g., insulin resistance) within the diagnostic framework.	Incorporates metabolic aspects to a limited degree, allowing for recognition of varied PCOS phenotypes influenced by metabolic presentations.	Minimally considers metabolic features; focuses more narrowly on androgen-related diagnostic elements over metabolic factors.
Diagnostic Flexibility	Least flexible; strictly requires both oligo-anovulation and hyperandrogenism.	Most flexible; diagnosis achieved with any two of the three features, permitting phenotypic diversity and accommodating broader diagnostic variations.	Moderately flexible; mandates hyperandrogenism with additional requirement of either ovulatory dysfunction or PCOM.
Primary Clinical Focus	Reproductive and hormonal symptoms (irregular ovulation and elevated androgen levels).	Broader clinical perspective encompassing reproductive, metabolic, and phenotypic diversity in PCOS symptoms.	Narrow focus on androgen-related symptoms with selective inclusion of reproductive features.

ULTRASOUND IMAGING:

The preferred imaging modality for assessing polycystic ovarian morphology (PCOM). The diagnostic criteria include either the presence of 12 or more follicles per ovary or an ovarian volume greater than 10 mL. While

PCOM is a key feature, it is not exclusive to PCOS and appears in a subset of women without PCOS, suggesting it should be used alongside other diagnostic indicators. [17, 22]

LABORATORY TESTS:

Androgen Levels: Quantifying androgens, particularly testosterone, is essential for evaluating hyperandrogenism, a hallmark of PCOS. Free testosterone is generally preferred for its more accurate representation of bioactive androgen. [17, 25]

LH and FSH: An elevated LH/FSH ratio is often seen in PCOS but is not definitive and varies among patients. An increased LH level in relation to FSH may contribute to the diagnosis, but it cannot independently confirm it. [27, 35]

Glucose and Insulin Levels: Assessments of fasting glucose and insulin are recommended to identify insulin resistance, which is prevalent in PCOS and contributes to its metabolic phenotype. [11,30]

Screening Tests:

Additional assessments, such as the oral glucose tolerance test (OGTT), are advised to evaluate type 2 diabetes risk, particularly in women with known insulin resistance. [29] Lipid profiling and blood pressure monitoring should be performed routinely, as these women are at increased risk of cardiovascular complications. [14, 32]

THERAPEUTIC APPROACHES TO PCOS

PHARMACOTHERAPY

Hormonal Therapy: Combined oral contraceptives (COCs) are a cornerstone of PCOS management, especially for women who do not wish to conceive. COCs suppress LH secretion, reduce ovarian androgen production, and increase SHBG levels, thereby lowering free testosterone and controlling hyperandrogenic symptoms such as hirsutism and acne. COCs also help mitigate endometrial hyperplasia by regulating the menstrual cycle. [8]

Metformin: This insulin-sensitizing agent is commonly used in adressing insulin resistance in PCOS. By enhancing peripheral insulin sensitivity, metformin assists in lowering insulin and androgen levels, improving menstrual regularity and ovulatory function. [11, 30]

Antiandrogens: Spironolactone, a frequently prescribed antiandrogen, works by blocking androgen receptors and reducing androgen synthesis. It is particularly effective for treating hirsutism and acne but is typically combined with COCs in women of reproductive age to prevent teratogenic effects on male fetuses. [4]

Insulin Sensitizers Beyond Metformin: Thiazolidinediones (TZDs), another class of insulin sensitizers, can be used in women with PCOS who are intolerant to metformin. Though effective, their use is limited by concerns surrounding weight gain and hepatotoxicity. [8, 11]

NON-PHARMACOLOGIC THERAPIES

Lifestyle Modification: Lifestyle interventions are essential for managing PCOS, emphasizing weight management through diet and exercise. Even modest weight loss has been shown to restore ovulation and alleviate symptoms. [9, 18]

Cognitive Behavioral Therapy (CBT): Given the high incidence of anxiety, depression, and body image issues in women with PCOS, CBT offers an effective tool for managing psychological distress associated with this condition. [9]

ALTERNATIVE AND COMPLEMENTARY THERAPIES

Acupuncture: Emerging evidence suggests acupuncture may improve ovulatory function and reduce stress in women with PCOS. [9, 10]

Herbal and Dietary Supplements: Inositol, especially in its myo-inositol form, is increasingly used as a dietary supplement to improve insulin sensitivity and support ovarian function. [4, 6]

INNOVATIVE APPROACHES AND FUTURE RESEARCH DIRECTIONS IN PCOS

NEW BIOMARKERS

Developing new biomarkers is essential to improve the accuracy of PCOS diagnosis, assess symptom severity, and enhance risk stratification. Among the most promising biomarkers is Anti-Müllerian Hormone (AMH), which reflects the antral follicle count, functioning as an indicator of ovarian reserve. Elevated AMH levels are typically observed in PCOS patients due to the increased follicle pool; however, its application as a sole diagnostic marker is still debated. Although high AMH levels can support PCOS diagnosis, especially in younger women, there is significant overlap in AMH levels between PCOS and non-PCOS populations, necessitating further validation studies for its diagnostic utility. [16, 25, 32]

In addition to AMH, microRNAs (miRNAs) represent a promising category of biomarkers. miRNAs are small, non-coding RNA molecules involved in gene regulation. Distinct miRNA expression profiles have been identified in women with PCOS, with certain miRNAs associated specifically with insulin resistance and hyperandrogenism—two hallmark features of the syndrome. [34] These miRNAs hold potential not only as diagnostic markers but also as therapeutic targets, providing a foundation for more personalized treatment approaches in PCOS. Although research into miRNAs is still developing, their role in regulating pathways related to PCOS suggests they could enhance individualized care for patients. [38]

ADVANCED DIAGNOSTIC TECHNOLOGIES

Advances in diagnostic imaging have significantly improved the detection and characterization of polycystic ovarian morphology (PCOM), a common feature in PCOS. High-resolution transvaginal ultrasound, facilitated by modern high-frequency transducers, allows for more precise follicle counts and accurate measurement of ovarian volume. This improved imaging capability is particularly beneficial for younger patients who may display with subtler symptoms, enabling early diagnosis. [22, 25] Additionally, machine learning-driven tools and automated image analysis are emerging to reduce inter-observer variability, which historically complicates PCOS diagnosis. These systems, driven by automation, improve diagnostic consistency and efficiency by combining ultrasound data with clinical indicators. [2, 22].

In parallel, genetic and epigenetic profiling are emerging as future diagnostic tools for PCOS. Genome-wide association studies (GWAS) have identified several genetic loci associated with pathways involved in androgen synthesis, insulin signaling, and neuroendocrine function—all integral to PCOS pathophysiology. [8, 12] Furthermore, research on epigenetic modifications reveals how environmental factors, including diet and stress, can lead to changes in gene expression, potentially influencing PCOS onset and severity. Advancements in genetics and epigenetics pave the way for personalized medicine in PCOS, enabling customized diagnostic and therapeutic approaches. [8, 38].

FUTURE THERAPEUTIC DIRECTIONS

Research is currently exploring new therapeutic approaches that address the specific pathophysiological pathways implicated in PCOS. For instance, novel insulin-sensitizing agents beyond metformin are being investigated for their potential to reduce insulin resistance and improve ovulatory function. These agents could provide more targeted metabolic management, especially in women with severe insulin resistance. [4, 8] Additionally, selective androgen receptor modulators (SARMs) offer a promising alternative to traditional antiandrogens like spironolactone. SARMs aim to alleviate symptoms of hyperandrogenism without the metabolic side effects associated with older medications, potentially offering a safer long-term treatment option for managing androgen excess. [4, 5]

Another emerging area of interest in PCOS treatment is anti-inflammatory therapy. Given the chronic low-grade inflammation observed in PCOS, certain anti-inflammatory agents, including omega-3 fatty acids and antioxidants, are being studied for their ability to mitigate inflammation and improve insulin sensitivity. Early studies suggest that these compounds might have a beneficial impact on PCOS symptoms, though larger clinical trials are needed to validate these findings. [9, 29] Additionally, herbal supplements such as myo-inositol (MYO) or D-chiro-inositol (DCI) have shown promise in enhancing insulin sensitivity and reducing androgen levels. However, more rigorous trials are essential to establish standardized guidelines for their use in clinical practice. [4, 31]

IMPORTANCE OF EDUCATION AND PREVENTION IN PCOS

ROLE OF PATIENT EDUCATION

Educating patients is essential for empowering women with PCOS to take an active role in managing their health. Research shows that many patients with PCOS lack comprehensive understanding of their condition, often relying on varied online resources that can differ in quality and reliability. Structured education programs should encompass a broad overview of PCOS, including symptoms, diagnostic criteria, treatment options, and lifestyle recommendations. Educated patients are more likely to adhere to lifestyle changes. [32, 33]

In addition, education should emphasize the long-term health risks associated with PCOS, such as the

increased likelihood of developing type 2 diabetes, cardiovascular disease, and endometrial cancer. By understanding these risks, patients are better prepared to prioritize regular health screenings and preventive measures. [17, 37] Support groups and counseling are vital for addressing the psychological impact of PCOS, including challenges like depression, anxiety, and body image concerns. Psychological therapy, particularly when adapted to individual needs and cultural contexts, offers essential support for mental health issues commonly associated with PCOS. Support groups create a community where women can share experiences, reduce isolation, and improve treatment adherence.

Group activities, such as exercise, provide both physical benefits and social support, fostering accountability and emotional resilience. These settings equip women with coping strategies to manage PCOS, ultimately enhancing both mental and physical well-being. [1, 32]

PREVENTION OF COMPLICATIONS

Preventive care is essential for reducing the risk of long-term complications in PCOS. Regular screening for type 2 diabetes through oral glucose tolerance tests (OGTT) and lipid profiling is recommended every two years, especially for women with concurrent insulin resistance or obesity. Monitoring blood pressure and evaluating cardiovascular risk factors, like dyslipidemia, are recommended due to the increased risk of cardiovascular disease in this population. [14, 32]

Additionally, the risk of endometrial hyperplasia and cancer is elevated in this population due to prolonged estrogen exposure from anovulatory cycles, routine endometrial screening is generally not recommended. Instead, screening should be considered in women who present additional risk factors, such as untreated prolonged amenorrhea, obesity, or type 2 diabetes. Monitoring these factors and addressing irregular menstrual patterns are key strategies in reducing the risk of endometrial complications, helping to ensure proactive and individualized preventive care. [17, 32]

Lifestyle interventions form the cornerstone of preventive care in PCOS. A diet with a low glycemic index, regular physical activity, and weight management are key strategies in mitigating insulin resistance and preventing obesity-related complications. Healthcare providers should work closely with patients to implement sustainable lifestyle changes tailored to individual needs, which can improve both metabolic and reproductive outcomes and significantly enhance quality of life. [9, 32]

CONCLUSIONS AND SUMMARY

SUMMARY OF KEY FINDINGS

This review underscores the multifaceted nature of PCOS, a syndrome with reproductive, metabolic, and psychological dimensions. Accurate diagnosis remains essential for effective care, relying on established criteria such as NIH, Rotterdam, and AE-PCOS. Each set of criteria addresses different phenotypic presentations of the syndrome, allowing healthcare providers to take a more personalized approach to diagnosis and treatment. By recognizing the diversity of symptoms and phenotypes within PCOS, practitioners can offer tailored care to better meet the needs of each patient.

EMPHASIS ON EARLY DIAGNOSIS AND PERSONALIZED TREATMENT

Early diagnosis is essential for effectively managing PCOS, as it enables timely interventions that may prevent the onset of severe complications in later life. Personalized treatment plans are crucial, incorporating a combination of hormonal therapies, insulin sensitizers, lifestyle interventions, and psychological support. Individualized care not only addresses physical health but also enhances quality of life by addressing the mental health challenges frequently associated with PCOS.

NEED FOR FURTHER RESEARCH

As the understanding of PCOS evolves, further research into the syndrome's underlying mechanisms, particularly genetic and epigenetic influences, is essential. Advances in molecular biology may lead to the discovery of novel therapeutic targets and biomarkers, thereby improving diagnostic precision and expanding treatment options. Additionally, clinical trials focusing on emerging therapies, such as SARMs and inositol supplements, are needed to validate these novel approaches and integrate them into the therapeutic landscape for PCOS, offering patients a wider range of effective management strategies.

AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST

Authors have declared no conflict of interests.

REFERENCES:

1. Adebisi, O. D., Denwigwe-Aggrey, B. C., Tairu, A. B., Ozoemena, N., David, J. F., & Monday, E. O. (2021). The effect of polycystic ovarian syndrome on the mental health of women of reproductive age. *International Journal of Research in Medical Sciences, 9*(6), 1741. https://doi.org/10.18203/2320-6012.ijrms20212245
2. Alamoudi, A., Khan, I. U., Aslam, N., Alqahtani, N., Alsaif, H. S., Al Dandan, O., Al Gadeeb, M., & Al Bahrani, R. (2023). A deep learning fusion approach to diagnose the polycystic ovary syndrome (PCOS). In R. Ejbali (Ed.), *Applied Computational Intelligence and Soft Computing*, 2023, 1–15. https://doi.org/10.1155/2023/9686697
3. Anjum, S., Askari, S., Riaz, M., & Basit, A. (2020). Clinical presentation and frequency of metabolic syndrome in women with polycystic ovary syndrome: An experience from a tertiary care hospital in Pakistan. *Cureus*. https://doi.org/10.7759/cureus.11860
4. Armanini, D., Boscaro, M., Bordin, L., & Sabbadin, C. (2022). Controversies in the pathogenesis, diagnosis and treatment of PCOS: Focus on insulin resistance, inflammation, and hyperandrogenism. *International Journal of Molecular Sciences, 23*(8), 4110. https://doi.org/10.3390/ijms23084110
5. Aversa, A., La Vignera, S., Rago, R., Gambineri, A., Nappi, R. E., Calogero, A. E., & Ferlin, A. (2020). Fundamental concepts and novel aspects of polycystic ovarian syndrome: Expert consensus resolutions. *Frontiers in Endocrinology, 11*, 516. https://doi.org/10.3389/fendo.2020.00516
6. Briden, L. (2022). Beyond the label: A patient-centered approach to polycystic ovary syndrome. *CAND Journal, 29*(2), 2–8. https://doi.org/10.54434/candj.114
7. Çelik, Ö., & Köse, M. F. (2021). An overview of polycystic ovary syndrome in aging women. *Journal of the Turkish-German Gynecological Association, 22*(4), 326–333. https://doi.org/10.4274/jtgga.galenos.2021.2021.0077
8. Chang, K. J., Chen, J. H., & Chen, K. H. (2024). The pathophysiological mechanism and clinical treatment of polycystic ovary syndrome: A molecular and cellular review of the literature. *International Journal of Molecular Sciences, 25*(16), 9037. https://doi.org/10.3390/ijms25169037
9. Cowan, S., Lim, S., Alycia, C., Pirotta, S., Thomson, R., Gibson-Helm, M., Blackmore, R., et al. (2023). Lifestyle management in polycystic ovary syndrome – beyond diet and physical activity. *BMC Endocrine Disorders, 23*(1), 14. https://doi.org/10.1186/s12902-022-01208-y
10. Cunha, A., & Póvoa, A. M. (2021). Infertility management in women with polycystic ovary syndrome: A review. *Porto Biomedical Journal, 6*(1), e116. https://doi.org/10.1097/j.pbj.0000000000000116
11. Ding, H., Zhang, J., Zhang, F., Zhang, S., Chen, X., Liang, W., & Xie, Q. (2021). Resistance to insulin and elevated level of androgen: A major cause of polycystic ovary syndrome. *Frontiers in Endocrinology, 12*, 741764. https://doi.org/10.3389/fendo.2021.741764
12. Dong, J., & Rees, D. A. (2023). Polycystic ovary syndrome: Pathophysiology and therapeutic opportunities. *BMJ Medicine, 2*(1), e000548. https://doi.org/10.1136/bmjmed-2023-000548
13. Ganie, M. A., Rashid, A., Sahu, D., Nisar, S., Wani, I. A., & Khan, J. (2020). Prevalence of polycystic ovary syndrome (PCOS) among reproductive age women from Kashmir Valley: A cross-sectional study. *International Journal of Gynecology & Obstetrics, 149*(2), 231–236. https://doi.org/10.1002/ijgo.13125
14. Guan, C., Zahid, S., Minhas, A. S., Ouyang, P., Vaught, A., Baker, V. L., & Michos, E. D. (2022). Polycystic ovary syndrome: A "risk-enhancing" factor for cardiovascular disease. *Fertility and Sterility, 117*(5), 924–935. https://doi.org/10.1016/j.fertnstert.2022.03.009
15. Harada, M. (2022). Pathophysiology of polycystic ovary syndrome revisited: Current understanding

and perspectives regarding future research. *Reproductive Medicine and Biology, 21*(1), e12487. https://doi.org/10.1002/rmb2.12487

16. Hoeger, K. M., Dokras, A., & Piltonen, T. (2021). Update on PCOS: Consequences, challenges, and guiding treatment. *The Journal of Clinical Endocrinology & Metabolism, 106*(3), e1071–e1083. https://doi.org/10.1210/clinem/dgaa839
17. Islam, H., Masud, J., Islam, Y. N., & Haque, F. K. M. (2022). An update on polycystic ovary syndrome: A review of the current state of knowledge in diagnosis, genetic etiology, and emerging treatment options. *Women's Health, 18*, 17455057221117966. https://doi.org/10.1177/17455057221117966
18. Kim, C. H., Chon, S. J., & Lee, S. H. (2020). Effects of lifestyle modification in polycystic ovary syndrome compared to metformin only or metformin addition: A systematic review and meta-analysis. *Scientific Reports, 10*(1), 7802. https://doi.org/10.1038/s41598-020-64776-w
19. Louwers, Y. V., & Laven, J. S. E. (2020). Characteristics of polycystic ovary syndrome throughout life. *Therapeutic Advances in Reproductive Health, 14*, 2633494120911038. https://doi.org/10.1177/2633494120911038
20. Macut, D., Mladenović, V., Bjekić-Macut, J., Livadas, S., Stanojlović, O., Hrnčić, D., Rašić-Marković, A., Vojnović Milutinović, D., & Andrić, Z. (2020). Hypertension in polycystic ovary syndrome: Novel insights. *Current Hypertension Reviews, 16*(1), 55–60. https://doi.org/10.2174/1573402115666190531071422
21. Morang, D., Chasta, P., & Chandrul, K. K. (2019). A review on "polycystic ovary syndrome PCOS". *International Journal of Trend in Scientific Research and Development, 3*(4), 60–66. https://doi.org/10.31142/ijtsrd23542
22. Pea, J., Bryan, J., Wan, C., Oldfield, A. L., Ganga, K., Carter, F. E., Johnson, L. M., & Lujan, M. E. (2024). Ultrasonographic criteria in the diagnosis of polycystic ovary syndrome: A systematic review and diagnostic meta-analysis. *Human Reproduction Update, 30*(1), 109–130. https://doi.org/10.1093/humupd/dmad027
23. Qu, X., & Donnelly, R. (2020). Sex hormone-binding globulin (SHBG) as an early biomarker and therapeutic target in polycystic ovary syndrome. *International Journal of Molecular Sciences, 21*(21), 8191. https://doi.org/10.3390/ijms21218191
24. Rababa'h, A. M., Matani, B. R., & Yehya, A. (2022). An update of polycystic ovary syndrome: Causes and therapeutic options. *Heliyon, 8*(10), e11010. https://doi.org/10.1016/j.heliyon.2022.e11010
25. Rao, P., & Bhide, P. (2020). Controversies in the diagnosis of polycystic ovary syndrome. *Therapeutic Advances in Reproductive Health, 14*, 2633494120913032. https://doi.org/10.1177/2633494120913032
26. *Recent approaches in the treatment of polycystic ovary syndrome: An update*. (2022). *Archives of Women Health and Care, 5*(1). https://doi.org/10.31038/AWHC.2022514
27. Saadia, Z. (2020). Follicle stimulating hormone (LH: FSH) ratio in polycystic ovary syndrome (PCOS) - obese vs. non-obese women. *Medical Archives, 74*(4), 289–293. https://doi.org/10.5455/medarh.2020.74.289-293
28. Saei Ghare Naz, M., Rostami Dovom, M., & Ramezani Tehrani, F. (2020). The menstrual disturbances in endocrine disorders: A narrative review. *International Journal of Endocrinology and Metabolism, 18*(4). https://doi.org/10.5812/ijem.106694
29. Shermin, S., Noor, A., & Jahan, S. (2020). Polycystic ovary syndrome: A brief review with recent updates. *Delta Medical College Journal, 7*(2), 84–99. https://doi.org/10.3329/dmcj.v7i2.45567
30. Siddiqui, S., Mateen, S., Ahmad, R., & Moin, S. (2022). A brief insight into the etiology, genetics, and immunology of polycystic ovarian syndrome (PCOS). *Journal of Assisted Reproduction and Genetics, 39*(11), 2439–2473. https://doi.org/10.1007/s10815-022-02625-7
31. Szczuko, M., Kikut, J., Szczuko, U., Szydłowska, I., Nawrocka-Rutkowska, J., Ziętek, M., Verbanac, D., & Saso, L. (2021). Nutrition strategy and lifestyle in polycystic ovary syndrome—Narrative review. *Nutrients, 13*(7), 2452. https://doi.org/10.3390/nu13072452
32. Teede, H. J. (2023). Recommendations from the 2023 international evidence-based guideline for the assessment and management of polycystic ovary syndrome.
33. Tremblay-Davis, A. C., Holley, S. L., & Downes, L. A. (2021). Diagnosis and treatment of polycystic ovary syndrome in primary care. *The Journal for Nurse Practitioners, 17*(10), 1226–1229. https://doi.org/10.1016/j.nurpra.2021.08.008
34. Tsai, Y.-R., Liao, Y.-N., & Kang, H.-Y. (2023). Current advances in cellular approaches for pathophysiology and treatment of polycystic ovary syndrome. *Cells, 12*(17), 2189. https://doi.org/10.3390/cells12172189
35. Waghmare, S. V., & Shanoo, A. (2023). Polycystic ovary syndrome: A literature review with a focus on diagnosis, pathophysiology, and management. *Cureus*. https://doi.org/10.7759/cureus.47408

36. Yang, R., Li, Q., Zhou, Z., Qian, W., Zhang, J., Wu, Z., Jin, L., et al. (2022). Changes in the prevalence of polycystic ovary syndrome in China over the past decade. *The Lancet Regional Health - Western Pacific, 25*, 100494. https://doi.org/10.1016/j.lanwpc.2022.100494
37. Yasmin, A., Roychoudhury, S., Choudhury, A. P., Ahmed, A. B. F., Dutta, S., Mottola, F., Verma, V., et al. (2022). Polycystic ovary syndrome: An updated overview foregrounding impacts of ethnicities and geographic variations. *Life, 12*(12), 1974. https://doi.org/10.3390/life12121974
38. Zhao, H., Zhang, J., Cheng, X., Nie, X., & He, B. (2023). Insulin resistance in polycystic ovary syndrome across various tissues: An updated review of pathogenesis, evaluation, and treatment. *Journal of Ovarian Research, 16*(1), 9. https://doi.org/10.1186/s13048-022-01091-0

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