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Exploring female infertility: A comprehensive review of polycystic ovary syndrome (PCOS) and its impact on reproductive health

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Highlights

- PCOS affects 6–10% of reproductive-age women, impacting fertility through hormonal imbalances.
- Key hormonal issues include low FSH, high LH, and elevated androgens leading to ovulation problems.
- Metabolic complications like insulin resistance and obesity significantly affect reproductive health.
- Treatment strategies encompass pharmacological options and lifestyle changes to improve outcomes.
- The psychosocial impacts of PCOS include mental health challenges and decreased quality of life.

Abstract

Polycystic ovary syndrome (PCOS), a complicated endocrine disorder that causes female infertility, affects 6–10% of reproductive-age women. Although it is necessary to intricate the relationship

between PCOS and reproductive health to illuminate how it affects female fertility. Pathophysiology describing that how the hormonal imbalances cause ovarian cyst formation following clinical issues in ovulation. These imbalances include low FSH, high LH, and high androgens as well as increased AMH, all of which disrupt normal follicular development and ovulation. PCOS related metabolic problems such insulin resistance, obesity, and dyslipidaemia have been carefully investigated for reproductive health implications along with the pharmacological aspects. The effects of oral contraceptives, anti-androgens (such as spironolactone), and insulin-sensitizing drugs (such as metformin) on ovulation and fertility have been reviewed. This article examines the use of the Rotterdam criteria and imaging techniques such as transvaginal ultrasound for diagnosing PCOS, while also exploring comprehensive management strategies including pharmacological treatments, alternative medicine approach and lifestyle modifications like diet and exercise to improve metabolic and reproductive outcomes. Besides those explorations of emerging treatments and early-stage studies for PCOS, including the potential of supplementary therapies like myo-inositol and lifestyle modifications tailored to individual metabolic profiles. It also highlights the latest studies on the factors contributing to PCOS and their implications for personalized treatment approaches. Emphasizing the importance of a holistic management plan, the article addresses both physical and emotional well-being, including the psychosocial impact of PCOS on mental health and overall quality of life.

Introduction

Polycystic ovary syndrome (PCOS) is a common hormonal condition in reproductive-age women worldwide (Deans, 2019). PCOS, also known as hyperandrogenic anovulation or Stein-Leventhal syndrome, is an endocrine condition that disproportionately affects reproductive-aged women. Hyperandrogenism, insulin resistance, enlarged and dysfunctional ovaries, and other symptoms are prevalent (Witchel et al., 2019a). One in ten women will have PCOS and related issues before menopause (Singh et al., 2023). The WHO estimated 116 million women (3.4%) PCOS in 2012. PCOS's high incidence, irregular menstruation and ovulation, infertility, hair loss, and metabolic issues make it a costly condition. PCOS is characterised by luteinizing hormone (LH) to follicle-stimulating hormone (FSH) ratios and increased GnRH frequency (Bednarska and Siejka, 2017), but its aetiology and pathophysiology remain unknown (Bednarska and Siejka, 2017; Ganie et al., 2019). Hyperandrogenism (HA), insulin resistance (IR), genes, environmental variables, and epigenetics have been connected to this disorder. PCOS increases the risk of cardiovascular disease, type 2 diabetes, metabolic syndrome, depression, and anxiety (Ganie et al., 2019; Kumar et al., 2016). Every woman with PCOS should eat a low-calorie, sugar-free diet, exercise consistently, and lose at least 5% of their body weight (Damone et al., 2019).

Women's reproductive health includes much more than simply biological processes—it is tied to a woman's emotional, psychological, and social health. Women's reproductive health encompasses all stages in a woman's reproductive life from their first menstrual cycle, through all stages of fertility, pregnancy and motherhood. Caring for a woman's body, understanding her cycles, facilitating her ability to conceive, and ensuring both her health and that of her child, are very important components of women's reproductive health. Supporting women's reproductive health means to respect the physiological changes, emotional struggles, and life transitions that women experience

from puberty to adulthood, with care, information, and dignity. Endometriosis, PCOS, fibroids, hormone abnormalities, and malignancies afflict women due to endocrine toxicant exposure (Escobar-Morreale, 2018). A common endocrine illness, PCOS is often misdiagnosed. Infertility as well as associated clinical and metabolic issues increase healthcare costs due to its 5%–25% incidence. PCOS is one of the most common endocrinopathies, although its causes and treatment are still unknown. Emerging research suggests environmental endocrine disruptors may affect (Sadeghi et al., 2021). This article discusses PCOS's critical assessment and pathogenic mechanisms to understand its complex evolution. The intricate interaction of genetics, hormones, the environment, and lifestyle decisions makes PCOS challenging. Understanding PCOS's complexity (Fig. 1) is essential to understanding its aetiology and devising personalised treatment plans.

Doctors administer oral contraceptives, insulin sensitisers, antiandrogens, and ovulation inducers. All of the above medicines are used off-label, and the USFDA has not approved a PCOS drug (El et al., 2016). In addition to the requirement for novel medication compounds and discoveries, drug repurposing procedures may lead to new drug discoveries (Motlagh Asghari et al., 2022). There is a movement to treat PCOS with numerous FDA-approved medicines for different applications. N-acetyl cysteine is a mucolytic, pioglitazone, empagliflozin, sitagliptin, and liraglutide are anti-diabetics, simvastatin and atorvastatin are HMG-CoA reductase inhibitors (Balen et al., 1993; Azziz et al., 2004). The disorder is on the rise, has many negative effects, and present treatments are ineffective, thus understanding its aetiology and finding novel pharmaceutical targets is vital (Vidya Bharathi et al., 2017; Dumesic et al., 2020; Azziz et al., 2009a).

This review systematically explores the extensive body of literature on polycystic ovary syndrome (PCOS) and critically analyzes its major findings. Molecular and genetic research has provided valuable insights into key mechanisms underlying the condition, including insulin resistance, hormonal imbalances, and dysregulated signaling pathways, thereby advancing our understanding of PCOS pathophysiology. Furthermore, environmental factors such as lifestyle habits and exposure to endocrine-disrupting chemicals add complexity to its etiology. The review also assesses the methodological strengths and limitations of existing studies, addresses inconsistencies in the findings, and highlights the need for standardized research approaches to improve comparability and reproducibility across future investigations.

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Pathophysiology

A number of studies have developed throughout the years to attempt and to explain PCOS pathogenesis. Initially, it was thought that this condition could be caused by an excess of intrauterine androgens. Therefore, insulin resistance may play a role in the development of PCOS and hyperandrogenemia (Witchel et al., 2019b; Ibáñez et al., 2017; Barrea et al., 2018). Pathophysiological aspects include ovarian folliculogenesis, changes in steroidogenesis, metabolism, inflammatory factors, ...

Diagnosis

Unfortunately, there is currently no fullproof method for diagnosing PCOS, as it is one of those rare diseases that evades the most fundamental diagnostic tools available. The process of reducing the possible diagnoses based on the patient's symptoms is known as differential diagnosis. The associated tests can rule out hyperprolactinemia, thyroid disease, Cushing's syndrome, and adrenal hyperplasia to diagnose PCOS (Witchel et al., 2019c). The patient's medical history, body weight, and insulin ...

Phenotype

The Rotterdam criteria divided this condition into four phenotypes. Although their BMIs are identical, women with a frank phenotype have worse metabolic and cardiovascular risk factors than those with a non-classical phenotype. According to the existing data, this phenotype may increase the risk of cardiovascular disease and sometimes assassination following menopause. Non-classic normoandrogenic women have lower insulin resistance and no PCOS metabolic characteristics than classical. Since ...

Sex hormone profile in PCOS

One component contributing to the development of PCOS is a hormonal imbalance affecting the ovaries and the organs responsible for regulating their activity, the hypothalamus and pituitary. This is why a testing of multiple hormones, including follicle-stimulating hormone (FSH), luteinizing hormone (LH), progesterone, estradiol (E2), sex hormone-binding globulin (SHBG), androstenedione, testosterone, 17-hydroxyprogesterone (17-OHP), dehydroepiandrosterone sulfate (DHEA-S), anti-Mullerian ...

LH and FSH

An abnormal release of gonadotropins is a hallmark of PCOS from a neuroendocrine perspective, showing that the hypothalamus-pituitary-ovary axis is abnormal and marked by the hyper-response to the GnRH test and increased frequency and amplitude of LH peaks under baseline conditions indicate increased LH secretion. LH gonadotropin can promote hyperplasia of thecal ovary cells, a substrate for hyperandrogenism (Fig. 3). Normal or low FSH levels indicate that the ovarian granulosa axis FSH cells ...

Management

Management and therapy will depend on the patient's priorities. Side effects include seeking fertility, regulating monthly irregularities, decreasing weight, and treating hyperandrogenic symptoms like hirsutism, acne, and androgenic alopecia. In fact, in order to achieve the best outcome, the strategy should be tailored to each individual. Physicians are left with no choice but to resort to symptomatic therapy when diagnosing PCOS because there is no perfect treatment for all women (Zeind and ...

Weight loss

Weight gain, especially around the middle, is a symptom of PCOS. Consequently, a lot of women with PCOS have an apple rather than a pear form. Reducing caloric consumption and losing weight should be the primary goals of women diagnosed with PCOS. Research shows that regular menstruation cycles can be restored with as little as a 5–10% weight loss. Reducing their body mass index (BMI) to a healthy range is the ideal goal for obese women. Loss of weight is associated with a drop in free ...

Conclusion

Anovulation, hyperandrogenism, and polycystic ovarian morphology are all symptoms of PCOS, a complicated endocrine condition. The growing importance of epigenetic alterations and their effect on gene expression highlights the need for more PCOS epigenetic research. Critical evaluation of current diagnostic criteria and phenotypic heterogeneity emphasises the need for a holistic approach to PCOS diagnosis and management, with personalised treatment strategies tailored to the specific ...

CRedit authorship contribution statement

Suparna Parua: Writing – original draft, Data curation. **Mahuya Patra Purkait:** Writing – original draft, Data curation. **Aniruddha Bhattacharjee:** Writing – review & editing, Validation, Investigation, Conceptualization. **Rajesh Thangarajan:** Software, Investigation. **Subramanian Rammohan:** Software, Resources. **Kamirul Islam:** Visualization, Supervision, Investigation. **Koushik Bhattacharya:** Writing – review & editing, Validation, Formal analysis, Conceptualization. **Alak Kumar Syamal:** Visualization, ...

Declaration

No conflict of interest. ...

Consent

NA. ...

Ethical Statement

I, Dr.Koushik Bhattacharya, hereby declaring that, the manuscript entitled “**Exploring Female Infertility: A Comprehensive Review of Polycystic Ovary Syndrome (PCOS) and Its Impact on Reproductive Health**” is a review article; thus this manuscript does not associated with any kind of ethical considerations. ...

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