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Clinical Perspectives and Diagnostic Challenges of Adolescent Polycystic Ovarian Syndrome: A Literature Review

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ABSTRACT

Polycystic ovarian syndrome (PCOS) is the most common endocrine disorder among females of reproductive age, increasingly recognized during adolescence. However, diagnosis at this stage remains challenging due to overlapping features with normal pubertal development. This review summarizes current evidence on the clinical characteristics, diagnostic challenges, and management of adolescent PCOS. Diagnosis should be based on both menstrual irregularity and hyperandrogenism, while avoiding premature reliance on polycystic ovarian morphology (PCOM) or anti-Müllerian hormone (AMH). Early recognition and holistic management through lifestyle modification, individualized pharmacologic therapy, and psychosocial support are essential to prevent long-term metabolic, reproductive, and psychological complications. Establishing well-defined diagnostic standards for menstrual irregularity and developing adolescent-specific thresholds are crucial to enhance diagnostic accuracy, ensure timely intervention, and improve overall quality of life among adolescents affected by PCOS.

Keywords: adolescent PCOS; menstrual irregularity; hyperandrogenism; diagnostic criteria; polycystic ovarian morphology; anti-Müllerian hormone; insulin resistance

INTRODUCTION

Polycystic ovarian syndrome (PCOS) is the most common endocrine disorder among females of reproductive age worldwide. A meta-analysis involving 149,477 girls aged 10–20 years estimated that the global prevalence of PCOS ranges from 3.4% to 11% [1]. PCOS is a disorder characterized by excess androgen levels, ovulatory dysfunction, and the presence of follicles in the ovaries on ultrasound [2]. Clinical manifestations typically arise between the ages of 18 and 39 years. However, diagnosis and treatment are often delayed, resulting in a substantial number of undiagnosed cases [3]. PCOS is associated with multiple comorbidities, including chronic anovulation, infertility, insulin resistance, type 2 diabetes mellitus, metabolic syndrome, cardiovascular disease, and psychological disturbances such as depression and anxiety [4].

The World Health Organization (WHO) defines adolescence as 10–19 years. The dynamic physiological and anatomical changes that occur during puberty make a diagnosis of PCOS in this age group difficult [5]. Over time, four major diagnostic criteria have been proposed: the NIH (1990), Rotterdam (2003), AE-PCOS Society (2006), and the International Evidence-based Guideline (2018, updated 2023) [6, 7]. Clinical manifestations such as menstrual irregularity, acne, and polycystic ovarian morphology (PCOM) are common in normal puberty, leading to both overdiagnosis and underdiagnosis when adult criteria are applied. This challenge underscores the need for adolescent-specific definitions, particularly for menstrual irregularity, to ensure accurate and timely identification [7, 8, 9]. This review aims to summarize the clinical features and diagnostic challenges of menstrual irregularity in adolescent PCOS and highlight the need for well-defined diagnostic criteria to improve early recognition and management.

METHODS

A literature search was performed across PubMed, SpringerLink, Frontiers, Elsevier, and ResearchGate to identify studies related to adolescent polycystic ovarian syndrome (PCOS) published between 2010

and 2025. Keywords used included "adolescent PCOS," "diagnosis of PCOS," "clinical features of PCOS," "hyperandrogenism," "menstrual irregularity," and "management of PCOS." The search was refined using Boolean operators AND and OR to ensure comprehensive retrieval. Studies focusing on clinical presentation, diagnostic evaluation, or management in adolescents were included. Eligible articles were reviewed in full, and findings were narratively synthesized under four domains: clinical perspectives, diagnostic challenges, management strategies, and research implications.

RESULT AND DISCUSSION

Clinical Perspectives in Adolescent PCOS

- *Common Clinical Features*

Adolescent polycystic ovarian syndrome (PCOS) represents a highly prevalent endocrine-metabolic disorder with potential reversibility if recognized early. Its pathophysiology is thought to be influenced by ectopic fat accumulation, often arising from developmental mismatches between early adipogenesis and later lipogenesis, or between prenatal and postnatal weight gain [10]. The syndrome is primarily characterized by gonadotropin imbalance, hyperandrogenism, insulin resistance (IR), and polycystic ovarian morphology (PCOM) [11]. Clinically, adolescents with PCOS frequently present with menstrual irregularities, manifestations of androgen excess such as acne and hirsutism, and variable metabolic dysfunction. These disturbances reflect underlying abnormalities in ovulatory function, gonadotropin ratio, insulin secretion, and androgen biosynthesis. Genetic predisposition and oxidative stress imbalance may further exacerbate the condition [11, 12, 13, 14, 15].

Beyond its physiological impact, PCOS contributes to considerable psychosocial distress. Physical manifestations such as weight gain, acne, and hirsutism are frequently linked to heightened anxiety and depressive symptoms, particularly in adolescents and young women [13]. Given its heterogeneous presentation, a thorough evaluation is required to exclude other endocrine or metabolic disorders that can mimic PCOS, including adrenal tumor, non-classic congenital adrenal hyperplasia, and hyperprolactinemia [11, 17].

- *Hormonal and Metabolic Correlations*

Several factors contribute to the development of adolescent polycystic ovarian syndrome (PCOS), including a family history of PCOS or metabolic syndrome and fetal androgen exposure [16]. Although the pathogenesis of PCOS remains unclear, hyperandrogenism is recognized as a central feature of its hormonal imbalance. The ovaries are typically the main source of excess androgens, with additional contributions from the adrenal glands in some cases. Early life factors, particularly rapid postnatal weight gain, have been implicated in disease onset through the promotion of ectopic lipid deposition in hepatic and visceral tissues, leading to insulin resistance and later PCOS development [6, 10, 18].

PCOS should be suspected in adolescents presenting with obesity, insulin resistance (IR), compensatory hyperinsulinemia, or features of metabolic syndrome (MetS) [19]. MetS is characterized by elevated blood pressure, fasting glucose, triglycerides, and waist circumference, accompanied by reduced high-density lipoprotein (HDL) levels [20]. Both MetS and PCOS share a strong pathophysiologic link through insulin resistance. Approximately half of adolescents with PCOS are obese, a condition that exacerbates insulin resistance and hyperinsulinemia, further enhancing androgen synthesis and ovulatory dysfunction. Hence, the presence of metabolic abnormalities such as obesity, dyslipidemia, or impaired glucose tolerance should prompt early clinical suspicion and screening for PCOS to enable timely intervention [11].

In adolescents with PCOS, elevated luteinizing hormone (LH) levels and an increased LH-to-FSH ratio are commonly observed [21]. Disruption of the hypothalamic–pituitary–ovarian axis leads to an increased gonadotropin-releasing hormone (GnRH) pulse frequency, which preferentially stimulates LH secretion while leaving follicle-stimulating hormone (FSH) relatively unchanged or even suppressed. Hyperinsulinemia further amplifies this process by enhancing GnRH activity, resulting in greater LH release and androgen production [11]. Although earlier studies used the LH/FSH ratio as a diagnostic marker, current thresholds remain based on adult reference values, as adolescent-specific data are still limited [11, 22].

- *Impact on Quality of Life (QoL)*

Adolescent PCOS is associated with a broad spectrum of reproductive and metabolic complications, including infertility, miscarriage, type 2 diabetes mellitus, metabolic syndrome, cardiovascular disease, and an increased lifetime risk of endometrial cancer [12]. Beyond physical health, PCOS exerts a significant impact on psychological well-being and overall quality of life (QoL). Findings from study indicate that adolescents with PCOS experience a notable decline in QoL, influenced by symptoms such as irregular menstruation, acne, hirsutism, and excess weight. Key QoL domains affected include general health perception, self-esteem, social and emotional functioning, physical and behavioral roles, and mental health [23].

Diagnostic Challenges in Adolescent PCOS

Diagnosing PCOS in adolescents is challenging because of the overlap between adult diagnostic criteria and normal pubertal development [7]. Irregular menstrual cycles, often the earliest sign of PCOS, are also a physiological hallmark of early adolescence, reflecting the gradual maturation of the hypothalamic–pituitary–ovarian axis. During this transitional period, incomplete establishment of estrogen feedback leads to anovulatory and irregular cycles that may persist for several years after menarche [24, 25].

Studies suggest that irregular menstruation does not necessarily indicate ovulatory dysfunction, as many adolescents with cycle variability continue to ovulate normally [26]. Therefore, menstrual irregularity alone should not be considered a diagnostic criterion for PCOS but rather a screening indicator that warrants further assessment of ovulatory function [27].

Inconsistent Diagnostic Criteria

• *National Institutes of Health (NIH) Criteria*

The diagnostic approach to PCOS has evolved over time, contributing to both underdiagnosis and overdiagnosis in adolescents. The first standardized criteria were proposed by the National Institutes of Health (NIH) in 1990, aiming to establish uniform diagnostic guidelines [6]. According to the NIH criteria, PCOS is diagnosed when both clinical or biochemical hyperandrogenism and ovulatory dysfunction are present, after excluding other secondary causes [33]. Hyperandrogenemia is identified by elevated levels of testosterone and/or free testosterone and/or dehydroepiandrosterone (DHEA) exceeding 75% of the normal upper limit [34]. Clinical hyperandrogenism is commonly assessed using the Ferriman–Gallwey (FG) score, which grades the extent of hirsutism, typically involving facial and chest regions [17]. The NIH criteria did not include polycystic ovarian morphology (PCOM), as this finding can occur in up to 20–30% of healthy women. NIH criteria served as the standard diagnostic reference for more than a decade until 2012, when NIH recommended using the Rotterdam criteria [5].

• *Rotterdam Criteria*

The Rotterdam criteria, introduced in 2003, marked a significant expansion in the diagnostic framework for PCOS by incorporating polycystic ovarian morphology (PCOM) as an additional diagnostic feature [36]. The criteria were designed to include the original NIH definition while broadening the spectrum of PCOS presentations. Under the Rotterdam consensus, a diagnosis requires the presence of two out of three features: oligo/anovulation (OD), clinical or biochemical hyperandrogenism (HA), and polycystic ovarian morphology (PCOM). This approach introduced new phenotypes, including women exhibiting PCOM with hyperandrogenism but regular ovulation (HA+PCOM), and those with PCOM and irregular ovulation without androgen excess (OD+PCOM) [35, 36].

Although both the NIH and Rotterdam criteria were derived from adult populations, they are often extrapolated to adolescents in clinical practice. However, international adolescent consensus statements over the past decade have recommended favoring the NIH criteria over the Rotterdam criteria, as PCOM is a common and physiologic finding in many healthy adolescents during the early post-menarcheal years, making the Rotterdam criteria less suitable for this age group [37, 38].

• *Androgen Excess–PCOS Society (AE-PCOS) Criteria*

The AE-PCOS Society criteria, introduced in 2006, sought to create a balance between the NIH and Rotterdam definitions by emphasizing hyperandrogenism as the central feature of the syndrome [17]. According to these guidelines, PCOS is defined by the presence of clinical or biochemical evidence of hyperandrogenism, accompanied by either ovulatory dysfunction or polycystic ovarian morphology on ultrasound. This framework aimed to reestablish androgen excess as the key diagnostic component of PCOS [39]. However, despite its conceptual clarity, the AE-PCOS criteria have not been widely adopted [33].

• *International Evidence-based PCOS Guideline*

The original consensus-based Rotterdam criteria for PCOS diagnosis were refined into evidence-based criteria in the 2018 and 2023 International Evidence-based PCOS Guideline. The full 2023 Guideline update provides recommendations in five areas: screening, diagnosis, and risk assessment; psychological features; lifestyle; management of nonfertility features; and infertility. The 2023 Guideline recommends adult diagnosis on the basis of the identification of at least two of these recognized features: (1) menstrual irregularities or ovulatory dysfunction, (2) clinical or biochemical hyperandrogenism, and (3) polycystic ovarian morphology (PCOM) on ultrasound or elevated anti-Müllerian hormone (AMH) levels. However, both PCOM and AMH are considered unsuitable for diagnosing PCOS during adolescence [7].

The criteria required to diagnose adolescent PCOS include menstrual irregularities or ovulatory dysfunction and hyperandrogenism, following the exclusion of conditions that mimic PCOS. However, the timing for recognizing menstrual irregularity as pathological remains uncertain, as cycle variability is common in the first years after menarche [7]. Among biochemical markers, free testosterone and the free androgen index (FAI) demonstrate the highest diagnostic accuracy, whereas total testosterone, androstenedione, and dehydroepiandrosterone (DHEA) show lower diagnostic reliability and are not routinely recommended [40]. No standardized threshold for androgen levels in adolescents with PCOS has been established. Most current guidelines recommend interpreting results according to age-appropriate reference ranges provided by local laboratories. Androgen concentrations in adolescents with PCOS may be normal or only mildly elevated. When markedly elevated androgen levels are detected, clinicians should investigate and exclude other causes of biochemical hyperandrogenism, such as non-classical congenital adrenal hyperplasia or androgen-secreting endocrine tumors. Clinically, severe acne and hirsutism are the most common manifestations of hyperandrogenism in adolescents [11]. Severe or treatment-resistant acne around menarche should raise suspicion for androgen excess [27]. Hirsutism, defined as excessive terminal hair growth in androgen-sensitive areas, is commonly assessed using the modified Ferriman–Gallwey (mFG) score, where values ≥4–6 indicate hirsutism, though ethnic variation affects interpretation [11, 41].

Although polycystic ovarian morphology (PCOM) and anti-Müllerian hormone (AMH) are established diagnostic markers in adults, their use in adolescents is not recommended due to the high risk of overdiagnosis [7]. These parameters become more reliable only around eight years post-menarche, when the hypothalamic–pituitary–ovarian (HPO) axis is fully mature [27]. During adolescence, ovarian size and follicle number increase rapidly, peaking in early adulthood, making adult-defined thresholds for PCOM unsuitable [7].

Adolescent at Risk and the Importance of Accurate Diagnosis

Adolescents who present with only one diagnostic feature of PCOS, either menstrual irregularities /ovulatory dysfunction or hyperandrogenism, should be considered "at risk" and require longitudinal follow-up. A diagnosis can later be confirmed if both features appear over time, even before eight years after menarche. Regular reassessment during adolescence and into early adulthood is therefore essential to establish diagnostic certainty [7].

In early adolescence, irregular menstrual cycles are often attributed to normal pubertal maturation, which may lead to underdiagnosis of ovarian dysfunction. On the other hand, premature or inaccurate labeling of PCOS may result in overdiagnosis, unnecessary testing, inappropriate treatment, and psychological distress. Although early recognition of PCOS is important for timely management, clinicians should proceed with caution to avoid misdiagnosis. Identifying adolescents who are at risk and ensuring regular reevaluation can help prevent both underdiagnosis and overdiagnosis, along with their associated consequences [42].

Clinical Management and Psychosocial Care in Adolescent PCOS

- *Non-Pharmacological Management*

The management of adolescent PCOS should emphasize lifelong lifestyle modification through a multidisciplinary approach involving health education, nutritional guidance, and prevention of long-term metabolic risks. All adolescents, regardless of body weight, are advised to adopt healthy eating habits, regular physical activity, sufficient sleep, and consistent circadian rhythms. Sustained lifestyle interventions can normalize androgen levels, improve insulin sensitivity, regulate menstrual cycles, and reduce cardiovascular risk [10, 29, 30]. Even a modest 5% weight reduction may improve metabolic and reproductive outcomes [28].

No specific diet or exercise regimen has proven superior to others [29]. In adolescents with obesity, lifestyle modification combined with liraglutide or semaglutide has demonstrated greater body mass index (BMI) reduction than lifestyle intervention alone, although liraglutide is currently the only drug approved for use in individuals aged 12 years and older [10, 31].

- *Pharmacological Management*

Pharmacologic therapy should be individualized based on symptoms and treatment goals [7]. Combined oral contraceptives (COCs) are the first-line option for managing menstrual irregularities, acne, and hirsutism, as they suppress gonadotropin release, reduce ovarian androgen production, and increase sex hormone-binding globulin (SHBG) levels. Some progestins also have direct antiandrogenic properties, improving hyperandrogenic symptoms. Metformin is recommended for adolescents with insulin resistance or irregular cycles, as it enhances metabolic function and ovulatory regulation [7, 27]. Emerging studies suggest that combining metformin, spironolactone, and pioglitazone may provide additional metabolic benefits, though more evidence is needed [10].

- *Psychosocial Support*

Adolescent PCOS is often accompanied by depression, anxiety, and low self-esteem. Routine mental health screening, psychological counseling, and patient-centered education are crucial for improving emotional well-being and treatment adherence [7, 32].

CONCLUSIONS

Adolescent polycystic ovarian syndrome (PCOS) remains difficult to diagnose due to overlapping features with normal puberty. Diagnosis should rely on both menstrual irregularity and hyperandrogenism, while avoiding early use of polycystic ovarian morphology (PCOM) or anti-Müllerian hormone (AMH) as diagnostic markers. Establishing a well-defined standard for menstrual irregularity is essential to improve diagnostic consistency. Comprehensive management, including lifestyle modification, individualized pharmacologic therapy, and psychosocial care, is recommended to address both metabolic and emotional impacts. Future research should focus on refining adolescent-specific diagnostic thresholds, evaluating long-term outcomes, and exploring the molecular mechanisms underlying disease progression to enable earlier detection and improved quality of life for adolescents affected by PCOS.

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