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ORIGINAL ARTICLE

CLINICAL, DERMATOLOGICAL, AND HORMONAL CORRELATES OF POLYCYSTIC OVARY SYNDROME: A CASE-CONTROL STUDY IN SOUTHERN PUNJAB, PAKISTAN

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ABSTRACT

Background: Polycystic Ovary Syndrome (PCOS) is a complex endocrine disorder. This study aimed to assess the clinical, menstrual, obstetric, and endocrine profiles of women with PCOS in comparison to healthy controls ascertained from Southern Punjab, Pakistan.

Materials & Methods: In a cross-sectional case-control study design, 204 PCOS patients and 150 controls were recruited from tertiary care hospitals. PCOS was diagnosed per Rotterdam criteria. Descriptive statistics was employed.

Results: Dermatological manifestations were significantly more prevalent among PCOS cases: hirsutism (Odd ratios, OR: 60.4), acne (OR: 11.2), alopecia (OR: 23.4), seborrhea (OR: 11.7), and acanthosis nigricans (OR: 58.8). Menstrual irregularities like oligomenorrhea and amenorrhea cases were significantly more common among PCOS cases. Abortions and miscarriages were slightly more common among cases, though not statistically significant. Endocrine profiling showed significantly lower FSH levels and higher LH, testosterone, and estradiol levels in PCOS cases. Serum leptin and insulin levels were also significantly elevated, indicating metabolic disturbances. Hirsutism correlated positively with serum testosterone levels in both groups, emphasizing the role of androgen excess in PCOS. Age-stratified analyses of PCOS individuals revealed significant association between waist-and-hip circumference and FSH and LH levels in older age patients.

Conclusions: This study highlights the multifaceted clinical and hormonal disturbances in PCOS and underscores the diagnostic value of dermatological features and endocrine markers. These findings also suggest that PCOS manifestations and hormonal imbalances vary with age, emphasizing the need for age-specific diagnostic and management approaches.

KEY WORDS: Endocrine disorder; Hirsutism; Acne; Acanthosis nigricans; Menstrual irregularities; Oligomenorrhea; Amenorrhea; Reproductive health.

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INTRODUCTION

Polycystic ovary syndrome (PCOS) is a common and heterogeneous endocrine disorder affecting approximately 5–20% of women of reproductive age worldwide.[1,2] Its prevalence is particularly increasing among South Asian populations, including in Pakistan. PCOS is a leading cause of female infertility and is typically characterized by ovulatory dysfunction, hyperandrogenism, and polycystic ovarian morphology. Clinically, it presents with symptoms such as irregular menstrual cycles, hirsutism, thinning scalp hair, acne, seborrhea, and weight gain or central obesity.[3,4] The syndrome is closely associated with metabolic disturbances, particularly insulin resistance, dyslipidemia, increased risk of developing type 2 diabetes mellitus, cardiovascular disease, endometrial hyperplasia, and complications during pregnancy.[5] In addition to its physical health impacts,

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PCOS carries a considerable psychosocial burden. Affected women frequently report higher rates of depression, anxiety, poor self-image, sexual dysfunction, and diminished quality of life.[6]

Although the exact cause of PCOS remains unclear, it is widely believed to result from a complex interplay of genetic, hormonal, and environmental factors. [7] Insulin resistance and the resulting compensatory hyperinsulinemia are central to its pathophysiology, as they exacerbate hyperandrogenism by stimulating ovarian androgen production.[4] Previous studies have reported a high prevalence of PCOS among Pakistani women, with estimates ranging from 15% to 52%.[8,9] Common clinical features in this population include hirsutism, menstrual irregularities, and obesity.[10,11] Additionally, insulin resistance and metabolic syndrome are frequently observed, with 30–40% of women with PCOS progressing to type 2 diabetes mellitus.[12] A recent study highlighted that central obesity and dyslipidemia are more pronounced among Pakistani PCOS patients compared to Western cohorts, indicating potential ethnicity-specific metabolic vulnerabilities.[9] Despite the high prevalence, regional data on the clinical presentation and complications of PCOS in Pakistan remain limited. Therefore, in order to fill this information gap, the aim of the present study was to assess the clinical manifestations and hormonal profiles associated with PCOS among women from Southern Punjab, Pakistan.

MATERIALS AND METHODS

In a cross-sectional, case-control study design, women of reproductive age with a confirmed diagnosis of PCOS were recruited as 'cases' from various private and public hospitals in Southern Punjab, Pakistan, as previously described. [7] All participants underwent detailed physical examinations by specialist physicians, along with comprehensive laboratory evaluations. PCOS was diagnosed based on the Rotterdam criteria. The study protocol was approved by the Ethical Review Committee. Written informed consent was obtained from all participants, and comprehensive information was provided prior to data and biological sample collection. Women with thyroid disorders, Cushing's syndrome, cardiovascular or renal diseases, those who were pregnant or lactating, or those using medications were excluded from the study. The 'control' group included women without PCOS who had regular menstrual cycles and no clinical signs of the disorder.

Blood samples were collected in clot-activator plain tubes for serum separation. Samples were centrifuged at 4000 rpm for 10 minutes (Hettich Zentrifugen, USA). Serum levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH), testosterone, estradiol, leptin, and insulin were measured using enzyme-linked immunosorbent assay (ELISA) with commercially available kits. Descriptive statistics were used to summarize the data, and relevant summary tables were generated. Odds ratios (ORs) were calculated to compare the likelihood of clinical features in affected individuals relative to controls across each category. Categorical variables were analyzed using the chi-square test, while the Pearson correlation coefficient was used for assessing relationships between variables. Continuous variables were compared using the t-test. All statistical analyses were conducted using SPSS version 20.0.

RESULTS

A total of 204 cases and 150 controls were recruited for the study. The mean age of participants was 27.2 ± 9.7 years. The majority belonged to the Saraiki ethnic group (70%), with 64% being literate and 62% residing in rural areas. Dermatological manifestations were significantly more prevalent among individuals with PCOS compared to controls (Table 1).

For instance, hirsutism was observed in 71.6% of PCOS cases versus 4.0% of controls (OR: 60.4; 95% CI: 25.3–144.4; $p < 0.0001$). Acne was present in 53.4% of cases vs. 9.3% of controls (OR: 11.2; 6.0–20.6; $p<0.0001$). Alopecia occurred in 24.0% of cases vs. 1.3% of controls (OR: 23.4; 5.6–97.9; $p<0.0001$). Seborrhea affected 50.5% of cases vs. 8.0% of controls (OR: 11.7; 6.1–22.5; $p<0.0001$). Acanthosis nigricans was reported in 16.2% of PCOS cases and was absent in controls (OR: 58.8; 3.6–968; $p<0.0001$).

Regarding menstrual history, irregularities were markedly more common among PCOS cases (Table 1). Only 20.6% of women with PCOS had regular menstruation, compared to 86.7% of controls. In contrast, oligomenorrhea was found in 58.3% of PCOS cases versus 0.7% of controls (OR: 368; 49–2719; $p<0.0001$); and amenorrhea in 14.2% of cases vs. 0.7% of controls (OR: 89; 11.9–679; $p<0.0001$).

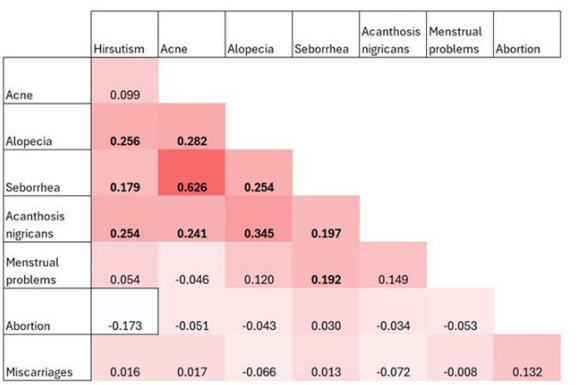

Fig 1: Spearman correlation matrix showing the pairwise associations among clinical features in PCOS patients. The values in boldface are statistically significant. The heatmap visualizes the strength and direction of correlations between key clinical manifestations.

Table 1: Clinical and endocrinological manifestations among PCOS and Controls

Parameters	PCOS	Controls	OR (95%CI)	*p*-value
	N (%)	N (%)		
Hirsutism				
Yes	146 (71.6)	6 (4.0)	60.4 (25.3-144.4)	<0.0001
No	58 (28.4)	144 (96)	Ref.	
Acne				
Yes	109 (53.4)	14 (9.3)	11.2 (6.0-20.6)	<0.0001
No	95 (46.6)	136 (90.7)	Ref.	
Alopecia				
Yes	49 (24.0)	2 (1.3)	23.4 (5.6-97.9)	<0.0001
No	155 (76.0)	148 (98.7)	Ref.	
Seborrhea				
Yes	103 (50.5)	12 (8.0)	11.7 (6.1-22.5)	<0.0001
No	101 (49.5)	138 (92.0)	Ref.	
Acanthosis nigricans				
Yes	33 (16.2)	0 (0.0)	58.8 (3.6-968)	<0.0001
No	171 (83.8)	150 (100.0)	Ref.	
Menstrual history				
Regular menstruation	42 (20.6)	130 (86.7)	Ref.	
Dysmenorrhea	6 (2.9)	10 (6.7)	1.86 (0.6-5.4)	0.251
Oligomenorrhea	119 (58.3)	1 (0.7)	368 (49-2719)	<0.0001
Amenorrhea	29 (14.2)	1 (0.7)	89 (11.9-679)	<0.0001
Menopause	8 (3.9)	8 (5.3)	-	-
Obstetric parameters				
Abortions				
No	110 (53.9)	54 (36)	Ref.	
Yes	20 (9.8)	7 (4.7)	1.4 (0.6-3.5)	0.471
Unmarried	74 (36.3)	89 (59.3)	-	-
Miscarriages				
No	79 (38.7)	44 (29.3)	Ref.	
Yes	51 (25.0)	17 (11.3)	1.7 (0.9-3.2)	0.128
Unmarried	74 (36.3)	89 (59.3)	-	-
Endocrinological parameters#				
FSH (mIU/ mL)	10.1±0.85	14.7±2.02		0.022
LH (mIU/ mL)	16.8±1.46	3.7±0.24		<0.0001
Testosterone (ng/mL)	2.3±0.17	0.1±0.02		<0.0001
Estradiol (pg/mL)	135.8±8.48	107.4±7.81		0.018
Serum Leptin (ng/mL)	72.4±2.52	40.9±3.76		<0.0001
Serum Insulin (µIU/mL)	37.3±3.42	15.2±1.62		<0.0001
LH:FSH (mIU/ mL)	5.3±1.29	0.7±0.07		0.003

OR, odds ratio; CI, confidence interval; #mean±SEM

The strongest correlations were observed between: acne and seborrhea (ρ=0.626), alopecia and acanthosis nigricans (ρ=0.345), and between alopecia and acne (ρ=0.282). In contrast, menstrual irregularities, abortions, and miscarriages exhibited weak and non-significant associations with other clinical variables. A modest negative correlation between abortion and hirsutism (ρ=-0.173) nearly approached statistical significance (p=0.0567).

Endocrinological profiling revealed significant differences between PCOS cases and controls. Serum FSH levels were significantly lower in PCOS cases, whereas LH, testosterone, and estradiol levels were significantly elevated compared to controls (Table 1). Additionally, the serum leptin concentration was markedly higher in individuals with PCOS (72.4±2.52 ng/mL) compared to controls (40.9±3.76 ng/mL) (p<0.0001). Similarly, serum insulin levels were significantly elevated in PCOS cases (37.3 ± 3.42 µIU/mL) versus controls (15.2±1.62 µIU/mL) (p<0.0001), highlighting the metabolic disturbances associated with the syndrome.

Given that hirsutism was a prominent clinical feature of PCOS, its correlation with various endocrine parameters was assessed (Table 2).

Table 2: Correlation of hirsutism with endocrine profile of PCOS and controls

Parameters	PCOS		Controls	
	r	p-value	**r**	**p-value**
FSH	-0.014	0.841	-0.088	0.283
LH	-0.055	0.437	-0.016	0.843
Testosterone	0.434	<0.0001	0.376	<0.0001
Estradiol	0.058	0.413	-0.049	0.55
Leptin	-0.038	0.674	-	-
Insulin	0.196	0.028	-	-
LH: FSH	-0.097	0.169	0.077	0.349

In both groups, hirsutism showed no significant correlation with FSH, LH, estradiol, or the LH:FSH ratio. However, a significant positive correlation was observed between hirsutism and serum testosterone levels in both PCOS cases and controls, underscoring the role of androgen excess in this manifestation. Participants were stratified into three age groups for comparative analysis: Group I: 15–30 years; Group II: >30–45 years; and Group III: >45–60 years. Anthropometric measurements and serum hormone levels were assessed across these age groups (Fig. 2).

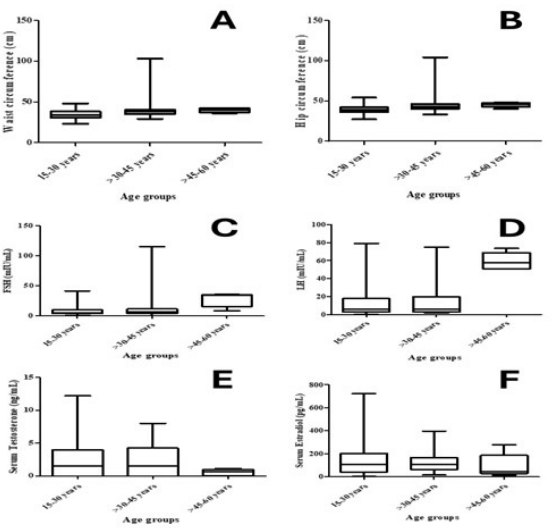

Fig 2: Box-plots depicting the distribution of anthropometric (A-B) and endocrinological variables (C-F) in various age groups of cases with PCOS.

Waist circumference was highest in Group III (39.6±1.2 cm) and lowest in Group I (34.0±0.4 cm), showing a significant increase with age (p<0.001). Hip circumference followed a similar pattern, with the largest values in Group III and the smallest in Group I (p<0.001).

In terms of gonadotropins, serum FSH levels increased significantly with age, being highest in Group III (26.9±5.2 mIU/mL) and lowest in Group I (8.5±0.6 mIU/mL) (p<0.001). Serum LH levels also peaked in Group III (59.4±4.3 mIU/mL) and were lowest in Group I (15.5±1.8 mIU/mL) (p<0.001). For sex hormones, serum testosterone levels were highest in Group II (2.3±0.3 ng/mL) and lowest in Group III (0.6±0.2 ng/mL); however, the difference was not statistically significant (p=0.30). On the other hand, serum estradiol levels were highest in Group I (141.6 ± 11.5 pg/mL) and lowest in Group III (94.1±47.9 pg/mL), with no significant variation across age groups (p=0.527).

DISCUSSION

Polycystic ovary syndrome (PCOS) is a complex endocrine disorder influenced by genetic, metabolic, and environmental factors, including ethnicity, geography, and dietary habits.[5] This study examines clinical, hormonal, and obstetric characteristics of PCOS in a previously underrepresented population—women from Southern Punjab, Pakistan. In this study, statistically significant associations were observed between PCOS and features of hyperandrogenism (hirsutism, acne, alopecia, seborrhea), and insulin resistance (acanthosis nigricans). These findings align with previous research [1,2], reinforcing hyperandrogenism and metabolic dysfunction as

core features of PCOS.

Further, statistically significant associations were observed between PCOS and menstrual irregularities (especially oligomenorrhea and amenorrhea). This is consistent with global studies [3], highlighting menstrual disruption as a key diagnostic criterion. Early recognition of these symptoms—particularly in resource-limited settings—could improve timely diagnosis and management. These results underscore the importance of recognizing dermatological and menstrual symptoms for early identification and diagnosis of PCOS, particularly in resource-limited settings. Further, adverse pregnancy outcome is an indicator or PCOS. [5] In these analyses, however, obstetric outcomes like abortions and miscarriages showed non-significant trends, possibly due to smaller sub-group sizes and the confounding effect of marital status.

In order to observe the relationship between clinical variables, Spearman correlation analyses were carried out. These analyses revealed the strongest correlation between acne and seborrhea ($\rho=0.626$), both driven by androgens. There was also significant association between alopecia and acanthosis nigricans ($\rho=0.345$), possibly reflecting shared insulin resistance pathways. Moderate associations were evident among androgenic traits (acne, alopecia, hirsutism), supporting the hyperandrogenic phenotype of PCOS.

Endocrinological profiling is a sensitive indicator of PCOS. This study highlights significant endocrine abnormalities in women with PCOS compared to controls, reinforcing the role of hormonal dysregulation in PCOS pathophysiology. Here, serum LH was significantly higher in PCOS cases, consistent with increased GnRH pulsatility a consequence of insulin resistance and hyperandrogenism. The LH/FSH ratio (>2.5) a well-established diagnostic marker[13] was notably elevated, reflecting theca cell hyperplasia and androgen excess.[1] The previous studies in Pakistani populations confirm that this ratio strongly predicts anovulation, even in lean PCOS women.[14,15]

Moreover, testosterone levels were significantly higher in PCOS women, driven by theca cell overactivity and insulin-enhanced steroidogenesis.[1,16] In Pakistani cohorts, free testosterone >1.5 ng/mL correlates with hirsutism and metabolic dysfunction, affecting 60-70% of PCOS patients.[14] The PCOS cases exhibited higher estradiol due to chronic anovulation, leading to unopposed estrogen secretion from persistent follicular cysts. The previous studies in Pakistani women associates E2 >120 pg/mL with an increased risk of endometrial hyperplasia, underscoring the need for progesterone therapy in these patients.[15] FSH was significantly lower in PCOS, likely due to negative feedback from elevated estradiol. The imbalanced LH/FSH ratio disrupts follicular development, favoring LH dominance—further contributing to anovulation and androgen excess.

In PCOS, reduced FSH levels are primarily caused by disrupted feedback in the hypothalamic-pituitary-ovarian (HPO) axis. Elevated estrogen and inhibin B suppress FSH secretion, contributing to follicular arrest and anovulation. [17] This mechanism is supported by studies from Pakistan and South Asia, which consistently associate FSH suppression with PCOS-related ovulatory dysfunction. [15,16] However, contrasting evidence exists. Some studies report non-significantly higher FSH levels in PCOS compared to controls [18], suggesting potential variability in FSH patterns across populations or PCOS phenotypes. Hirsutism is one of the most common clinical features of PCOS, supported by multiple studies.[10] This study also witnessed a significant positive correlation between hirsutism and serum testosterone levels, consistent with previous research.[14] In PCOS, theca cells exhibit upregulated steroidogenesis due to LH hyperactivity and insulin resistance. These factors cause excessive testosterone and androstenedione production.[1] Further, testosterone is converted into dihydrotestosterone (DHT) a more potent androgen by 5α-reductase in hair follicles. Elevated 5α-reductase activity in PCOS worsens hirsutism.[17] Despite these findings, hirsutism did not correlate with other endocrine markers, including FSH, LH, estradiol and LH: FSH ratio. This may suggests that testosterone and 5α-reductase activity are the primary drivers of hirsutism in PCOS, while other hormonal axes may play a less direct role.

CONCLUSION

This study reiterates that PCOS has a distinct clinical and hormonal features, with dermatological manifestations such as hirsutism, acne, and seborrhea being highly prevalent and strongly associated. Significant hormonal imbalances, including elevated LH, testosterone, insulin, and leptin levels, were observed in PCOS cases, reflecting underlying metabolic and endocrine dysfunction. Correlations among specific symptoms, especially between acne and seborrhea, further support the interconnected nature of PCOS manifestations. The strong association between hirsutism and serum testosterone reaffirms the role of hyperandrogenism in PCOS. These findings can aid in early identification and better clinical management of women with PCOS.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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None declared.

AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	AM, AB
Acquisition, Analysis or Interpretation of Data:	AM, AB, MAIQ, FR, SM, NK
Manuscript Writing & Approval:	AM, AB, MAIQ, FR, SM, NK

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.