European Journal of Clinical Pharmacy
Print ISSN: 2385-409X **Online ISSN**: 3105-0409
Website: https://farmclin.com/

Original Research Article

A study of reproductive hormone profiles and anthropometric parameters in females with Polyendocrine Metabolic Ovarian Syndrome (PMOS)

Article History:

Name of Author:
Anuja Bhalerao[1], Ivan Aranha[1]*, Urmila Shinde [2], Gautam Aher [2]

Affiliation: *[1]Department of Zoology, BPHE Society's Ahmednagar College, Ahilyanagar, Savitribai Phule Pune University, Maharashtra 414 001*
[2]Department of Obstetrics and Gynaecology, Dr. Vithalrao Vikhe Patil Foundation's Medical College, Ahilyanagar, Maharashtra 414001

Corresponding Author:
Ivan Aranha

Received: 12-05-2026
Revised: 25-05-2026
Accepted: 06-06-2026
Published: 19-06-2026

Abstract: Polyendocrine metabolic ovarian syndrome (PMOS), formerly called polycystic ovary syndrome (PCOS), is a complex endocrine- metabolic disorder with multiple causes. It features menstrual irregularities, signs of hyperandrogenism, irregular gonadotropin levels, and various metabolic effects. This study compares hormonal, anthropometric, and clinical parameters between women with PCOS and those without to determine the significance of the differences and explore relationships among the variables. The sample included 94 women, with 47 diagnosed with PCOS and 47 without. Hormonal measurements included prolactin, LH, FSH, estrogen, total serum testosterone, and the LH/FSH ratio. Anthropometric measures were BMI and W/H ratio. Clinical features assessed included acanthosis nigricans, hirsutism, acne, hair loss, menstrual regularity, cycle length, and bleeding days. Descriptive statistics such as mean, standard deviation, variance, and standard error were calculated. Group differences were analysed using Welch's t-test and the Mann–Whitney U test; categorical clinical variables and median- categorised hormone levels were tested with chi-square. Results show that the PCOS group has significantly higher levels of testosterone, LH, BMI, and longer menstrual cycles, along with fewer bleeding days. Testosterone is the only biochemical marker consistently significant across both parametric and non- parametric tests. LH is elevated according to the t- test but not the Mann-Whitney U test, suggesting potential skewness or outliers. No significant differences are found for FSH, estrogen, prolactin, or FSH: LH ratio between groups. Strong associations are observed between PCOS and clinical features such as acanthosis nigricans, hirsutism, acne, hair loss, menstrual irregularity, prolonged cycle (> 35 days), very long cycle (≥ 90 days), and reduced bleeding (≤ 2 days), with all being statistically significant ($P < 0.05$). Hormone-only chi-square analysis post-median categorisation did not find significant associations for PRL, LH, FSH, estrogen, testosterone, or LH/FSH ratio, however there is a non-significant trend with testosterone. BMI is significantly correlated with PCOS and several clinical features, especially acanthosis nigricans, hirsutism, irregular cycles, and long cycle periods. Overall, the study suggests that PCOS's clinical presentation is largely driven by biochemical hyperandrogenism, abnormal gonadotropin activity, menstrual issues, and clinical symptoms. This underscores the importance of a comprehensive evaluation combining hormonal, menstrual, dermatological, and anthropometric assessments rather than relying on a single diagnostic marker.

Keywords: PMOS, Testosterone, LH, FSH, LH/FSH ratio, BMI, Hirsutism, Acanthosis nigricans, Menstrual irregularity, Hyperandrogenism.

INTRODUCTION

Polycystic ovary syndrome (PCOS) is a very prevalent endocrine disease in reproductive-age women. Now widely recognized as a heterogeneous disease, not a

single uniform disease. The syndrome can be manifested in the reproductive, endocrine, dermatological, metabolic and psychological domains. According to the International recommendations, PCOS is defined by the presence of ovulatory dysfunction, clinical and/or biochemical hyperandrogenism and polycystic ovarian morphology and/or anti-Müllerian hormone in adults [1-3]. Adolescent PCOS is often diagnosed with extra care since normal pubertal physiology can present similarly; thus, attention is typically placed on ovulatory dysfunction and hyperandrogenism before diagnosis of adolescent PCOS [3-4]. The signs/symptoms of PCOS are not uniform and may vary. Many have just irregular cycles and are infertile; others exhibit androgenic dermatological symptoms like hirsutism, acne and androgenic baldness. Many also exhibit metabolic characteristics such as raised BMI, central adiposity, insulin resistance, and acanthosis nigricans. Due to this variation, PCOS is a condition that needs to be assessed clinically, biochemically and anthropometrically. New evidence-based advice suggests that the diagnosis and interpretation of PCOS should not rely on a single parameter, as no single hormone, clinical feature or ultrasound finding fully explains PCOS in all individuals [3,5-6]. Evaluation of PCOS is important, and hormonal assessment is a significant factor. Many patients will have a higher LH due to changes in the activity of the hypothalamic-pituitary-ovarian axis. A rise in LH may promote the production of androgen by the ovarian theca cells. In some patients, the level of FSH is normal or relatively low, with a higher ratio of LH/FSH. However, the LH/FSH ratio is not a good standalone test for PCOS, as it is different among PCOS phenotypes, BMI ranges, age categories, menstrual-cycle phase, and test conditions [3] [7]. Total testosterone is clinically relevant as biochemical hyperandrogenism is a hallmark of PCOS and may be associated with hirsutism, acne and androgenic alopecia [8-9]. Additionally, women with menstrual dysfunction often have their prolactin and estrogen levels checked. They are different from testosterone and gonadotropins, though. Evaluation of prolactin is crucial as hyperprolactinemia is a standalone cause of menstrual irregularity and infertility, and should be ruled out in the evaluation of PCOS-like symptoms. Estrogen fluctuates significantly throughout the follicular phase and menstrual cycle, and therefore, a single estrogen reading does not necessarily represent the overall pattern. Changes in LH level and androgen levels are more consistent in PCOS, while those in prolactin and estrogen are less consistent across samples in recent hormone profile studies [10-11]. Anthropometric parameters are also significant, as PCOS is closely associated with metabolic dysfunction. BMI is a general indicator of body mass and waist circumference, and the ratio of waist to hip circumference is an indicator of central or abdominal adiposity. Hyperandrogeny may be exacerbated by increased adiposity, which may exacerbate insulin resistance, which may increase ovarian androgen production, lower sex hormone-binding globulin, and exacerbate hyperandrogeny effects. Acanthosis nigricans is considered a physiological marker of insulin resistance and is frequently seen in metabolically affected PCOS phenotypes [9,12-13]. Hence, BMI and waist-related assessment measures not only provide descriptive body measurements but are also clinically meaningful indicators of potential metabolic burden. This present analysis aimed to assess the effect of the interaction between hormonal, anthropometric and clinical parameters in PCOS and non-PCOS individuals. The statistical technique applied included central tendency calculations, independent t-test, Mann-Whitney U test, chi-square analysis and hormone-clinical comparisons. In this study, the PRL, LH, FSH, estrogen, testosterone, LH/FSH ratio, BMI, Waist-Hip ratio, Acanthosis nigricans, hirsutism, acne, hair loss, menstrual regularity, cycle duration and bleeding days are specifically studied. This holistic approach is helpful as PCOS can only be best understood when all aspects of endocrine imbalance, menstrual dysfunction, metabolic tendency, and clinical symptoms are all considered.

CONTEXTUAL FRAMEWORK

The perception of PCOS as a solely ovarian condition has changed in the modern definition of PCOS. Now recognized as a complex endocrine-metabolic disorder with reproductive, metabolic, dermatological and psychosocial implications [14]. The 2023 International Evidence-based Guideline (IEG) suggests a diagnosis of adult polycystic ovary syndrome (PCOS) should be made based on two of three features: oligomenorrhea (abnormally irregular periods), clinical or biochemical hyperandrogenism, and polycystic ovary morphology (PCO) or elevated AMH levels (after exclusion of other related conditions) [3]. This framework is significant because the disorder's symptoms vary from person to person. In some patients, hyperandrogenism is prominent and in others, the menstrual or metabolic characteristics. Christ and Cedars (2023) highlighted the importance of diagnostic accuracy in PCOS, noting the risks of both overdiagnosis and underdiagnosis [5]. Joham et al., (2025) also identified the following diagnostic difficulties: mild symptoms, early assessment of the adolescent, and influence of hormonal therapy on biochemical testing [6]. Current recommendations also emphasize the importance of irregular cycles and hyperandrogenism when they occur together. Thus, a diagnosis of PCOS should rely on a combination of menstrual history, clinical signs, hormone levels and exclusion of underlying disorders, including thyroid disease, hyperprolactinemia, congenital adrenal hyperplasia, or androgen-secreting tumour. The hormones of the ovary are regulated by central

hormones, LH and FSH. LH induces theca cells to produce androgens, and FSH promotes follicular maturation and granulosa cell functions. Given the abnormal gonadotropin pulsatility in PCOS, there may be a greater release of LH, which can further stimulate androgen excess. Increased levels of LH and the altered LH/FSH ratio have been reported in PCOS subjects, particularly in lean or classic (hyperandrogenic) phenotypes [7,11].

In the past, the LH/FSH ratio was a supportive indicator in PCOS diagnosis, but this is no longer recommended. This is because the ratio is not consistent, and it could be influenced by age, BMI, assay method, the cycle phase, and PCOS phenotype [3,7]. One major symptom of PCOS is hyperandrogenism, which might be biochemical or clinical. Total testosterone is a good indicator of biochemical hyperandrogenism; however, free testosterone or calculated free androgen index is more sensitive depending on the quality of the assays and levels of sex hormone binding globulin [3]. Clinically, the androgen excess can manifest itself through hirsutism, acne, seborrhoea and androgenic alopecia. Of these, hirsutism is often regarded as the ideal clinical indicator of androgen excess [8]. Several factors, including peripheral sensitivity to androgens, 5 alpha reductase activity, ethnic background, sensitivity of the hair follicles, insulin resistance, and the length of time during which the hair follicles are exposed to the androgen, have all been shown to affect the clinical androgenic signs. Hence, serum testosterone might be more effective at differentiating PCOS from a single clinical sign in a small or mixed sample [8,15-16].

Prolactin is not among the primary hormones of PCOS, but is clinically significant as hyperprolactinemia is a cause of menstrual irregularity, infertility and anovulation. So, it is a good idea to check prolactin when the person has symptoms of PCOS to rule out other causes. Crnovrsanin and Dzeko (2025) also found that reproductive hormone differences in PCOS may be more pronounced for the LH pattern than for the estrogen and prolactin [11]. Importance of the metabolic component of PCOS: many patients exhibit insulin resistance, increased adiposity, dyslipidaemia and an increased risk of type 2 diabetes. BMI is a useful measure of total fatness, and waist circumference, waist-height ratio and waist-hip ratio offer further information regarding central fat distribution. The association of abdominal adiposity with increased insulin resistance and reproductive and androgenic symptoms in PCOS has been suggested by the available evidence [17-19]. It may be possible that waist circumference or the waist-height ratio would have been more sensitive parameters than the waist-hip ratio, as recent studies indicated that the waist-based index might be more sensitive in assessing the risk of insulin resistance in PCOS [19, 20-21].

Signs of PCOS can often be seen on the skin. Hirsutism is a characteristic of terminal hair growth in response to androgens and is closely associated with clinical hyperandrogenism. Hormonal influences, the activity of the sebaceous glands, skin type, genetics and age may also play a role in the development of acne and androgenic alopecia. Acanthosis nigricans is not linked to these androgenic effects, as it is more strongly associated with insulin resistance and hyperinsulinemia [12, 9]. PCOS can have a dual impact on both the androgenic and metabolic pathways. Hyperandrogenism, insulin resistance and acanthosis nigricans have been described as a clinically significant phenotype of PCOS [13,22-23]. One of the most significant clinical clues of an ovulatory dysfunction is menstrual irregularity. The current guideline-based interpretation of prolonged cycles, infrequent cycles or cycles longer than 90 days is a clinically relevant indicator of ovulatory disturbance, based on time since menarche [3]. In general, all the literature agrees that PCOS should be assessed as an integrated endocrine-metabolic-clinical problem [1, 24].

In this data set, the most significant indicators are testosterone, LH, BMI, duration of menstrual cycle, bleeding days, acanthosis nigricans, acne, and hair loss. The results also demonstrate that parameters like LH/FSH ratio and waist-hip ratio (WHR) can exhibit the directionality of change without attaining statistical significance. This emphasizes the need for the size of the sample, the variation of phenotype and the use of the right statistical tests. While PCOS is extensively studied, there are still some gaps in the research. First, many studies take into account hormone levels per se, and fewer combine hormone values with clinical signs, menstrual variables and anthropometric parameters in the same analysis. Second, although it is not a particularly reliable indicator of diagnosis, the LH/FSH ratio is still often referred to in clinical practice. Third, the dermatological signs (hirsutism, acne, alopecia, acanthosis nigricans) can present as different biological mechanisms, and it is often not possible to differentiate between androgenic and metabolic mechanisms. Fourth, BMI is frequently researched, whereas waist circumference, waist-height ratio and waist-hip ratio are not always analysed together. Lastly, many small data sets lack statistical power when continuous hormones are transformed into categorical hormones for chi-square testing. Here, the present analysis fills part of this void by evaluating all the hormonal, clinical, menstrual and anthropometric parameters simultaneously. It reports that the testosterone-BMI ratio and waist-hip ratio seemed less statistically informative than testosterone and BMI alone, and that clinical features had stronger chi-square associations with PCOS than did the median-categorized hormone variables.

European Journal of Clinical Pharmacy
Print ISSN: 2385-409X **Online ISSN**: 3105-0409
Website: https://farmclin.com/

MATERIALS AND METHODS

94 female subjects were included in the study after their clinical assessment by an expert. The females were divided into two groups: 37 were categorised as PCOS subjects, and the remaining 37 were non-PCOS subjects. Serum analysis was performed for LH, FSH, Estrogen, Total Testosterone, and PRL after obtaining their informed consent. Clinical parameters dictating classic PCOS features, such as acanthosis nigricans, hirsutism, acne, and hair loss, were also assessed. Anthropometric parameters such as BMI, waist circumference, and hip circumference were recorded. Blood sample collection for serum analysis of hormones was done after acquiring Ethical Committee permission (Reference No. DVVPF's VIMS/ICE/C2021/01) from Vithalrao Vikhe Patil Foundation's Medical College, Ahilyanagar.

OBSERVATIONS

Table 1: Descriptive statistics among the PCOS and Non-PCOS groups

Groups	PCOS				Non-PCOS			
Parameters	Mean	Standard Deviation	Variance	Standard error	Mean	Standard Deviation	Variance	Standard error
LH	16.542	19.621	384.971	2.862	10.14	8.702	75.718	1.269
FSH	8.113	13.199	174.203	1.925	5.672	2.378	5.655	0.347
LH/FSH	2.21	1.528	2.335	0.223	1.8	1.094	1.196	0.16
Estrogen	70.688	47.888	2293.297	7.061	80.34	53.778	2892.102	7.844
Testosterone	36.761	16.788	281.834	2.449	28.928	12.849	165.09	1.874
PRL	16.093	18.512	342.711	2.7	16.466	15.368	236.179	2.24224.043
Age	25.043	5.357	28.694	0.781	20.043	3.085	9.52	0.45

Table 2: Welch t-test and Mann-Whitney test for hormonal and clinical parameters

Parameter	Welch t p-value	Mann-Whitney p-value	Inference
Age	0.000056	0.000028	Significant
PRL	0.919601	0.794179	Not significant
LH	0.046341	0.209374	Significant by t-test only
FSH	0.216879	0.418437	Not significant
Estrogen	0.363310	0.364179	Not significant
Testosterone	0.024412	0.020056	Significant
BMI	0.032035	0.016695	Significant
Waist-hip ratio	0.061838	0.075447	Not significant, near trend
LH/FSH ratio	0.158019	0.380389	Not significant
Cycle duration	<0.001	<0.001	Significant
Bleeding days	<0.001	<0.001	Significant

Table 3: Chi-square analysis of clinical features among PCOS and Non- PCOS females

Clinical parameter	PCOS counts		Non-PCOS counts		χ^2	p-value	Inference
	Yes	No	Yes	No			
Acanthosis nigricans	30	17	1	46	37.735	<0.001	Significant
Hirsutism	40	7	3	44	55.551	<0.001	Significant
Acne	30	17	7	40	21.572	<0.001	Significant
Hair loss	39	8	19	28	16.252	<0.001	Significant
Irregular Menstrual cycle	47	0	0	47	90.043	<0.001	Significant
Cycle >=90 days	9	38	0	47	7.864	0.005	Significant
Cycle >35 days	38	9	1	46	56.794	<0.001	Significant
Bleeding =<2 days	23	24	2	45	21.797	<0.001	Significant

Table 4: Chi-square analysis of hormonal parameters among PCOS and Non-PCOS females

Hormones	Median cutoff used	PCOS <= median	PCOS > median	Non-PCOS <= median	Non-PCOS > median	χ^2	p-value	Result
PRL	11.140	21	26	26	21	0.681	0.409	Not Significant
LH	8.890	21	26	26	21	0.681	0.409	Not Significant
FSH	5.915	23	24	24	23	0.0001	1.000	Not Significant
Estrogen	60.650	23	24	24	23	0.0001	1.000	Not Significant
Testosterone	31.940	19	28	28	19	2.723	0.099	Near trend, not Significant
LH/FSH ratio	1.791	21	26	26	21	0.681	0.409	Not Significant

Table 5: Comparison of clinical parameters with hormonal mean values

Clinical Comparison	Hormone/measure	Mean with feature	Mean without feature	p-value interpretation
Hirsutism (Yes vs No)	BMI	23.735	20.781	Significant
Acanthosis nigricans (Yes vs No)	BMI	23.701	21.360	Significant
Menstrual irregularity	Testosterone	36.761	29.563	Significant
Menstrual irregularity	BMI	23.167	21.097	Significant
Menstrual cycle > 35 days	Testosterone	37.090	30.377	Significant
Menstrual cycle > 35 days	BMI	23.556	21.122	Significant
Amenorrhea/prolonged menstrual cycle >= 90 days	LH/FSH ratio	3.168	1.892	Significant by Mann-Whitney
Acne (Yes vs No)	Testosterone	37.107	30.601	Near Significant trend
Acanthosis nigricans (Yes vs No)	Waist-hip ratio	0.774	0.748	Near Significant trend

Table 6: Independent t-test for Hormonal and clinical parameters among PCOS vs non-PCOS

Parameter	PCOS mean	Non-PCOS mean	t-test p-value	Mann-Whitney p-value	Interpretation
Age	24.043	20.191	<0.001	<0.001	Significant
PRL	16.093	16.448	0.9196	0.7942	Not Significant
LH	16.542	10.183	0.0463	0.2094	Significant by t-test only
FSH	8.113	5.666	0.2169	0.4184	Not Significant
Estrogen	73.163	83.253	0.3633	0.3642	Not Significant
Total Testosterone	36.761	29.563	0.0244	0.0201	Significant
LH/FSH	2.210	1.819	0.1580	0.3804	Not Significant
BMI	23.167	21.097	0.0320	0.0167	Significant
Waist-hip ratio	0.767	0.745	0.0618	0.0754	Not Significant; near trend
Menstrual cycle duration	63.213	28.447	<0.001	<0.001	Significant
Bleeding days	3.149	4.787	<0.001	<0.001	Significant

Table 7: Comparison between hormonal and clinical parameters of PCOS

Clinical comparison	Parameter	Group1 mean	Group2 mean	t-test p-value	Mann-Whitney p-value	Interpretation
Menstrual cycle regular vs irregular	LH	Regular 10.183	Irregular 16.542	0.0463	0.2094	Significant by t-test only
Menstrual cycle regular vs irregular	FSH	Regular 5.666	Irregular 8.113	0.2169	0.4184	Not significant
Menstrual cycle regular vs irregular	LH/FSH ratio	Regular 1.819	Irregular 2.210	0.1580	0.3804	Not significant
Cycle>= 35 days	LH	No 12.905	Yes 14.008	0.7482	0.7530	Not significant
Cycle>= 35 days	FSH	No 7.554	Yes 5.953	0.3523	0.6425	Not significant
Cycle>= 35 days	LH/FSH ratio	No 1.924	Yes 2.142	0.4504	0.4802	Not significant
Cycle>=90 days	LH	No 12.060	Yes 25.662	0.2465	0.0730	Not significant, near trend
Cycle>=90 days	FSH	No 6.938	Yes 6.429	0.7611	0.9385	Not significant
Cycle>=90 days	LH/FSH ratio	No 1.892	Yes 3.168	0.0698	0.0163	Significant by Mann-Whitney
Bleeding<= 2 days	LH	No 12.717	Yes 15.145	0.6047	0.7418	Not significant
Bleeding<= 2 days	FSH	No 7.182	Yes 6.083	0.4571	0.6875	Not significant
Bleeding<= 2 days	LH/FSH ratio	No 1.968	Yes 2.144	0.6265	1.0000	Not significant
Hirsutism, yes/no	LH	No 12.261	Yes 14.669	0.4698	0.5692	Not significant
Hirsutism, Yes/No	FSH	No 6.222	Yes 7.681	0.4986	0.2549	Not significant
Hirsutism, Yes/No	LH/FSH ratio	No 1.928	Yes 2.118	0.5001	0.6653	Not significant
Acanthosis nigricans Yes/No	PRL	No 15.325	Yes 18.192	0.5170	0.8187	Not significant
Hirsutism, Yes/No	Testosterone	No 31.466	Yes 35.173	0.2444	0.0870	Not significant; weak trend
Hair loss, Yes/No	Testosterone	No 34.839	Yes 32.121	0.4496	0.7031	Not significant

Descriptive and inferential statistical analysis was performed on the collected data. Mean standard deviation, variance and standard error were calculated separately for the hormonal assay and menstrual health of PCOS and non-PCOS groups. Independent sample t-test was performed to compare the mean hormone levels between two independent groups. The Mann-Whitney U test was also performed due to skewed hormonal values. Chi-square test was performed for categorical variables such as clinical parameters of PMOS, menstrual cycle health and hormone levels.

The data included 94 female patients, divided equally into two groups: 47 with PCOS and 47 without. Reproductive hormones, anthropometric data, and clinical signs were analyzed. Hormonal tests measured prolactin, luteinizing hormone, follicle-stimulating hormone, estrogen, serum testosterone, and the LH/FSH ratio (see Table 1). Clinical features assessed included acanthosis nigricans, hirsutism, acne, hair loss, menstrual regularity, cycle length, and bleeding duration (see Table 3). Generally, the PCOS group showed higher average levels of LH, FSH, testosterone, BMI, waist-hip ratio, LH/FSH ratio, and longer menstrual cycles compared to the non-PCOS group. They also experienced fewer bleeding days. Total serum testosterone showed the most significant difference among biochemical

variables, highlighting its role as a marker of hyperandrogenism in PCOS [1-3]. The PCOS group also had elevated LH levels and LH/FSH ratios, indicating altered hypothalamic-pituitary-ovarian axis function; however, the LH/FSH ratio difference was not statistically significant. Clinically, there was a notable disparity: PCOS subjects had higher incidences of acanthosis nigricans, hirsutism, acne, hair loss, irregular periods, and longer cycles compared to controls. These findings suggest that PCOS manifestations encompass hormonal, dermatological, and menstrual abnormalities.

RESULTS

There is a difference between the mean ages of these groups, as observed in descriptive statistics. The mean age of the two groups was PCOS group *vs* the non-PCOS group, is 24.043 years *vs* 20.191 years, respectively. Welch's independent t-test and Mann-Whitney U test analysis show this difference is statistically significant (Table 2). The mean prolactin concentration is almost the same for both groups. The mean PRL for the PCOS group is 16.093, and for the non-PCOS group is 16.448. The difference is not statistically significant. This indicates that the present data set did not contain a large amount of prolactin as a discernible hormone. The mean LH concentration is higher in the PCOS group: 16.542 versus 10.183 in the non-PCOS group (Table 6). Welch t-test shows statistical significance, although the Mann-Whitney U test is not significant, suggesting that the distribution is shifted towards higher levels of LH in the PCOS group; however, this could be due to skewness or outliers. Hence, LH must be used as a supporting rather than a standalone marker of LH. The mean value of FSH is higher in the PCOS group (8.113) than in the non-PCOS group (5.666). There is no statistically significant difference, however. The LH/FSH ratio is also elevated in PCOS group subjects, but the difference is not statistically significant (2.210 vs 1.819 in non-PCOS group subjects). This indicates the ratio of LH/FSH is in the same direction as observed in PCOS, but was not a statistically significant discriminator in this data set (Table 6). The mean estrogen level of the PCOS group is 73.163, while the mean level of the non-PCOS group is 83.253. There is no significant difference. This may be explained by the cyclical variation, the inter-individual variability of endocrine function and the absence of standardization of the sampling throughout the day of the menstrual cycle. The level of total serum testosterone is significantly elevated in the PCOS group. The mean of Testosterone for the PCOS group is 36.761, and for the non-PCOS group is 29.563. This difference is significant for both the Welch t-test and the Mann–Whitney U test (Table 6). This is one of the most significant findings of the study, since the rise in testosterone contributes to biochemical hyperandrogenism, a core problem in PCOS [1-3, 5].

BMI is also significantly elevated in the PCOS group (Table 6). The average BMI of the PCOS group is 23.167, and that of the non-PCOS group is 21.097. There is no significant difference between the two groups with respect to the WHR. These results indicate that body composition and metabolic disposition may play a role in the clinical manifestation of PCOS in this data set. The period of menstruation is significantly longer amongst PCOS subjects. The mean cycle duration is 63.213 days for the PCOS group and 28.447 days for the non-PCOS group. The difference is statistically significant (Table 6). Leading the way is the PCOS group with an average of 3.149 bleeding days *versus* 4.787 days in the non-PCOS group. This difference is also very significant. The results corroborate the occurrence of ovulatory dysfunction and menstrual irregularity in the PCOS subjects. There are significant associations between PCOS status and acanthosis nigricans, hirsutism, acne, hair loss, menstrual irregularity, cycle duration>35 days, cycle duration>90 days and bleeding duration>12 hrs. Hirsutism is strongly associated with the 40 PCOS subjects having hirsutism compared to 3 of the non-PCOS subjects (Table 5). There are 30 (30%) subjects with PCOS and 1 (1%) without PCOS who have acanthosis nigricans. All the subjects of PCOS are suffering from irregular menstrual cycles, while all the non-PCOS subjects have regular cycles. Results from independent t-test indicate that there are significant differences in age, LH, testosterone, BMI, menstrual-cycle duration and bleeding days between PCOS and non-PCOS groups (Table 6). The hormone parameters that were significant in both the Welch t-test and Mann-Whitney U test were the most consistent, and the parameter most consistently significant was testosterone. The difference of LH was significant by t-test but not by the Mann-Whitney U test, indicating that the difference of LH might be influenced by the non-normal distribution or by extreme values.

There are no statistically significant differences between the PCOS group and the non-PCOS groups for FSH, estrogen, PRL, and LH/FSH ratio (Table 7). The mean LH/FSH ratio is elevated in the PCOS group, although statistically, the ratio is not elevated sufficiently in this set of data. In the irregular cyclers, LH is increased. However, this comparison overlaps greatly with the PCOS vs non-PCOS comparison, as all the PCOS subjects are irregular and all the non-PCOS subjects are regular. There are no significant differences among LH, FSH and LH/FSH ratio for the categories of cycle duration >35 days, except for the LH/FSH ratio, which is significantly higher in those with cycle duration of 90 days or more compared to those with shorter duration, using the Mann-Whitney U-test (Table 7).

The PRL level does not significantly differ between individuals with and without acanthosis nigricans. In general,

there was no significant difference in the testosterone levels between respondents who were hirsute and those who were not, as well as between those who had hair loss and those who did not. However, testosterone levels are often much higher in PCOS participants, indicating that biochemical hyperandrogenism is more closely associated with PCOS status than with any particular clinical indication in this data set.

Comparing hormone levels and clinical characteristics reveals significant variations between those with irregular menstrual periods and those whose cycles extend more than 35 days. When testosterone hormone levels are evaluated with clinical criteria, significant differences are observed between women with irregular menstrual cycles and those with cycles longer than 35 days. BMIs are significantly greater in those with hirsutism, acanthosis nigricans, irregular periods, and prolonged cycle durations (Table 5). Those whose cycles lasted 90 days or longer also had higher LH/FSH ratios, and Mann-Whitney testing showed a significant difference between the two groups. Testosterone levels and acne exhibit a statistically significant trend, indicating a possible androgen connection.

DISCUSSION

The study's findings showed that PCOS and non-PCOS participants differed in their endocrine and clinical traits. An elevated amount of both LH and testosterone is the most noticeable biochemical change. Significant levels of total serum testosterone, a key pathophysiological and diagnostic feature of PCOS, are one of the most significant biochemical indicators supporting hyperandrogenism. The clinical manifestations of androgenisation, such as acne, hirsutism, and hair loss, may be explained by elevated testosterone levels [8]. The clinical relevance of androgen excess was highlighted by the considerably higher prevalence of hirsutism, acne, and hair loss among the PCOS participants in the current dataset.

The elevated LH level in the PCOS group is consistent with the changes in gonadotropin activity. The abnormal pulsatile GnRH activity can lead to excessive LH secretion, possibly causing excessive androgen production as a result of excessive stimulation of the theca cells of the ovary. LH/FSH ratio was found to be elevated in the PCOS group; this difference was non-significant. This is because, in some PCOS phenotypes, the LH/FSH ratio can be raised, but how variable it is, and should not be relied on as a single diagnostic marker [7]. The elevated ratio of LH/FSH in this data set must be looked upon as supportive but not conclusive.

The chi-square analysis indicates that acanthosis nigricans is significantly related to PCOS, while PRL is not significantly related to acanthosis nigricans. Clinically, sensible as acanthosis nigricans is more related to insulin resistance and metabolic disturbance than prolactin [14]. A lack of a significant prolactin difference indicates that prolactin is not a major factor in the development of PCOS in this data set. This finding is important because hyperprolactinemia alone can also cause irregular periods and can be a symptom of PCOS [24]. Similarly, there is no significant difference in estrogen between the groups. There are complex issues with estrogen interpretation, as values fluctuate throughout the menstrual cycle and not all estrogen levels can be used to represent the entire endocrine environment [26].

Menstrual results are quite encouraging. PCOS participants have longer cycles and fewer bleeding days. Every PCOS participant has irregular periods, and several of them lasted more than 35 days. There is evidence of substantial oligomenorrhea or amenorrhea-like prolonged cycle intervals in nine PCOS participants whose cycles lasted 90 days or more. According to current international guidelines, cycles that start more than 35 days following menarche or any cycle that starts more than 90 days after menarche are regarded as irregular [3]. As a result, the menstrual profile in this dataset clearly suggests that the PCOS group has ovulatory failure.

The clinical variables also clearly separated the groups. Hyperandrogenism is a clinical characteristic of PCOS that is strongly associated with hirsutism. Acne and hair loss also have a significant association with PCOS, but these can be determined by other non-androgenic factors as well. It is found that acanthosis nigricans is significantly associated with PCOS, as well as BMI. This provides evidence for the potential metabolic implications and insulin resistance of PCOS individuals. Acanthosis nigricans is considered a visual indicator of insulin resistance, and should be analyzed in conjunction with other metabolic indicators such as BMI, WHR, glucose, insulin, and lipid parameters when available [9]. Results show that BMI is a better predictor of clinical PCOS criteria compared to WHR. The BMI is significantly higher in the PCOS group, indicating that excess body weight may play a role in the clinical burden of PCOS. This makes sense biologically, since PCOS is a reproductive endocrine disorder as well as a metabolic one for many patients. Higher adiposity could be a contributor to insulin resistance, while insulin resistance may increase ovarian androgen production, menstrual dysfunction, and metabolic risk [18, 27]. The association between BMI and acanthosis nigricans is particularly important. Insulin resistance is thought to be a clinical marker of acanthosis nigricans. The present analysis shows that the BMI is significantly higher in the subjects with acanthosis nigricans. This lends credit to the potential association between increased adiposity and metabolic disorders in PCOS [18].

Subjects with hirsutism also proved to have significantly higher BMI. One of the main factors of PCOS is the presence of androgen excess, which is a clinical manifestation of hyperandrogenism (hirsutism). When BMI is tested alone in this dataset, however, it had a stronger relationship with hirsutism than did testosterone. This indicates that clinical hirsutism might not hinge just on the measured serum testosterone. BMI is also statistically significantly related to irregular periods. Irregular cycles have higher BMI, and also cycles >35 days have higher BMI. This strengthens the notion that a rise in adiposity can lead to ovulatory dysfunction [28]. BMI is clinically associated with important clinical parameters, but is not significantly related to individual hormone levels (LH, FSH, PRL, estrogen, testosterone, and LH/FSH ratio). Waist-hip ratio is also found to be higher in the PCOS group, without being statistically significant. Subjects with PCOS might also have central fat distribution, though there is currently no robust statistical evidence. These results indicate that the biochemical hyperandrogenism, the pattern of gonadotropin, menstrual irregularity and the clinical features of the androgens are the main features of the PCOS phenotype in this dataset. The most significant differentiating factors are the duration of the cycle, the number of bleeding days, acanthosis nigricans, hirsutism and irregular menstruation. To create a new name that accurately reflects the condition's diverse and multisystem features and avoids misleading references to ovarian cysts, PCOS, a historically neglected female condition affecting over 170 million people worldwide, led global engagement of PCOS patients and health professionals through a structured, multistep, robust process. Polyendocrine metabolic ovarian syndrome, or PMOS, is the new term for the condition formerly known as PCOS [14].

CONCLUSION

The present statistical analysis shows excellent differences between PCOS and non-PCOS subjects. Total serum testosterone is significantly higher in the PCOS group, which is indicative of biochemical hyperandrogenism. PCOS subjects also have elevated LH, reflecting dysregulated gonadotropins. However, the ratio of LH/FSH is elevated in PCOS subjects but not significantly different and should not be considered a separate diagnostic parameter. Testosterone, LH, BMI, menstrual-cycle duration, and bleeding days are the most significant (for statistical purposes) continuous parameters. The best categorical clinical correlations are: Hirsutism, acanthosis nigricans, acne, hair loss, irregular menstrual cycle, cycle >35 days, cycle ≥90 days, bleeding ≤2 days. The specific comparisons reveal higher levels of LH in irregular cycles and a higher LH/FSH ratio in those with a cycle duration of ≥90 days (Mann-Whitney U test). There is no association between acanthosis nigricans and PRL.

When clinical signs of hirsutism and alopecia are tested separately, there is no significant correlation between these signs and testosterone, but testosterone is significantly increased in PCOS. There is no statistically significant difference between the groups for FSH, estrogen, prolactin or waist-hip ratio. The results indicate that reproductive hormones may not be equally effective for discriminating between PCOS and non-PCOS subjects in this set of data. The most consistent biochemical marker of the hormones studied is testosterone. PCOS have a strong association with clinical features. Significant difference is observed between the PCOS subjects and control subjects as regards hirsutism, acne, alopecia, acanthosis nigricans, irregular period, duration of period and number of days in period. The highly significant differences in menstrual cycle duration and menstrual days show that ovulatory and menstrual disturbance are important factors in the PCOS group. When comparing the hormones, it is observed that there is a significant correlation between the use of the hormones and the menstrual irregularity, as well as the prolonged duration of the menstrual cycle. BMI is significantly elevated in PCOS subjects and is significantly correlated with several clinical parameters, particularly hirsutism, acanthosis nigricans, menstrual irregularity and prolonged cycles. The WHR was numerically elevated in PCOS subjects and did not reflect any significant differences or strong correlation with hormonal and clinical parameters. There are no significant direct correlations between BMI and PRL, LH, FSH, estrogen, testosterone or LH/FSH ratio, nor is there a correlation between the WHR and any of these variables. This suggests that anthropometric changes can influence PCOS by a more global metabolic influence, not because of a direct one-on-one correlation with any individual hormone level. These results indicate that androgen and metabolic factors play a role in the clinical manifestations of PCOS.

In conclusion, the data presented here point to PCOS as an endocrino-metabolic disorder marked by excess androgen, irregular reproductive hormone regulation, irregular menstruation, and/or observable clinical symptoms. The most significant variables in this study were testosterone, LH, BMI, menstrual cycle length, bleeding days, hirsutism, acanthosis nigricans, acne, and hair loss. In order to strengthen the clinical interpretation and better highlight the relationship between obesity, central adiposity, insulin resistance, hormonal imbalance, and PCOS severity, future analysis should include waist-height ratio, insulin, fasting glucose, HOMA-IR, lipid profile, AMH, ultrasound findings, and progesterone-based ovulation confirmation.

REFERENCES

1. Bhalerao, A., & Aranha, I. Polycystic ovarian syndrome (PCOS), a distress of female reproductive health. Shanlax International Journal of Arts Science and Humanities. 2021 Feb 06; 8(S1-Feb), 46-53. 10.34293/sijash.v8iS1-Feb.3930.
2. Bhalerao, A., & Aranha, I. Polycystic Ovarian Syndrome (PCOS): A Lifestyle Upshot and Cluster of Maladies. Quantum Journal of Medical and Health Sciences. 2023 Mar 20; 2(1), 50-62. 10.55197/qjmhs.v2i1.35.
3. Teede HJ, Misso ML, Costello MF, Dokras A, Laven J, Moran L, Piltonen T, Norman RJ; International PCOS Network. Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome. Fertil Steril. 2018 Aug;110(3):364-379. doi: 10.1016/j.fertnstert.2018.05.004. Epub 2018 Jul 19. PMID: 30033227; PMCID: PMC6939856.
4. Peña AS, Witchel SF, Boivin J, Burgert TS, Ee C, Hoeger KM, Lujan ME, Mousa A, Oberfield S, Tay CT, Teede H. International evidence-based recommendations for polycystic ovary syndrome in adolescents. BMC Med. 2025 Mar 11;23(1):151. doi: 10.1186/s12916-025-03901-w. PMID: 40069730; PMCID: PMC11899933.
5. Christ JP, Cedars MI. Current Guidelines for Diagnosing PCOS. Diagnostics (Basel). 2023 Mar 15;13(6):1113. doi: 10.3390/diagnostics13061113. PMID: 36980421; PMCID: PMC10047373.
6. Joham AE, Tay CT, Laven J, Louwers YV, Azziz R. Approach to the Patient: Diagnostic Challenges in the Workup for Polycystic Ovary Syndrome. J Clin Endocrinol Metab. 2025 Jun 17;110(7):e2298-e2308. doi: 10.1210/clinem/dgae910. PMID: 39836632; PMCID: PMC12187463.
7. Pratama G, Wiweko B, Asmarinah, Widyahening IS, Andraini T, Bayuaji H, Hestiantoro A. Mechanism of elevated LH/FSH ratio in lean PCOS revisited: a path analysis. Sci Rep. 2024 Apr 8;14(1):8229. doi: 10.1038/s41598-024-58064-0. PMID: 38589425; PMCID: PMC11002031.
8. Azziz R, Amiri M, Bril F, Joham AE, Kelestimur F, Ottey S, Suturina L, Tay CT, Teede H, Yildiz BO, Zhao X. Approach to the Patient: Hirsutism. J Clin Endocrinol Metab. 2025 Sep 16;110(10):e3503-e3519. doi: 10.1210/clinem/dgaf226. PMID: 40200552.
9. Farhan M, Seyfi A, Alnuaimi A, Alamour M, Alwarafi S, Elastal H, Nazir MH, Kamaraj B, Putta Nagarajan HD, Delianne D, Ganesan S, Patel T. A narrative review on cutaneous manifestations in polycystic ovary syndrome: pathophysiology, diagnosis, management, and psychosocial impact. Ann Med Surg (Lond). 2025 Mar 28;87(5):2804-2811. doi: 10.1097/MS9.0000000000003217. PMID: 40337376; PMCID: PMC12055046.
10. Khmil, Mariya and Khmil, Stephan and Marushchak, Mariya. Hormone Imbalance in Women with Infertility Caused by Polycystic Ovary Syndrome: Is There a Connection with Body Mass Index?. Open Access Macedonian Journal of Medical Sciences. 2020 June; 8: 731-737. 10.3889/oamjms.2020.4569.
11. Crnovrsanin Z, Dzeko A. Evaluation of Reproductive Hormones (FSH, LH, E2, and Prolactin) in Patients From Bosnia With Polycystic Ovary Syndrome. Mater Sociomed. 2025;37(4):330-333. doi: 10.5455/msm.2025.37.330-333. PMID: 41726070; PMCID: PMC12923279.
12. Hughes, E. K., & Brady, M. F. Acanthosis nigricans. StatPearls Publishing, 2023
13. Lewin Z, Vitek WS, O'Malley W, Astapova O. Resolution of Hyperandrogenism, Insulin Resistance and Acanthosis Nigricans (HAIR-AN) Syndrome After Sleeve Gastrectomy. JCEM Case Rep. 2023 Jan 17;1(1):luac030. doi:10.1210/jcemcr/luac030. PMID: 37908254; PMCID: PMC10578405.
14. Teede HJ, Khomami MB, Morman R, Laven JSE, Joham AE, Costello MF, Patil M, Rees DA, Berry L, Cree MG, Zhao H, Norman RJ, Dokras A, Piltonen T; Global Name Change Consortium. Polyendocrine metabolic ovarian syndrome, the new name for polycystic ovary syndrome: a multistep global consensus process. Lancet. 2026 Jun 6;407(10545):2329-2339. doi: 10.1016/S0140-6736(26)00717-8. Epub 2026 May 12. PMID: 42119588.
15. Kumar PR, Telagareddy RK, Dash DK, Patro D. Diagnostic Utility of Various Hormones across Different Polycystic Ovary Syndrome Phenotypes: A Cross-sectional Study. J Hum Reprod Sci. 2024 Oct-Dec;17(4):275-283. doi: 10.4103/jhrs.jhrs_152_24. Epub 2024 Dec 23. PMID: 39831099; PMCID: PMC11741125.
16. Raju B.P., V. Methre, Shanmukha M N, N. Billalar. Cutaneous Manifestations and Their Relationship with Serum Testosterone and DHEAS Levels in Women with Polycystic Ovary Syndrome: A Cross Sectional Clinical Study. 2026 Feb 25. International Journal of Medical and Pharmaceutical Research, 7(1), 2718-2725. 10.5281/zenodo.18813290
17. Singh S, Pal N, Shubham S, Sarma DK, Verma V, Marotta F, Kumar M. Polycystic Ovary Syndrome: Etiology, Current Management, and Future Therapeutics. J Clin Med. 2023 Feb 11;12(4):1454. doi: 10.3390/jcm12041454. PMID: 36835989; PMCID: PMC9964744.
18. Morshed MS, Banu H, Hossan MS, Mahrukh H, Hasanat MA. Association of adiposity indices

with insulin resistance among women with polycystic ovary syndrome. Clin Exp Reprod Med. 2025 Dec;52(4):342-347. doi: 10.5653/cerm.2024.07388. Epub 2025 Aug 27. PMID: 41354032; PMCID: PMC12682414.

19. Prosperi S, Chiarelli F. Insulin resistance, metabolic syndrome and polycystic ovaries: an intriguing conundrum. Front Endocrinol (Lausanne). 2025 Oct 1;16:1669716. doi: 10.3389/fendo.2025.1669716. PMID: 41103651; PMCID: PMC12520869.
20. Zhu M, Wang K, Feng J, Liu Y, Guan M, Wang Y, Wu X. The waist-to-height ratio is a good predictor for insulin resistance in women with polycystic ovary syndrome. Front Endocrinol (Lausanne). 2024 Dec 9;15:1502321. doi: 10.3389/fendo.2024.1502321. PMID: 39717101; PMCID: PMC11664359.
21. Zeng J, Li Y, Zhou L, Gao L, Huang J, Tong X, Zhao Y, Lu T, Fu Z, Tan L. Clinical Insights into the Pathogenesis and Treatment Strategies of Acanthosis Nigricans: A Bibliometric Study of Current Trends and Future Directions. Clin Cosmet Investig Dermatol. 2026 Mar 9;19:572050. doi: 10.2147/CCID.S572050. PMID: 41835959; PMCID: PMC12984052.
22. Gheshlagh RA, Topsakal S. A Complex Clinical Situation in Polycystic Ovary Syndrome: HAIR-AN Syndrome "Case Report". Case Rep Med. 2025 Apr 29;2025:5825601. doi: 10.1155/carm/5825601. PMID: 40330136; PMCID: PMC12055325.
23. O'Brien B, Dahiya R, Kimble R. Hyperandrogenism, insulin resistance and acanthosis nigricans (HAIR-AN syndrome): an extreme subphenotype of polycystic ovary syndrome. BMJ Case Rep. 2020 Apr 9;13(4):e231749. doi: 10.1136/bcr-2019-231749. PMID: 32276996; PMCID: PMC7167451.
24. Bhalerao, A., Aranha, I., Yewale, Y., Shinde, U., & Aher, G. An Analysis of Polycystic Ovarian Syndrome (PCOS) Among College Students in Ahilyanagar, Maharashtra, Based on Different Statistical Models. The Bioscan. 2024 Dec 30; 19(2): S2: 507-512.
25. Kulshreshtha B, Pahuja I, Kothari D, Chawla I, Sharma N, Gupta S, Mittal A. Menstrual Cycle Abnormalities in Patients with Prolactinoma and Drug-induced Hyperprolactinemia. Indian J Endocrinol Metab. 2017 Jul-Aug;21(4):545-550. doi: 10.4103/ijem.IJEM_515_16. PMID: 28670538; PMCID: PMC5477442.
26. Xu Y, Zhang Z, Wang R, Xue S, Ying Q, Jin L. Roles of estrogen and its receptors in polycystic ovary syndrome. Front Cell Dev Biol. 2024 Jun 19;12:1395331. doi: 10.3389/fcell.2024.1395331. PMID: 38961865; PMCID: PMC11219844.
27. Jurczewska J, Ostrowska J, Chełchowska M, Panczyk M, Rudnicka E, Kucharski M, Smolarczyk R, Szostak-Węgierek D. Abdominal Obesity in Women with Polycystic Ovary Syndrome and Its Relationship with Diet, Physical Activity and Insulin Resistance: A Pilot Study. Nutrients. 2023 Aug 20;15(16):3652. doi: 10.3390/nu15163652. PMID: 37630842; PMCID: PMC10459970.
28. Savran Üçok B, Dikici Aktaş T, Özalp E, Ulusoy CO, Akbulut ÖV, Kından A, Fıratlıgil FB. Comparative analysis of hormonal and metabolic indices in phenotypic subgroups of polycystic ovary syndrome. J Turk Ger Gynecol Assoc. 2026 Mar 3;27(1):29-35. doi: 10.4274/jtgga.galenos.2026.2025-9-22. Epub 2026 Feb 4. PMID: 41636273; PMCID: PMC12954625.

