ORIGINAL ARTICLE

Hormonal and lifestyle risk factors for polycystic ovarian syndrome among women in Karnataka: A case control study

Soujanya J Pujar[1*], Neelamma Patil[2]

[1]Department of Obstetrics and Gynecological Nursing, BLDE's Shri B M Patil Institute of Nursing Sciences, Vijayapur-586103 (Karnataka) India, [2]Department Obstetrics and Gynecology, BLDE Deemed to be University Shri B M Medical College, Hospital and Research Centre, Vijayapur-586103 (Karnataka) India

Abstract

Background: Polycystic Ovarian Syndrome (PCOS) is one of the most common endocrine disorder affecting women of reproductive age. *Aim and Objectives:* To assess the clinical, selected lifestyle components and hormonal differences between women with and without PCOS. *Material and Methods:* A total of 96 women aged 21-35 were evaluated, with 49 diagnosed with PCOS based on the Rotterdam criteria and 47 women without PCOS and from same out-patient department serving as controls. Sociodemographic profiles, lifestyle habits, clinical features and hormonal parameters were assessed. Data were analyzed using SPSS version 20, with $p < 0.05$ considered statistically significant. *Results:* Women with PCOS exhibited significantly lower physical activity (24.5% vs. 57.4%, $p = 0.001$) higher intake of non-vegetarian diet and elevated hormonal parameters – prolactin (26.26 ± 3.78), testosterone (3.7526 ± 2.02) and luteinizing hormone to follicle stimulating hormone ratio > 2 in 55.1% of cases. Clinical features such as menstrual irregularities (100%), hirsutism (69.4%), acne (89.8%) and acanthosis nigricans (46.9%) were more prevalent among PCOS cases. *Conclusion:* The findings underscore the impact of physical inactivity, limited awareness, and hormonal imbalances in PCOS pathogenesis. Enhancing health education and early screening particularly in rural and disadvantaged populations may support timely diagnosis and effective management of PCOS.

Keywords: Polycystic Ovarian Syndrome, Hormonal Parameters, Lifestyle

Introduction

Polycystic Ovarian Syndrome (PCOS) is one of the most common endocrine- metabolic disorders among women of reproductive age with prevalence estimates ranging from 4% to 20% [1]. The link between obesity, hirsutism, amenorrhea and polycystic ovaries was initially reported by Stein and Leventhal in 1935 [2].

Two out of the three criteria- (a) oligo/ anovulation (b) polycystic ovaries on USG, and (c) Hyperandrogenism (HA) were required to establish PCOS at 2003 consensus meeting of European Society of Human Reproduction and Embryology and American Society for Reproductive Medicine in Rotterdam. A polycystic ovary is currently defined as having 12 + follicles that are 2-9 mm in size or having a larger volume (more than $10 cm^3$) [3]. The diverse clinical and biochemical phenotype of PCOS, an oligogenic condition, is determined by the interplay of many genetic and environmental variables [4]. Its pathogenesis involves complex interactions between insulin resistance, ovarian dysfunction, and hypothalamic-pituitary axis disturbances [5]. Insulin-related syndrome burdens

individuals by worsening essence while HA drives adipose tissue accumulation and dysfunction which results in oxidative stress [6]. HA is influenced by the up-regulation of Luteinizing Hormone (LH) receptors in ovarian thecal cell. In addition, obesity contributes to this process, as Dehydroepiandrosterone Sulfate (DHEA-S) is readily converted to testosterone within adipose tissue, thereby reinforcing the effects of hyperinsulinemia [7]. The complete range of this syndrome manifests as a combination of metabolic disturbances alongside reproductive and psychological dysfunction [8]. The presentation of symptoms encompasses acne development together with hirsutism and weight gain [9].

PCOS, as it progresses, can lead to multiple health complications such as irregular uterine bleeding, weight gain, type 2 diabetes, and increased risk of endometrial cancer, high cholesterol, and heart diseases [10]. It is caused by a combination of genetic and environmental factors, including excessive androgen exposure, Reactive Oxygen Species (ROS), immunological and endocrinal abnormalities along with genetic predispositions related to HA and insulin resistance [11]. Inflammatory pathways have also been implicated in its pathogenesis, with chronic low-grade inflammation contributing to both reproductive and metabolic disturbances [12]. Furthermore, epigenetic changes in genes regulating glucose and lipid metabolism have been associated with increased susceptibility to HA and insulin resistance in affected women [13].

Although sedentary lifestyle patterns and hormonal dysregulation in PCOS have been extensively investigated, there remains limited evidence from developing district-level contexts, where socio-demographic characteristics, levels of health literacy, and access to health care services may shape both lifestyles behaviors and awareness of PCOS. This study was therefore designed to examine the clinical features, selected lifestyle components and hormonal differences between women with and without PCOS.

Material and Methods
Study setting and design
This study took place at the gynaecology OPD of Shri B M Patil Medical College, Hospital and Research Centre in Vijayapur, Karnataka, India spanning March 2023 to March 2024. It followed a hospital-based observational case-control design across one year.

Study participants
A total of 96 women aged 21-35 years, who attended the outpatient department of gynaecology were the study participants. Among them, 49 women aged between 18-35 years who met Rotterdam Criteria [14] were recruited as cases (49). The control group comprised 47 women in the same age range (18-35) recruited from the same gynaecology OPD with regular menstruation cycles and no clinical signs of PCOS. Written informed consent was obtained from all participants before enrolment.

Sample size determination
The study enrolled 96 women (49 cases and 47 controls). Prevalence estimates of PCOS from prior Indian studies (12-14%) [15] were applied using the Leslie-Kish formula [16] to guide sample size estimation at 95% confidence level with a 5% margin of error. Given the constraints of the study period and available participants, the final sample achieved was 96, and findings are interpreted as exploratory.

Inclusion and exclusion criteria

The study included women aged between 18-35 years who attended the outpatient department. Participants were not included if they had a confirmed pregnancy, concurrent medical or surgical disorders, were on contraceptive medication, receiving hormone replacement therapy, or were absent at the time of data collection. Additional exclusions included women with thyroid disorders, hyperprolactinemia, Cushing syndrome or congenital adrenal hyperplasia to avoid confounding endocrine conditions.

Method of data collection

Information provided details on demographic factors such as age, education, occupation, and residence via a structured questionnaire. The questionnaire was administrated through face-to-face interviews conducted by trained researchers to ensure accuracy and completeness. Height and weight were assessed using established protocols, and Body Mass Index (BMI) was calculated as kilograms per square meter of height. Participants' menstrual history was documented, including cycle length and regularity. Cycles longer than 37 days were classified as oligomenorrhea. A detailed clinical examination was conducted to assess for signs of HA, including acne, hirsutism (using the modified Ferriman-Gallwey score), and acanthosis nigricans. Waist and hip circumferences were measured and waist –hip ratio was calculated. The ultrasonography records and hormonal levels including prolactin, Thyroid Stimulating Hormone (TSH), LH, Follicle Stimulating Hormone (FSH), and total testosterone were obtained from participant's medical reports. Assay methods and cycle phase for controls were noted to ensure comparability.

Statistical analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (IBM SPSS) version 20 and the results were expressed as frequencies as well as percentages and mean ± standard deviation. Continuous variables were compared using Student's t-test and categorical variables using with chi-squared test. A p value less than 0.05 was considered statistically significant.

Ethical considerations

This study was done in accordance with Declaration of Helsinki and approved by Institutional Ethical Committee at (Ref no: BLDE (DU)/IEC/584/2021-22) at BLDE (DU) Shri B M Patil Medical College, Hospital, and Research Centre, Vijayapur.

Results

A total of 96 participants, comprising 49 women with PCOS and 47 controls were included in this study. The age distribution showed 44% of cases were between 21-25 years old, with a similar distribution in controls. A significant association was observed between PCOS and marital status, with 75.5% of cases married compared to 46.8% of controls. Furthermore 49.0% of cases reported consanguineous marriages, compared to 8.5% of controls which was statistically significant.

Employment status also differed significantly; 67.3% of cases were homemakers, whereas controls were primarily students (57.4%). This difference in employment was statistically significant ($p = 0.001$). Regarding education, a significant association was found, with a majority of cases 69.4% having degree compared to 59.6% of controls. An overview of sociodemographic factors and their link to PCOS is provided in Table 1.

Table 1: Socio-demographic data and their association with polycystic ovary syndrome					
Characteristics		**Cases n (%)**	**Controls n (%)**	**Total (96)**	**Chi Square test score**	***p***
Age in years:	**< 21**	7 (14.3)	11 (23.4)	18	5.520	0.238
	21-25	22 (44.9)	18 (38.3)	40		
	26-31	14 (28.5)	7 (14.9)	20		
	31-35	6 (12.2)	11 (23.4)	17		
Residence	**Rural**	34 (69.4)	14(29.8)	48	16.980	0.001*
	Urban	15 (30.6)	33 (70.2)	47		
Religion	**Hindu**	47 (95.9)	46 (97.9)	93	0.303	0.582
	Muslim	2 (4.1)	1 (2.1)	3		
Education	**Secondary school**	6 (12.2)	0 (0.0)	6	16.306	0.001*
	High school	3 (6.1)	0 (0.0)	3		
	Degree	34 (69.4)	28 (59.6)	62		
	Post-graduation	6 (12.2)	19 (40.4)	25		
Marital status	**Married**	37 (75.5)	22 (46.8)	59	8.343	0.004*
	Unmarried	12 (24.5)	25 (53.2)	37		
Type of marriage	**Consanguineous**	24 (49.0)	4 (8.5)	28	29.695	0.001*
	Non-consanguineous	21 (42.9)	18 (38.3)	39		
	NA	4 (8.2)	25 (53.2)	29		
Employment	**Housemaker**	33 (67.3)	0 (0.0)	33	48.716	0.001*
	Student	11 (22.4)	27 (57.4)	38		
	Working	5 (10.2)	20 (42.6)	25		

Statistically significant at p<0.05

Table 2: Clinical data and their association with polycystic ovary syndrome

Clinical Parameter	Cases n (%)	Controls n (%)	Chi Square test	*p*
Irregular menstrual cycles	49 (100)	0 (0)	96	< 0.001*
Regular menstrual cycles	0 (0)	47 (100)		
Dysmenorrhea				
No	20 (40.8)	30 (63.8)	5.09	0.024
Yes	29 (59.2)	17 (36.1)		
Hirsutism	34 (69.4)	4 (8.5)	37.1759	0.001*
Acne	44 (89.8)	6 (12.8)	5.267	0.153
Acanthosis Nigricans	23 (46.9)	2 (4.3)	77.085	0.001*
Family History of PCOS	37 (75.5)	2 (4.25)	50.4958	0.001*
BMI *(Mean ± SD)	23.6954 ± 3.587	22.7471 ± 3.941	1004.000	0.279

Statistically significant at p<0.05; BMI: Body Mass Index; SD: Standard Deviation

Table 3: Lifestyle parameters and their association with polycystic ovary syndrome

Lifestyle parameters		Cases n (%)	Controls n (%)	Chi Square test	*p*
Diet	**Vegetarian**	18 (36.7%)	21(44.7%)	0.6279	0.428
	Non vegetarian	31(63.3%)	26 (55.3%)		
Physical activities	**Moderate to high activity**	12 (24.5%)	27 (57.4%)	10.8025	0.001*
	Mild activity	37 (75.5%)	20 (42.6%)		
Consumption of junk food	**Weekly once**	17 (34.7%)	18 (38.3%)	1.4028	0.236
	Weekly twice	15 (30.6%)	11 (23.4%)		
	More than 3 times a week	11 (22.4%)	9 (19.1%)		
	Not at all	6 (12.2%)	9 (19.1%)		

Statistically significant at p<0.05

Table 4: Biochemical profile and their association with polycystic ovary syndrome

Parameter	PCOS Cases (Mean ± SD)	Controls (Mean ± SD)	Chi-Square Value	p	Odds Ratio
Prolactin (ng/mL)	26.26 ± 6.78	16.25 ± 2.44	34.33	< 0.001*	0.05
TSH (µIU/mL)	6.30 ± 1.80	2.37 ± 1.40	73.22	0.695	441.0
Free Testosterone (pg/mL)	3.75 ± 2.02	2.13 ± 0.75	12.01	0.048*	0.23
LH (mIU/mL)	15.84 ± 2.85	15.81 ± 3.60	—	NS	—
FSH (mIU/mL)	9.03 ± 4.28	10.97 ± 5.49	—	NS	—
LH:FSH Ratio	> 2:1 in 27 (55.1%)	7 (14.9%)	3.46	0.063	0.14

*Statistically significant at p<0.05; ng/mL: nanograms per millimeter; µIU/mL: milli – international units per milliliter; pg/mL: picograms per milliliter; mIU/mL: milli-international units per milliliter; TSH: Thyroid stimulating hormone; LH: Luteinizing hormone; FSH: Follicle stimulating hormone

In the study, we observed that all cases reported irregular menstruation cycles, a defining criterion of the syndrome. Majority of the cases (59.2%) had painful menstruation compared to controls (36.1%). Hirsutism (69.4%), acne (89.8%) and acanthosis nigricans (46.9%) were found more in cases compared to controls. A statistically significant association was observed for hirsutism and acanthosis nigricans (p = 0.001 for both). Additionally, 75.5% of cases had a family history of PCOS. Significant associations were noted between PCOS and painful menstruation, acanthosis nigricans, as well as family history (p = 0.001). The clinical characteristics and their relationship with PCOS are summarized in Table 2. Table 3 shows that dietary pattern did not have a statistically significant association with PCOS, although a higher proportion of cases consumed a non-vegetarian diet (63.3%) compared to controls (55.3%). Moderate to high physical activity was observed in 24.5% of PCOS cases versus 57.4% of controls, a difference that reached statistical signi-

ficance (p = 0.001). However, the intake of junk food was similar in both groups and did not demonstrate a significant link to PCOS.

Table 4 presents that a statistically significant elevation in serum prolactin (p < 0.001) and free testosterone levels (p = 0.048) was observed among PCOS cases, indicating hyperprolactinemia and HA as key hormonal features of the syndrome. While PCOS cases showed higher mean TSH values, the difference was not significant. LH and FSH levels were also comparable across groups. A larger proportion of PCOS cases (55.1%) had an LH: FSH ratio above 2:1 compared to 14.9% of controls, with the association approaching statistical significance (p = 0.063).

Discussion

This study provides further insight into the socio-demographic, clinical, and genetic factors associated with PCOS. A significant association between PCOS and rural residence (69.4% of cases, p = 0.001), suggests that lifestyle factors prevalent

in rural areas may contribute to the development of the syndrome. The findings support previous evidence suggesting that rural women, who often face limited healthcare access and engage in poor dietary practices and reduced physical activity, are more likely to be affected by PCOS [17].

A significant relationship was observed between lower educational attainment and PCOS (p = 0.001), highlighting the importance of health-related knowledge is for PCOS. Only 12.2% of PCOS cases had a postgraduate degree compared to 40.4% of controls, indicating that access to health information may contribute effective management of the PCOS. A study done by Carl *et al.* [18] in the Philippines also noted that only 32.4% of women diagnosed with PCOS had completed post-graduate education. The correlation found between marital status and PCOS (p = 0.004) warrants further investigation, particularly regarding socioenvironmental and educational influences on early detection and management. The consistent association between the capacity for consanguineous marriages and PCOS (49.0% of cases, p = 0.001) suggests possible genetic predisposition. This conclusion aligns well with earlier findings by Abedalthagafi *et al.*, which identify consanguinity as a well-established risk factor for PCOS [19].

A significant proportion of PCOS cases were homemakers (67.3%) (p = 0.001), suggesting that reduced physical activity could be a contributing factor to the PCOS. These findings correspond with earlier studies, including the study conducted by Jayamani *et al.* [20], which highlights that physical inactivity, increased consumption of calorie-rich foods, and using labor-saving household's appliances are the major causes underpinning the higher incidence of obesity.

Menstrual irregularities were a predominant clinical feature in PCOS cases. In the present study, 100% of PCOS cases reported irregular cycles, consistent with existing literature that identifies menstrual dysfunction as a hallmark symptom of PCOS. This finding aligns with the observations of Kugugahanti *et al.* [21] indicating that irregularities may also reflect underlying insulin resistance and adverse metabolic outcomes. Furthermore, the study findings indicated a notable dysmenorrhea experienced mostly by women with PCOS. Similar findings were reported by Behzadfar *et al.* [22] who found an increased frequency of painful menstruation in PCOS cases. The study also highlighted a high incidence of HA-related clinical symptoms, including hirsutism (69.4%), acne (89.8%), and acanthosis nigricans (46.9%). These results are consistent with those reported by Ashraf *et al.* [23] who reported that HA in PCOS women clinically present as hirsutism, acne, and androgenic alopecia. Similar observations were noted in another study, where hyperandrogenic phenotypes of PCOS showed a high prevalence of hirsutism and alopecia, with acanthosis nigricans present in nearly all cases [24].

Furthermore, family history was found to have the strongest association, with 75.5% of PCOS cases reporting a positive family history. This aligns with the findings of Vidya *et al.* [25], who also emphasized significant contribution of genetic predisposition to the pathogenesis of PCOS.

In this study, a significantly lower proportion of women affected by PCOS reported regular physical activity (24.5%) compared to controls (57.4%) (p = 0.001), highlighting the protective role of exercise. The present findings corresponds with the study conducted by Butt *et al.* [26], who

documented significantly reduced daily physical activity levels in women diagnosed with PCOS compared to controls ($p = 0.001$). Additionally, a higher proportion of PCOS cases (63.3%) consumed a non-vegetarian diet compared to controls (53%), which aligns with findings by Das *et al*. [27], who observed that the majority of PCOS cases followed a non-vegetarian diet. An altered pulsatility of gonadotropin-releasing hormone is a key factor contributing to an elevated LH to FSH ratio which is well known hormonal imbalance in PCOS. In this study, 55.1% of PCOS cases had an LH: FSH ratio greater than 2:1, consistent with the study reported Malini *et al*. [28].

Elevated levels of serum prolactin were significantly associated with PCOS, aligning with the findings of Latha *et al*. [29], in particular, the mean prolactin level in PCOS cases was 26.26 ± 6.78, which was greater than that of control group. The analysis showed that the mean testosterone concentration in PCOS cases was 3.75 ± 2.02, significantly exceeding that of the controls, supported by similar findings by Abdelazim *et al*. [30] who noted an increase in testosterone levels in PCOS cases.

Limitations

This study is limited by its relatively small sample size, which may affect the precision of estimation and generalizability. Lifestyle data were self-reported, introducing potential recall bias, and domains such as sleep, stress and substance use were not assessed. As a hospital based study, the findings may not fully represent women in the broader community.

Conclusion

PCOS represents one of the most frequent endocrine disorder affecting females during puberty. This study demonstrated higher prolactin, testosterone and LH/FSH ratios, along with lifestyle variations such as reduced physical activity and greater intake of non-vegetarian diets. Awareness of PCOS was limited among participants, suggesting underestimation of its burden in semi-urban settings. These findings emphasize the demand for strengthening health education and early screening strategies to promote timely diagnosis and better management of PCOS in affected populations.

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Author for Correspondence:

Dr. Soujanya J Pujar, Department of Obstetrics and Gynecological Nursing, BLDE's Shri B M Patil Institute of Nursing Sciences, Vijayapur-586103, Karnataka. Email: jpsoujanya141@gmail.com Cell: 7892752628