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Understanding polycystic ovarian syndrome and its association with menstrual dysfunction and body fat distribution: A comparative study

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ABSTRACT

Introduction: Polycystic ovarian syndrome (PCOS) is one of the most common metabolic-endocrine disorder among the women and is associated with wide variety of manifestations like hyperandrogenism (hirsutism, acne, alopecia), menstrual disturbance, infertility, obesity, type II diabetes mellitus, dyslipidaemia, hypertension, etc.

Study aim: The present study is an endeavour to understand the prevalence of Polycystic Ovarian Syndrome and also to examine its association with menstrual dysfunction and body fat patterning among the Hindu and Muslim women of Kolkata, West Bengal, India.

Material and Methods: This cross-sectional study included 723 (371 Hindus and 352 Muslims), Bengali women aged between 15 and 30 years. Principal Component Analysis (PCA) and Multiple linear regression was used to determine the predictors of premenstrual symptoms.

Results and Conclusion: The result shows that menstrual characteristics differed significantly between the Hindu and Muslims participants (PCOS and Non PCOS). Among Hindus only waist circumference is a significant predictor of the premenstrual syndrome score while among the Muslims, waist circumference, cycle length and weight are the significant predictor of the premenstrual syndrome score. Thus, understanding premenstrual syndrome (PMS) as a multifaceted biopsychosocial phenomenon, it is essential to underscore the importance of adopting a comprehensive approach to address its complexities.

Introduction

Polycystic ovarian syndrome (PCOS) stands out as the most common endocrine disorder among women of reproductive age (15–49 years). PCOS is linked to a broad spectrum of health issues, encompassing hypertension, dyslipidaemia, insulin resistance, hyperandrogenemia, and type 2 diabetes mellitus (T2DM), along with metabolic disorders [1,2]. PCOS was initially defined by Stein and Leventhal in 1935 as increasing in ovarian diameter, presence of numerous follicular cysts and increasing in the thickness of the capsule [3]. Later, it was characterized by chronic hyperandrogenism, oligomenorrhoea and/or anovulation [4].

Recently, there is an increasing report on the prevalence of PCOS in various parts of the world, which is a major concern for adolescents worldwide because of the modern lifestyle [5]. Depending on the diagnostic criteria, prevalence of PCOS in India range from 8.2 % to 22.5 % [6]. Diagnosing PCOS in adolescents also poses challenges due to symptom overlap with the natural transition of puberty into adulthood [7–9]. To avoid the early and late sequelae of the condition, it is crucial to make an early diagnosis [10]. PCOS has a complicated pathophysiology that includes primary ovarian abnormalities, hyperinsulinemia, insulin resistance, and body fat [11]. Studies reported that, in younger women with PCOS, hyperandrogenism and persistent anovulation may be the main issues. It was also evident that hirsutism, acne, dysmenorrhea, and oligomenorrhea were the most prevalent clinical manifestation [12]. PCOS can also be a risk factor for, rising abdominal adiposity among obese adolescent girls [13,14]. Obesity and Insulin Resistance (IR) are additional significant risk factors for metabolic syndrome in PCOS. Majority of the studies suggested a strong association between Metabolic Syndrome (MBS) and visceral adiposity. A growing body of data suggests that ethnicity and PCOS are closely related because different ethnic groups have varied genetic and environmental predispositions to metabolic and hormonal abnormalities [15]. Furthermore, to determine anthropometric criteria and phenotypic expression for improved screening and diagnosis in high-risk ethnic groups, ethnicity-specific PCOS guidelines may be required [16]. The present study is an attempt to understand the prevalence of PCOS and also to examine its association with menstrual dysfunction and body fat patterning among the Hindu and Muslim women of Kolkata, West Bengal, India.

Materials and methods

The present cross-sectional study was carried out among 723 (371 Hindus and 352 Muslims) women aged between 15 and 30 years. Participants' informed consent was obtained prior to data collection. A pretested structured schedule was used to collect information about their menstrual characteristics and premenstrual symptoms. Anthropometric

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measurements were taken using standard protocol [17] and other fat patterning variables were recorded from the Omron Body Composition Monitor (model HBF-375) following the standard technique provided in the instruction manual. Body mass index (BMI) was calculated by using the standard formula: BMI (kg/m2) = Weight (kg)/Height2 (m2). Waist-hip ratio (WHR) was calculated (WHO 2000) using the formula: WHR = WC (m)/HC (m). The following equations of Vanitallie et al. (1990) [18] were utilized to assess the proportion of Fat mass (FM) and Fat mass index (FMI): (i) FM (kg) = (PBF/100) × weight (kg); (ii) FMI (kg/m2) = FM (kg) /Height2 (m2). Principal Component Analysis (PCA) and Multiple linear regression were used to determine the predictors of premenstrual symptoms. The analyses of the data were done using the Statistical Package for Social Sciences version 26.0 (IBM SPSS). $p < 0.05$ was considered as statistically significant.

Results

The result of the study reveals that the occurrence of the syndrome is higher among the Hindus 91 (24.5 %) than the Muslim participants 78 (22.2 %). Age at menarche did not show any significant association but, skipping the menstrual cycle, regularity of the cycle, duration of bleeding, menstrual flow during peak discharge days and nature of discharge differed significantly across the two groups of PCOS and Non-PCOS among the Hindu and Muslim participants. No significant association was observed among the Hindu and Muslim PCOS participants except the nature of discharge (Table 1).

Principal Component Analysis (PCA) was performed with varimax rotation and the components were selected based on Eigen value ≥ 1. Sample adequacy was checked for applicability of PCA. In the case of Hindus, Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.831 (Bartlett's Test of Sphericity=0.000) whereas in the case of Muslim participants, Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.752 (Bartlett's Test of Sphericity=0.000). Factor loadings highlighted that in the case of Hindu PCOS participants total 6 factors were loaded whereas in the case of Muslims it was 7 factors. Component loadings represents the rotated component matrix, the correlation coefficient between the initial variables and their corresponding components with Eigen value and Individual Variance and Cumulative Variance. Higher loading suggests that the factors formed the PC scores more successful. A negative loading value suggested a negative correlation, a positive loading value indicated a positive correlation. Findings highlighted that Insomnia and Social withdrawal was loaded in PC1 for both the Hindus and Muslim PCOS participants. Additionally, crying, concentration and appetite was loaded in PC1 for Hindus and Depression, mood swing in Muslim PCOS participants. Fatigue or Weakness and Abdominal bloating is loaded in PC2 for both participants Whereas for Hindus feels heavy body and mood swing was loaded in PC2 and fluid retention, dizziness or fainting and headache was loaded in PC2 for Muslims. On the other hand, Muscle/ joint ache, Pain in lower abdomen, Pain in lower extremities and Flatulence was loaded in PC3 and Crying, Concentration, Vomiting and Appetite was loaded in PC3 for Muslims. In PC4, Dizziness or fainting, Fluid retention and Headache was loaded in case of Hindus but Pain in lower extremities, Pain in lower abdomen, Lower backache and Muscle or joint ache was loaded for Muslims. Breast tenderness, Oily skin and Acne in PC5 was loaded in PC5 for both the Hindus and Muslims. For Hindus, in PC6 vomiting and anger was loaded while feels heavy body and food craving was loaded for Muslims. Moreover, only in case of Muslims flatulence was loaded in PC7. Additionally, in the case of Hindu PCOS participants the total variance explained by the factor loading was 66.554 % whereas in the case of Muslim participants 68.057 % variance was explained (Table 2).

The Hindu and Muslim PCOS participants significantly differed in various anthropometric measures and body fat patterning variables (Table 3) fat mass and fat free mass showed significant difference

Table 1
Menstrual characteristics of the participants (n = 723).

Characteristics		Hindu (n = 371)		Chi Square/ Mann-Whitney *U* test (p value)	Muslim (n = 352)		Chi Square/ Mann-Whitney *U* test (p value)	Hindu PCOS vs Muslim PCOS		Chi Square// Mann-Whitney *U* test (p value)
		PCOS (n = 91)	Non- PCOS (n = 280)		PCOS (n = 78)	Non-PCOS (n = 274)		Hindu PCOS (n = 91)	Muslim PCOS (n = 78)	
Age at menarche		10.59 ± 1.90	10.75 ± 1.99	13285.00[b] (0.535)	10.88 ± 2.06	10.60 ± 1.96	9831.00[b] (0.275)	10.59 ± 1.90	10.88 ± 2.06	3822.50[b] (0.383)
Skip cycle	Yes	71 (78.0)	15 (5.4)	203.647[a]	52 (66.7)	25 (9.1)	84.708[a]	71 (78.0)	52 (66.7)	2.734[a]
	No	20 (22.0)	265 (94.6)	(0.000)*	26 (33.3)	249 (90.9)	(0.000)*	20 (22.0)	26 (33.3)	(0.098)
Cycle length	21–25	9 (9.9)	32 (11.4)	112.028[a]	6 (7.7)	32 (11.7)	74.719[a]	9 (9.9)	6 (7.7)	0.642[a]
	26–30	38 (41.8)	238 (85.0)	(0.000)*	37 (47.4)	226 (82.5)	(0.000)*	38 (41.8)	37 (47.4)	(0.725)
	> 30	44 (48.4)	10 (3.6)		35 (44.9)	16 (5.8)		44 (48.4)	35 (44.9)	
Regularity	Regular	35 (38.5)	267 (95.4)	146.850[a]	36 (46.2)	260 (94.9)	173.800[a]	35 (38.5)	36 (46.2)	1.020[a]
	Irregular	56 (61.5)	13 (4.6)	(0.000)*	42 (53.8)	14 (5.1)	(0.000)*	56 (61.5)	42 (53.8)	(0.312)
Duration of bleeding	1–4 days	31 (34.1)	208 (74.3)	73.737[a]	26 (33.3)	174 (63.5)	50.520[a]	31 (34.1)	26 (33.3)	0.018[a]
	5–8 days	42 (46.2)	70 (25.0)	(0.000)*	36 (46.2)	96 (35.0)	(0.000)*	42 (46.2)	36 (46.2)	(0.991)
	≥ 8 days	18 (19.8)	2 (0.7)		16 (20.5)	4 (1.5)		18 (19.8)	16 (20.5)	
Nature of menstrual flow	Heavy	81 (89.0)	193 (68.9)	14.344[a]	73 (93.6)	186 (67.9)	20.639[a]	81 (89.0)	73 (93.6)	1.089[a]
	Scanty/ Moderate	10 (11.0)	87 (31.1)	(0.000)*	5 (6.4)	88 (32.1)	(0.000)*	10 (11.0)	5 (6.4)	(0.297)
Nature of white discharge	Thin water like	15 (16.5)	78 (27.9)	7.644[a]	10 (12.8)	51 (18.6)	1.462[a]	15 (16.5)	10 (12.8)	1.980[a]
	Thick curdy	34 (37.4)	106 (37.9)	(0.054)	37 (47.4)	124 (45.3)	(0.691)	34 (37.4)	37 (47.4)	(0.577)
	With blood stain	25 (27.5)	47 (16.8)		20 (25.6)	63 (23.0)		25 (27.5)	20 (25.6)	
	Foul smelling	17 (18.7)	49 (17.5)		11 (14.1)	36 (13.1)		17 (18.7)	11 (14.1)	
Nature of discharge	With clot	37 (40.7)	28 (10.0)	44.675[b]	20 (25.6)	25 (9.1)	14.856[a]	37 (40.7)	20 (25.6)	4.238[a]
	Without clot/ occasionally	54 (59.3)	252 (90.0)	(0.000)*	58 (74.4)	249 (90.9)	(0.000)*	54 (59.3)	58 (74.4)	(0.040)*

* $p \leq 0.05$
[a] Chi Square
[b] Mann-Whitney *U* test

Table 2
Results of Principal component analysis for Premenstrual Syndrome of the Hindu PCOS (n = 91) and Muslim PCOS (n = 78) participants.

	Hindu (n = 91)			Muslim (n = 78)	
	Variables	PC1Factor loadings		Variables	Factor loadings
PC1	Insomnia	0.756		Insomnia	0.804
	Social withdrawal	0.604		Social withdrawal	0.680
	Crying	0.774		Depression	0.788
	Concentration	0.789		Mood Swing	0.686
	Appetite	0.587			
	Eigenvalue	4.021		Eigenvalue	3.172
	Individual Variance (percent)	16.083		Individual Variance (percent)	12.689
	Cumulative variance (percent)	16.083		Cumulative variance (percent)	12.689
PC2	Fatigue / Weakness	0.749	PC2	Fatigue or Weakness	0.649
	Abdominal bloating	0.526		Abdominal bloating	0.610
	Feels heavy body	0.698		Fluid retention	0.687
	Mood Swing	0.659		Dizziness or fainting	0.819
				Headache	0.615
	Eigenvalue	3.430		Eigenvalue	2.932
	Individual Variance (percent)	13.721		Individual Variance (percent)	11.729
	Cumulative variance (percent)	29.804		Cumulative variance (percent)	24.418
PC3	Muscle/ joint ache	0.726	PC3	Crying	0.808
	Pain in lower abdomen	0.695		Concentration	0.790
	Pain in lower extremities	0.693		Vomiting	0.740
	Flatulence	0.653		Appetite	0.591
	Eigenvalue	2.911		Eigenvalue	2.853
	Individual Variance (percent)	11.645		Individual Variance (percent)	11.413
	Cumulative variance (percent)	41.449		Cumulative variance (percent)	35.831
PC4	Dizziness or fainting	0.778	PC4	Pain in lower extremities	0.748
	Fluid retention	0.620		Pain in lower abdomen	0.718
	Headache	0.561		Lower backache	0.705
	Eigenvalue	2.260		Muscle or joint ache	0.546
	Individual Variance (percent)	9.041		Eigenvalue	2.555
	Cumulative variance (percent)	60.032		Individual Variance (percent)	10.220
				Cumulative variance (percent)	46.051
PC5	Breast tenderness	0.746	PC5	Breast tenderness	0.762
	Oily skin	0.560		Oily skin	0.751
	Acne	0.513		Acne	0.743
	Food craving	0.584		Eigenvalue	2.464
	Eigenvalue	2.260			
	Individual Variance (percent)	9.041		Individual Variance (percent)	9.854
	Cumulative variance (percent)	60.032		Cumulative variance (percent)	55.905
PC6	Vomiting	−0.672	PC6	Feels heavy body	0.689
	Anger	0.649		Food craving	0.647
	Eigenvalue	1.630		Eigenvalue	1.756
	Individual Variance (percent)	6.522		Individual Variance (percent)	7.025
	Cumulative variance (percent)	66.554		Cumulative variance (percent)	62.930
			PC7	Flatulence	0.864
				Eigenvalue	1.282
				Individual Variance (percent)	5.127
				Cumulative variance (percent)	68.057

between both Hindus (PCOS and Non-PCOS group) and Muslims (PCOS and Non-PCOS group) as well as Hindu PCOS and Muslim PCOS group. PMS_H represents the average score computed from 6 Principal Components of Premenstrual Syndrome for Hindus and PMS_M represents the average score of 7 Principal Components for Muslim PCOS participants.

The average scores are used as dependent variables and Multiple Linear Regression was performed. In the case of Hindu participants only waist circumference shows a significant effect on the dependent variable which is the average score computed from Principal Component Analysis (PCA). Among the Muslims, waist circumference, cycle length and weight have positive significant effects on the dependent variable. In Hindus R square= 0.138 indicates 13.8 percentage variance of the Average score of PMS, similarly, for the Muslim participants the R square= 0.198 indicates 19.8 percentage variance of Average score of PMS which is more than Hindus (Table 4).

Discussion

This study discusses the prevalence and determinants of PCOS among the Bengali Hindu and Muslim women, owing to their differential lifestyle and cultural background. Menstrual characteristics is a crucial tool for identifying teenagers who are more likely to develop PCOS. Irregular menstrual cycle is a very common scenario among most of the PCOS participants. Majority of the studies highlighted that menstrual irregularity within the first post-menarchal years can be an early clinical sign of PCOS [19–23]. Similarly, the present study showed significant differences in cycle length, menstrual irregularity, skipping of the menstrual cycle, cycle length and duration of bleeding between the PCOS and Non-PCOS group (for both Hindus and Muslims). An imbalance in hormones can cause disruptions in the menstrual cycle and hinder ovulation, which can result in irregular menstrual cycles [24].

The present study identified the most predominant premenstrual symptoms (PMS) and the significant predictors of PMS among both the Hindu and Muslim PCOS participants. This is in concordance with [25] where the most prevalent premenstrual symptoms were back ache followed by anger, anxiety, tearfulness or crying, hopelessness and difficulty with sleeping. A study also highlighted that nutritional intake and anthropometric measures were associated with PMS and anxiety and irritability were the most observed symptoms [26]. Increased body composition indices have also been linked to increased levels of PMS symptoms. Premenstrual syndrome can worsen with rising BMI and abdominal obesity [27]. Moreover, a suggested that adolescent girls who live in urban areas are more susceptible to premenstrual syndrome [28]. Additionally, another study revealed that the most common symptoms among the participants were fatigue, lethargy and abdominal pain [29].

Table 3
Anthropometric Variables, Skinfold measurements and Body fat patterning of the participants (n = 723).

Hindu (n = 371)				Muslim (n = 352)			Hindu PCOS vs Muslim PCOS		
Variables	PCOS (n = 91)	Non-PCOS (n = 280)	Mann-Whitney *U* test/ t test (p value)	PCOS (n = 78)	Non-PCOS (n = 274)	Mann-Whitney *U* test/ t test (p value)	Hindu PCOS (n = 91)	Muslim PCOS (n = 78)	Mann-Whitney *U* test/ t test (p value)
Anthropometric Measurements									
Height (cm)	154.05 ± 7.06	155.91 ± 8.49	6.201[b] (0.000)*	154.45 ± 7.18	155.20 ± 7.70	−0.767[b] (0.444)	154.05 ± 7.06	154.45 ± 7.18	0.360[b] (0.719)
Weight(kg)	60.10 ± 9.25	51.66 ± 11.86	6824.50[a] (0.000)*	54.58 ± 11.32	48.19 ± 9.15	7227.50[a] (0.000)*	60.10 ± 9.25	54.58 ± 11.32	2388.5[a] (0.000)*
Body Mass Index (BMI)	25.40 ± 4.52	21.11 ± 4.61	7.732[b] (0.000)*	22.85 ± 4.94	19.91 ± 3.70	6730.00[a] (0.000)*	25.40 ± 4.52	22.85 ± 4.94	3.491[b] (0.001)*
Mid upper arm Circumference (cm)	23.97 ± 4.116	22.19 ± 3.09	9729.00[a] (0.001)*	22.98 ± 3.55	22.06 ± 3.26	2.148[b] (0.032)*	23.97 ± 4.11	22.98 ± 3.55	3099.50[a] (0.156)
Hip Circumference (cm)	87.56 ± 16.16	79.21 ± 12.73	4.495[b] (0.000)*	80.76 ± 11.00	77.42 ± 10.45	9544.50[a] (0.150)	87.56 ± 16.16	80.76 ± 11.00	3.238[b] (0.001)*
Waist Circumference (cm)	73.10 ± 14.13	66.43 ± 11.99	8937.00[a] (0.000)*	68.51 ± 11.36	63.41 ± 10.19	7924.50[a] (0.000)*	73.10 ± 14.13	68.51 ± 11.36	2817.00[a] (0.021)*
Waist-Hip-Ratio	0.83 ± 0.07	0.83 ± 0.07	12681.00[a] (0.947)	0.84 ± 0.07	0.81 ± 0.09	8735.00[a] (0.014)*	0.83 ± 0.07	0.84 ± 0.07	3936.00[a] (0.221)
Body fat patterning									
Percent body fat (PBF)	30.48 ± 5.67	25.26 ± 5.62	7.659[b] (0.000)*	27.11 ± 6.20	23.55 ± 4.44	6879.00[a] (0.000)*	30.48 ± 5.67	27.11 ± 6.20	3.677[b] (0.000)*
Visceral fat (VF)	2.88 ± 0.84	2.62 ± 0.080	10248.50[a] (0.005)*	2.67 ± 0.82	2.62 ± 0.081	0.42[b] (0.673)	2.88 ± 0.84	2.67 ± 0.82	1.661[b] (0.099)
Whole body subcutaneous fat (%)	27.79 ± 7.01	25.70 ± 6.93	10358.5[a] (0.007)*	27.07 ± 7.04	26.59 ± 7.66	0.50[b] (0.614)	27.79 ± 7.01	27.07 ± 7.04	3201.00[a] (0.272)
Whole body skeletal fat (%)	24.14 ± 3.29	25.84 ± 6.76	10729.5[a] (0.024)*	25.11 ± 5.67	25.79 ± 6.29	11261.50[a] (0.468)	24.14 ± 3.29	25.11 ± 5.67	4333.00[a] (0.013)*
Trunk subcutaneous fat (%)	26.26 ± 5.51	24.09 ± 8.26	10019.50[a] (0.002)*	23.77 ± 6.23	23.25 ± 7.17	0.575[b] (0.566)	26.26 ± 5.51	23.77 ± 6.23	2.757[b] (0.006)*
Trunk skeletal fat (%)	22.63 ± 6.01	25.69 ± 7.43	9361.00[a] (0.000)*	23.27 ± 6.55	26.07 ± 8.20	12991.50[a] (0.004)*	22.63 ± 6.01	23.27 ± 6.55	3770.00[a] (0.486)
Leg subcutaneous Fat (%)	42.64 ± 6.40	35.11 ± 8.99	8.755[b] (0.000)*	38.72 ± 7.90	36.95 ± 9.08	1.560[b] (0.120)	42.64 ± 6.40	38.72 ± 7.90	3.506[b] (0.001)*
Leg skeletal fat (%)	35.65 ± 2.80	34.53 ± 5.45	10672.00[a] (0.020)*	35.48 ± 6.00	32.91 ± 6.64	3.069[b] (0.002)*	35.65 ± 2.80	35.48 ± 6.00	3886.00[a] (0.288)
Arm subcutaneous Fat (%)	44.68 ± 7.55	37.54 ± 11.06	6.92[b] (0.000)*	33.58 ± 9.99	34.66 ± 9.24	−.893[b] (0.372)	44.68 ± 7.55	33.58 ± 9.99	8.208[b] (0.000)*
Arm skeletal fat (%)	27.44 ± 5.41	29.45 ± 7.21	−2.44[b] (0.015)*	27.69 ± 4.60	27.28 ± 6.92	0.494[b] (0.621)	27.44 ± 5.41	27.69 ± 4.60	−0.329[b] (0.743)
Fat mass (kg)	18.76 ± 5.92	13.63 ± 6.36	6381.00[a] (0.000)*	15.42 ± 6.73	11.68 ± 4.54	6975.50[a] (0.000)*	18.76 ± 5.92	15.42 ± 6.73	2319.50[a] (0.000)*
Fat free mass (kg)	41.33 ± 4.12	38.01 ± 6.06	4.869[b] (0.000)*	39.15 ± 5.21	36.49 ± 5.08	4.056[b] (0.000)*	41.33 ± 4.12	39.15 ± 5.21	2.982[b] (0.003)*

* $p \leq 0.05$
[a] Mann-Whitney *U* test
[b] *t*-test

Furthermore, various researches reported that there is a significant association of PCOS with premenstrual symptoms [30,31]. On the other hand, a study portrayed that, lethargy, anxiety, appetite changes, anger, concentration, social withdrawal and mood swings are most common PMS among the PCOS participants [32]. One possible cause for irregular menstruation in obese women is leptin, which is secreted from adipose tissue and has a part in the control of gonadotropin throughout puberty, pregnancy, and breastfeeding. The hypothalamo-pituitary-gonadal axis is influenced by the interaction between higher levels of circulating leptin and leptin resistance observed in overweight women. Greater adiposity can worsen the situation of Premenstrual syndrome and also elevate with BMI, waist circumference [33]. In this present study, both

Table 4
Results of Multiple linear regression for Hindu PCOS (n = 91) and Muslim PCOS (n = 78) participants.

Dependent variable	Independent variable	Unstandardized Coefficients B	Standardized Coefficients Beta	t value	p value	95.0 % Confidence Interval for B		R square
						Lower bound	Upper bound	
PMS_H	Waist Circumference	0.010	0.353	3.470	0.001*	0.004	0.016	0.138
PMS_M	Waist Circumference	0.014	0.416	3.778	0.000*	0.007	0.021	0.198
	Cycle length	0.021	0.257	2.432	0.017*	0.004	0.038	
	Weight (kg)	−0.007	−0.220	−2.011	0.048*	−0.015	0.000	

PMS_H= Premenstrual syndrome score for Hindu PCOS participants
PMS_M= Premenstrual syndrome score for Muslim PCOS participants
* $p \leq 0.05$; Only significant values are presented in this table

the Hindu and Muslim PCOS participants' waist circumference had a significant effect on the average scores computed from Principal Component Analysis. But along with waist circumference cycle length and weight have positive significant effects on the dependent variable among Muslim participants. This is in agreement that PMS is dependent on fat distribution and hormonal imbalance due to hyperandrogenism resulting in menstrual irregularities. A similar study is in accordance with the present study concluding that during female puberty, the gynoid type of fat distribution emerges and continues throughout the fertile years of adulthood [34]. Because androgens are aromatized into estrogens in peripheral adipose tissue, particularly in the lower body, this tissue serves as a major source of extraovarian estrogen production. It is noteworthy that a preponderance of fat concentrated in the upper body regions is strongly connected with hyperandrogenicity, the primary endocrine symptom of PCOS. This sex-specific fat distribution, also known as the "android fat distribution," is linked to obesity and several metabolic characteristics [35]. These statements are supporting the findings of this present study. Moreover, it was also revealed that both lean and obese women with PCOS show signs of impaired insulin sensitivity; however, insulin resistance is more pronounced in cases where obesity and PCOS combine [36]. Insulin and luteinizing hormones work together to increase the production of androgens [37,38]. Similarly, a high waist to-hip ratio is linked to abnormal body fat distribution in adults with hyperinsulinemia and hyperandrogenemia [39]. However, it is generally accepted that obese women have significantly lower levels of sex hormone-binding globulin (SHBG) than lean PCOS patients. Therefore, compared to non-obese women, obese women with PCOS showed greater free androgen indices, lower SHBG, and more severe functional hyperandrogenism [40,41]. Moreover, the most likely cause of the variation in premenstrual symptoms and associated factors may be cultural and lifestyle factors, such as stress levels, physical activity, and dietary preferences. Furthermore, hormonal imbalances that affect the intensity of PMS may be influenced by patterns of fat distribution, particularly android obesity. Furthermore, persons who reside in metropolitan regions are more prone to experience PMS due to dietary changes, lifestyle adjustments, and environmental stressors.

The current study depicts that body mass index (BMI), abdominal obesity and fat patterning differed significantly between the PCOS and Non-PCOS participants, which is in congruence with the findings reported in several studies [42–50]. Women with PCOS may have a change in satiety, which might result in overeating and obesity. Possible confounding variables that affect satiety include meal-stimulated reductions in glucagon-like peptide-1 levels as well as lower levels of cholecystokinin. Even in PCOS women who weigh normal, other environmental and genetic variables, may lead to increased visceral and abdominal obesity [51–53].

Conclusions

It is concluded from this study that Menstrual characteristics and body fat distribution were associated in determining PMS. Premenstrual syndrome (PMS) is a multifaceted phenomenon that involves biological, psychological, and social factors. Therefore, understanding and addressing this complex interaction is essential for reducing PMS. Treatment approaches may involve a combination of lifestyle modifications, stress management techniques, psychotherapy, and medication to address both the biological and psychosocial aspects of PMS. Additionally, raising awareness and reducing stigma surrounding menstruation can help create a more supportive environment for individuals dealing with PMS and other menstrual health related issues.

Limitations of the study

The findings of the present study should be viewed under certain limitations. The diagnosis of PMS was based on retrospective symptom reporting, which has limited validity. Thus, the reported frequency and intensity of symptoms may over or under estimate true effects. To obtain accurate estimates, it is necessary to use a prospective design across at least three menstrual cycles and include large, representative samples. This study may help the policy makers to develop strategies to ameliorate the prevalence and intensity of PMS by addressing the reproductive, lifestyle and nutritional factors. Therefore, there is a need for larger prospective research focusing PMS and to address this complex relationship. Moreover, the participants' age range (15–30 years) limits the study findings because older-aged women and younger adolescents were excluded in the broader reproductive age range of 15–49 years. As a result, the findings may be unrepresentative of the full reproductive population. Furthermore, the study was only carried out in Kolkata, West Bengal, it could not portray the huge cultural, ethnic, and socioeconomic diversity of other regions of India and individuals from across the world. Moreover, a lack of hormonal and biochemical indicators, including but not limited to insulin resistance indicators or serum androgen levels, limits a more robust understanding of the multifactorial and complex pathophysiology of PCOS and limits the clinical significance of the findings.

CRediT authorship contribution statement

Pal Baidyanath: Formal analysis. **MAJI SUVENDU:** Conceptualization. **GOSWAMI MONALI:** Writing – review & editing, Writing – original draft, Supervision. **Ghosh Titas:** Software, Methodology, Investigation, Data curation.

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Data availability

Data will be made available on request.

References

[1] C.M. Gordon, Menstrual disorders in adolescents: excess androgens and the polycystic ovary syndrome, Pediatr. Clin. North Am. 46 (3) (1999) 519–543, https://doi.org/10.1016/S0031-3955(05)70135-8.

[2] T.S. Mehreen, H. Ranjani, R. Kamalesh, U. Ram, R.M. Anjana, V. Mohan, Prevalence of polycystic ovarian syndrome among adolescents and young women in India, J. Diabetol. 12 (3) (2021) 319–325, https://doi.org/10.4103/JOD.JOD_105_20.

[3] I.F. Stein, M.L. Leventhal, Amenorrhea associated with bilateral polycystic ovaries, Am. J. Obstet. Gynecol. 29 (2) (1935) 181–191.

[4] E. Diamanti-Kandarakis, C.R. Kouli, A.T. Bergiele, F.A. Filandra, T.C. Tsianateli, G. G. Spina, E.D. Zapanti, M.I. Bartzis, A survey of the polycystic ovary syndrome in the Greek island of Lesbos: hormonal and metabolic profile, J. Clin. Endocrinol. Metab. 84 (11) (1999) 4006–4011, https://doi.org/10.1210/jcem.84.11.6148.

[5] M.S.G. Naz, F.R. Tehrani, H.A. Majd, F. Ahmadi, G. Ozgoli, F.R. Fakari, V. Ghasemi, The prevalence of polycystic ovary syndrome in adolescents: A systematic review and meta-analysis, Int. J. Reprod. Biomed. 17 (8) (2019) 533, https://doi.org/10.18502/ijrm.v17i8.4818.

[6] M. Gupta, D. Singh, M. Toppo, A. Priya, S. Sethia, P. Gupta, A cross sectional study of polycystic ovarian syndrome among young women in Bhopal, Central India, Int J. Community Med Public Health 5 (1) (2018) 95–100.

[7] B. Meczekalski, O. Niwczyk, A. Kostrzak, M. Maciejewska-Jeske, G. Bala, A. Szeliga, PCOS in Adolescents—Ongoing riddles in diagnosis and treatment, J. Clin. Med. 12 (3) (2023) 1221, https://doi.org/10.3390/jcm12031221.

[8] M. Sharma, M. Khapre, V. Saxena, P. Kaushal, Polycystic ovary syndrome among Indian adolescent girls–a systematic review and metanalysis, Nepal J. Epidemiol. 11 (3) (2021) 1063, https://doi.org/10.3126/nje.v11i3.38460.

[9] N. Sharma, Y. Lugani, A. Kaur, V.K. Ahuja, Effect of metformin on insulin levels, blood sugar, and body mass index in polycystic ovarian syndrome cases, J. Fam. Med. Prim. care 8 (8) (2021) 2691–2695, 0.4103/jfmpc.jfmpc_490_19.

[10] B. Joshi, S. Mukherjee, A. Patil, A. Purandare, S. Chauhan, R. Vaidya, A cross-sectional study of polycystic ovarian syndrome among adolescent and young girls in Mumba, i, India, Indian J. Endocrinol. Metab. 18 (3) (2014) 317–324, https://doi.org/10.5468/ogs.2019.62.5.329.

[11] L. Ibáñez, R. Díaz, A. López-Bermejo, M.V. Marcos, Clinical spectrum of premature pubarche: links to metabolic syndrome and ovarian hyperandrogenism, Rev. Endocr. Metab. Disord. 10 (2009) 63–76, https://doi.org/10.1007/s11154-008-9096-y.

[12] N.A. Desai, R.Y. Tiwari, S.S. Patel, Prevalence of polycystic ovary syndrome and its associated risk factors among adolescent and young girls in Ahmedabad region, Indian J. Pharm. Pract. 11 (3) (2018).

[13] S.F. Michaliszyn, S. Lee, H. Tfayli, S. Arslanian, Polycystic ovary syndrome and nonalcoholic fatty liver in obese adolescents: association with metabolic risk profile, Fertil. Steril. 100 (6) (2013) 1745–1751, https://doi.org/10.1016/j.fertnstert.2013.08.015.

[14] S. Petta, A. Ciresi, J. Bianco, V. Geraci, R. Boemi, L. Galvano, F. Magliozzo, G. Merlino, A. Craxì, C. Giordano, Insulin resistance and hyperandrogenism drive steatosis and fibrosis risk in young females with PCOS, PloS One 12 (11) (2017) e0186136, https://doi.org/10.1371/journal.pone.0186136.

[15] T. Ding, P.J. Hardiman, I. Petersen, F.F. Wang, F. Qu, G. Baio, The prevalence of polycystic ovary syndrome in reproductive-aged women of different ethnicity: a systematic review and meta-analysis, Oncotarget 8 (56) (2017) 96351, https://doi.org/10.18632/oncotarget.19180.

[16] Y. Zhao, J. Qiao, Ethnic differences in the phenotypic expression of polycystic ovary syndrome, Steroids 78 (8) (2013) 755–760.

[17] T.G. Lohman, A.F. Roche, R. Martorell, Anthropometric Standardization Reference Manual Chicago, Human Kinetics Books, 1988.

[18] T.B. Vanitallie, M.U. Yang, S.B. Heymsfield, R.C. Funk, R.A. Boileau, Height-normalized indices of the body's fat-free mass and fat mass: potentially useful indicators of nutritional status, Am. J. Clin. Nutr. 52 (6) (1990) 953–959.

[19] C.K. Avvad, R. Holeuwerger, V.C.G. Silva, M.A.N. Bordallo, M.M.D. Breitenbach, Menstrual irregularity in the first postmenarchal years: an early clinical sign of polycystic ovary syndrome in adolescence, Gynecol. Endocrinol. 15 (3) (2001) 170–177, https://doi.org/10.1080/gye.15.3.170.177.

[20] I.C. Da Silva Bouzas, S.A. Cader, L. Leão, M.C. Kuschnir, C. Braga, Menstrual cycle alterations during adolescence: early expression of metabolic syndrome and polycystic ovary syndrome, J. Pediatr. Adolesc. Gynecol. 27 (6) (2014) 335–341, https://doi.org/10.1016/j.jpag.2014.01.002.

[21] P. Vaddi, T. Paipuru, H. Fatima, Study of menstrual disorders in 12-25 age group women in urban population and their relation to demographics, medical history, personal habits and impact on, Indian J. Obstet. Gynecol. Res. 9 (1) (2022) 25–30.

[22] H. Thakur, P. Pareek, M.G. Sayyad, S. Otiv, Association of Premenstrual Syndrome with adiposity and nutrient intake among young Indian women, Int. J. Women'S. Health (2022) 665–675, https://doi.org/10.2147/IJWH.S359458.

[23] A. Satyaraddi, K.E. Cherian, N. Kapoor, A.T. Kunjummen, M.S. Kamath, N. Thomas, T.V. Paul, Body composition, metabolic characteristics, and insulin resistance in obese and nonobese women with polycystic ovary syndrome, J. Hum. Reprod. Sci. 12 (2) (2019) 78–84, https://doi.org/10.4103/jhrs.JHRS_2_19.

[24] Y.M. Mittiku, H. Mekonen, G. Wogie, M.A. Tizazu, G.E. Wake, Menstrual irregularity and its associated factors among college students in Ethiopia 2021, Front. Glob. Women'S. Health 3 (2022) 917643.

[25] P. Vaddi, T. Paipuru, H. Fatima, Study of menstrual disorders in 12-25 age group women in urban population and their relation to demographics, medical history, personal habits and impact on, Indian J. Obstet. Gynecol. Res. 9 (1) (2022) 25–30.

[26] H. Thakur, P. Pareek, M.G. Sayyad, S. Otiv, Association of Premenstrual Syndrome with adiposity and nutrient intake among young Indian women, Int. J. Women'S. Health (2022) 665–675, https://doi.org/10.2147/IJWH.S359458.

[27] H.E. Shahrjooye, J.M. Koushkie, Brief Report: The Correlation Between Some Body Composition Indices and Premenstrual Syndrome in Young Females, Women'S. Health Bull. 6 (1) (2019) 1–4, https://doi.org/10.5812/whb.83750.

[28] A. Drosdzol, K. Nowosielski, V. Skrzypulec, R. Plinta, Premenstrual disorders in Polish adolescent girls: prevalence and risk factors, J. Obstet. Gynaecol. Res. 37 (9) (2011) 1216–1221, https://doi.org/10.1111/j.1447-0756.2010.01505.x.

[29] N. Naeimi, The prevalence and symptoms of premenstrual syndrome under examination, J. Biosci. Med. 3 (01) (2015) 1, https://doi.org/10.4236/jbm.2015.31001.

[30] S. Hashemi, F.R. Tehrani, N. Mohammadi, M.R. Dovom, F. Torkestani, M. Simbar, F. Azizi, Comparison of metabolic and hormonal profiles of women with and without premenstrual syndrome: A community based cross-sectional study, Int. J. Endocrinol. Metab. 14 (2) (2016), https://doi.org/10.5812/ijem.28422.

[31] C.L. Weiner, M. Primeau, D.A. Ehrmann, Androgens and mood dysfunction in women: comparison of women with polycystic ovarian syndrome to healthy controls, Psychosom. Med. 66 (3) (2004) 356–362.

[32] Y.J. Park, H. Shin, S. Jeon, I. Cho, Y.J. Kim, Menstrual cycle patterns and the prevalence of premenstrual syndrome and polycystic ovary syndrome in Korean young adult women, Healthcare 9 (1) (2021) 56, https://doi.org/10.3390/healthcare9010056.

[33] S. Blüher, C.S. Mantzoros, Leptin in reproduction, Curr. Opin. Endocrinol. Diabetes Obes. 14 (6) (2007) 458–464, https://doi.org/10.1097/MED.0b013e3282f1cfdc.

[34] S. Kirchengast, J. Huber, Body composition characteristics and body fat distribution in lean women with polycystic ovary syndrome, Hum. Reprod. 16 (6) (2001) 1255–1260, https://doi.org/10.1093/humrep/16.6.1255.

[35] A. Ahmadi, M. Akbarzadeh, F. Mohammadi, M. Akbari, B. Jafari, H.R. Tolide-Ie, Anthropometric characteristics and dietary pattern of women with polycystic ovary syndrome, 10.4103/2230-8210.113759. Indian J. Endocrinol. Metab. 17 (4) (2013) 672–676, https://doi.org/10.4103/2230-8210.113759.

[36] E. Diamanti-Kandarakis, A. Dunaif, Insulin resistance and the polycystic ovary syndrome revisited: an update on mechanisms and implications, Endocr. Rev. 33 (6) (2012) 981–1030, https://doi.org/10.1210/er.2011-1034.

[37] S. Franks, Polycystic ovary syndrome, N. Engl. J. Med. 333 (13) (1995) 853–861, https://doi.org/10.1056/NEJM199509283331307.

[38] D.A. Ehrmann, Polycystic ovary syndrome, N. Engl. J. Med. 352 (12) (2005) 1223–1236, https://doi.org/10.1056/NEJMra041536.

[39] M.H. van Hooff, F.J. Voorhorst, M.B. Kaptein, R.A. Hirasing, C. Koppenaal, J. Schoemaker, Polycystic ovaries in adolescents and the relationship with menstrual cycle patterns, luteinizing hormone, androgens, and insulin, Fertil. Steril. 74 (1) (2000) 49–58, https://doi.org/10.1016/S0015-0282(00)00584-7.

[40] D. Bernasconi, P. Del Monte, M. Meozzi, M. Randazzo, A. Marugo, B. Badaracco, M. Marugo, The impact of obesity on hormonal parameters in hirsute and non-hirsute women, Metabolism 45 (1) (1996) 72–75.

[41] T.H. Liou, J.H. Yang, C.H. Hsieh, C.Y. Lee, C.S. Hsu, M.I. Hsu, Clinical and biochemical presentations of polycystic ovary syndrome among obese and non-obese women, Fertil. Steril. 92 (6) (2009) 1960–1965, https://doi.org/10.1016/j.fertnstert.2008.09.003.

[42] S. Ahmadi, M. Jamilian, M. Karamali, M. Tajabadi-Ebrahimi, P. Jafari, M. Taghizadeh, M.R. Memarzadeh, Z. Asemi, Probiotic supplementation and the effects on weight loss, glycaemia and lipid profiles in women with polycystic ovary syndrome: a randomized, double-blind, placebo-controlled trial, Hum. Fertil. 20 (4) (2017) 254–261, https://doi.org/10.1080/14647273.2017.1283446.

[43] E. Cosar, K. Üçok, L. Akgün, G. Köken, F.K. Sahin, D.T. Arioz, O. Baş, Body fat composition and distribution in women with polycystic ovary syndrome, Gynecol. Endocrinol. 24 (8) (2008) 428–432, https://doi.org/10.1080/09513590802234253.

[44] T. Douchi, H. Huin, S. Nakamura, T. Oki, S. Yamamoto, Y. Nagata, Body fat distribution in women with polycystic ovary syndrome, Obstet. Gynecol. 86 (4) (1995) 516–519, https://doi.org/10.1016/S0029-7844(95)80008-5.

[45] S.K. Graff, F.M. Mário, B.C. Alves, P.M. Spritzer, Dietary glycemic index is associated with less favorable anthropometric and metabolic profiles in polycystic ovary syndrome women with different phenotypes, Fertil. Steril. 100 (4) (2013) 1081–1088, https://doi.org/10.1016/j.fertnstert.2013.06.005.

[46] M.J. Khan, A. Ullah, S. Basit, Genetic basis of polycystic ovary syndrome (PCOS): current perspectives, Appl. Clin. Genet. 12 (2019) 249–260, https://doi.org/10.2147/TACG.S200341.

[47] S. Kirchengast, J. Huber, Body composition characteristics and body fat distribution in lean women with polycystic ovary syndrome, Hum. Reprod. 16 (6) (2001) 1255–1260, https://doi.org/10.1093/humrep/16.6.1255.

[48] P.K. Nayak, S. Mitra, J. Sahoo, E. Mahapatra, S. Agrawal, Z. Lone, Relationship of subclinical hypothyroidism and obesity in polycystic ovarian syndrome patients, J. Fam. Med. Prim. care 9 (1) (2020) 147–150, https://doi.org/10.4103/jfmpc.jfmpc_654_19.

[49] T. Strowitzki, E. Capp, H. Von Eye Corleta, The degree of cycle irregularity correlates with the grade of endocrine and metabolic disorders in PCOS patients, Eur. J. Obstet. Gynecol. Reprod. Biol. 149 (2) (2010) 178–181, https://doi.org/10.1016/j.ejogrb.2009.12.024.

[50] G. Tena, C. Moran, R. Romero, S. Moran, Ovarian morphology and endocrine function in polycystic ovary syndrome, Arch. Gynecol. Obstet. 284 (2011) 1443–1448.

[51] L.J. Moran, M. Noakes, P.M. Clifton, G.A. Wittert, L. Tomlinson, C. Galletly, N. D. Luscombe, R.J. Norman, Ghrelin and measures of satiety are altered in polycystic ovary syndrome but not differentially affected by diet composition, J. Clin.

Endocrinol. Metab. 89 (7) (2004) 3337–3344, https://doi.org/10.1210/jc.2003-031583.
[52] A. Satyaraddi, K.E. Cherian, N. Kapoor, A.T. Kunjummen, M.S. Kamath, N. Thomas, T.V. Paul, Body composition, metabolic characteristics, and insulin resistance in obese and nonobese women with polycystic ovary syndrome, J. Hum. Reprod. Sci. 12 (2) (2019) 78–84, https://doi.org/10.4103/jhrs.JHRS_2_19.
[53] J. Vrbikova, M. Hill, B. Bendlova, T. Grimmichova, K. Dvorakova, K. Vondra, G. Pacini, Incretin levels in polycystic ovary syndrome, Eur. J. Endocrinol. 159 (2) (2008) 121–127.

Titas Ghosh *
The Neotia University, Department of Humanities, Management and Social Sciences, Sarisha, Jhinga, West Bengal 743368, India

Baidyanath Pal
PKG Medical College and Hospital, Newtown, Kolkata 700156, India

Suvendu Maji
Department of Anthropology, University of Calcutta, Kolkata, West Bengal 700019, India

Monali Goswami
[a] *Department of Anthropology, University of Calcutta, Kolkata, West Bengal 700019, India*
[b] *Department of Anthropology & Tribal Studies, MSCB University, Baripada, Odisha 757003, India*

* Correspondence to: 1, Banerjee Para Road, P.O-Sarsuna, Amiya Apartment, Flat No, 103, Kolkata 700061, India.
E-mail address: titasghoshanta@gmail.com (T. Ghosh).