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Menstrual disorder is associated with blood type in PCOS patients: evidence from a cross-sectional survey

Shuhan Yang[1,2†], Hua Zhang[3†], Li Shi[2†], Yang Yang[1,2], Yonghao Lu[1,2], Weiyu Qiu[1,2], Ii Fukuzawa[1,2], Lifei Zhou[1,2], Xiyan Xin[1,4], Ning Ding[1,4], Liyan Luo[2], Wei Wang[2*] and Haolin Zhang[1,2*]

Abstract

Background Previous studies have shown a correlation between ABO blood type and the occurrence of certain diseases. However, there is limited research on the potential association between ABO blood group and polycystic ovary syndrome (PCOS). This study aims to investigate the potential connection between ABO blood type and the regularity of menstrual cycles, menstrual bleeding level, and additional metabolic indicators among individuals diagnosed with PCOS.

Methods This cross-sectional study involved 312 PCOS patients and 133 healthy controls whose menstruation and blood type were investigated by questionnaires. Their blood lipid content and hormone levels were also measured. We assessed the association between ABO blood type distribution in different groups and the occurrence of menstrual conditions in PCOS patients.

Results 445 women participated in the study. There was a statistically significant difference in ABO blood type distribution among PCOS patients with varying menstrual levels ($P=0.036$). Compared with other blood type groups, PCOS patients with blood type O exhibited statistically significant differences in BMI ($P=0.033$), E2 levels ($P<0.001$), LH levels ($P=0.022$), and FSH levels ($P<0.001$), and showed a higher tendency towards greater menstrual bleeding.

Conclusion There exists a correlation between ABO blood type and menstrual bleeding level among PCOS patients. In particular, individuals with blood type O display a heightened likelihood of experiencing greater menstrual bleeding with more favorable endocrine status compared to non-O blood types in the population.

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Keywords Polycystic ovary syndrome, Blood type O, Menstrual disorder, Menstrual bleeding, Ovarian function

†Shuhan Yang, Hua Zhang, Li Shi these authors contribute equally.

*Correspondence:
Wei Wang
bysywangwei@163.com
Haolin Zhang
zoe@bjmu.edu.cn
[1]Department of Traditional Chinese Medicine, Peking University Third Hospital, Beijing 100191, China
[2]State Key Laboratory of Female Fertility Promotion, Center for Reproductive Medicine, Department of Obstetrics and Gynecology, Peking University Third Hospital, Beijing, China
[3]Research Centre of Clinical Epidemiology, Peking University Third Hospital, Beijing, China
[4]Department of Integration of Chinese and Western Medicine, Peking University Health Science Center, Beijing, China

Introduction

Polycystic Ovary Syndrome (PCOS) is a complex endocrine, metabolic, and emotional disorder affecting 6-21% of reproductive-age women and has become a significant factor in menstrual irregularities and anovulatory infertility [1, 2]. The primary clinical features of PCOS include ovulatory dysfunction, hyperandrogenism, polycystic ovaries, as well as insulin resistance and metabolic dysfunction [3]. PCOS is also associated with other complications such as type 2 diabetes, endometrial dysfunction, and pregnancy-related issues [4]. Psychological and emotional disturbances often coexist with PCOS, predisposing patients to heightened anxiety and depression [5, 6]. Menstrual disorders are typically a prominent feature of PCOS, encompassing extended or irregular menstrual cycles, abnormal bleeding volume, and dysmenorrhea, among others [7–9]. High menstrual bleeding can arise from various factors such as uterine abnormalities (polyps, adenomyosis, leiomyoma, malignancies or hyperplasia), endometrial abnormalities, ovulatory disorders, iatrogenic factors, coagulation disorders, or certain yet unidentified reasons [10, 11]. Additionally, dietary factors, vitamin deficiencies, parity, history of cesarean section, and exposure to certain medications contribute to the incidence of abnormal uterine bleeding etiology [12]. Studies show that BMI is a significant influencing factor on menstruation; both high and low BMI can result in menstrual irregularities or even amenorrhea [12–14]. Insulin receptor expression on the ovaries might also affect menstrual cycle regulation. Primary dysmenorrhea is caused by prostaglandin and leukotriene-mediated inflammatory response, leading to lower abdominal spasms and systemic symptoms. Secondary dysmenorrhea is mostly associated with pelvic abnormalities, and endometriosis is a common causative factor [14]. It is noteworthy that research have reported association between genetic polymorphisms in the ABO blood group chromosomal region and menstrual disorders, as well as ovarian reserve function and infertility. ABO blood group genes and downstream tumor necrosis factor cofactor TRAF2 genes are implicated as potential etiological factors for menstrual disorders [15]. One study has reported that antigen A might confer a protective influence on ovarian reserve capacity, while Blood Type O exhibits an association with infertility [16]. In specific investigations, women with Blood Type A seem more predisposed to ovarian hyperstimulation compared to women with Blood Type O. These findings highlight the close interrelation between the ABO blood system and female reproductive system disorders [17, 18]. Menstrual disorders are common gynecological ailments that serve as reflections of ovarian status, and their occurrence may be linked to the ABO blood type system. Genes susceptible to Polycystic Ovary Syndrome (PCOS) are located on chromosome 9q33.3, often accompanied by menstrual and metabolic disturbances. Coincidentally, ABO genes are located on chromosome 9q34.1-9q34.2 [15]. This proximity prompts our hypothesis that ABO genes might be associated with PCOS phenotypes.

It has been reported that the methylation level of the ABO gene promoter region is higher in PCOS patients with blood type B than in healthy individuals [19, 20]. However, there is currently limited research exploring the linkage between the ABO blood type and the PCOS phenotype. Despite some clinical studies pointing to disparities in ovarian reserve and various gynecological disorders based on ABO blood types, few studies have shown the connection between menstrual and metabolic disruptions in PCOS females and ABO blood types. Thus, we conducted a cross-sectional study to analyze the correlation between blood types and menstrual irregularities, as well as metabolic profiles in PCOS patients. We investigated the distribution of ABO blood types across different phenotypes of PCOS and explored the potential of blood types as biomarkers for PCOS, as well as their application in clinical diagnosis.

Methods

Subjects

This was a cross-sectional study that included PCOS women diagnosed by Rotterdam criteria 2003 and age-matched healthy control women in Peking, University Third Hospital from March 1st, 2016 to September 1st, 2021. All subjects signed a written informed consent to participate in the study. Study protocol was approved by the Medical Science Research Ethics Committee of Peking University Third Hospital (No. 2016-212-02) and registered on ClinicalTrial.gov (NCT04264832, website: https://clinicaltrials.gov). Recruited subjects aged between 18 and 45. The control women were healthy, without a history of endocrine disorders, lacked clinical and biochemical evidence of hyperandrogenism (total testosterone < 60 ng/ml, free testosterone < 2 ng/ml, dehydroepiandrosterone sulfate < 271 mg/dl), had regular menstrual cycles occurring every 21–35 days, and had normal ovarian morphology on ultrasonography. They are excluded if they have menstrual irregularities, signs of hyperandrogenism (Ferriman-Gallwey score > 4), evidence of PCO morphology on ultrasound. The exclusion criteria include other endocrine disorders such as androgen secreting tumors, suspected Cushing's syndrome, non-classic congenital adrenal hyperplasia (17-hydroxyprogesterone < 3nmol/L), thyroid dysfunction, hyperprolactinemia, type I diabetes or not well controlled type II diabetes, stage 2 hypertension, psychiatric diagnoses or using psychiatric medications including antidepressants, pharmacological treatment (cortizone, antidepressant, other antidiabetic treatment such as insulin and

acarbose, hormonal contraceptives, hormonal ovulation induction, or other drugs judged by discretion of investigator) within 12 weeks or Depo Provera or similar within 6 months.

Clinical data collection

The study recruited participants through community posters and hospital pamphlets, selecting eligible individuals with polycystic ovary syndrome (PCOS) and a healthy control group. Blood samples were collected, and participants were instructed to complete questionnaires. Participants were carefully characterized regarding a general health history, a medical history, clinical, demographic and anthropomorphic measurements, skin problems (hirsutism modified by Ferriman-Gallwey (mF-G) score, global acne score and premature alopecia). A transvaginal ultrasound scan was performed on every participant during a clinical examination to determine the number of follicles and ovarian volume. Blood samples were collected for analysis of metabolic biomarkers, metabolomics, and hormone levels. Glucose tolerance and insulin sensitivity were assessed by using the oral glucose tolerance test and Ins with 75 g glucose. The Homeostasis model assessment of insulin resistance (HOMA-IR) was calculated by using the formula: [fasting insulin ($\mu U\ mL^{-1}$) × fasting glucose ($mmol\ L^{-1}$)] / 22.5 [21]. Hormonal profiles including androgen hormones (A2, nmol/L), estrogen (E2, pmol/L), prolactin(PRL, ng/mL), luteinizing hormone (LH, mIU/mL), FSH (Follicle-stimulating hormone, mIU/mL) and testosterone(T, nmol/L), blood lipid profiles including total cholesterol (TG, mmol/L) and high-density lipoprotein (HDL, mmol/L) were measured with the Immulite 2000 immunoassay system (Siemens Healthcare Diagnostics, Siemens, Germany) [22]. The Perceived Stress Scale (Chinese 14-item PSS), Self-Rating Anxiety Scale (SAS), and Self-Rating Depression Scale (SDS) were employed to evaluate the psychological well-being status of the subjects.

Data quality control

Standardized assessment scales with good feasibility were meticulously chosen for the comprehensive evaluation of patients' conditions. Adequate time intervals were provided to each participant to ensure the completion of questionnaire with precision. To limit response bias, caution was exercised to avoid incorporating leading questions within the questionnaire. Participants were also explicitly advised against engaging in conversations with their peers during the questionnaire completion process. The collection of any personally identifiable information was strictly prohibited.

Questionnaire scoring was carried out by designated individuals possessing the necessary expertise. To ensure the utmost accuracy of the database, a process of double data entry was undertaken, followed by meticulous validation by computer specialists. After the data entry phase, an additional investigator meticulously scrutinized the dataset, aiming to validate and rectify any discrepancies.

Sample size

This study follows a cross-sectional design aimed at examining the relationship between menstrual status, blood type, and other clinical characteristics, considering 10 variables. Based on the Event Per Variable (EPV) principle, the required sample size was greater than 100. The sample size of the PCOS group was 312, which met the required criteria.

Statistical analysis

The statistical data were analyzed using SPSS 28.0 (IBM, America) and GraphPad Prism 10.0. For continuous (quantitative) data, the Shapiro normality test was employed to assess the normality of sample data. Normally distributed continuous variables are presented as mean ± standard deviation, and comparisons were conducted using a two-sided t-test. Continuous variables with non-normal distribution are presented as median (upper quartile, lower quartile), and comparisons were carried out using the Kruskal-Wallis test. Categorical (qualitative) data were statistically described using frequencies (percentages), and inter-group comparisons were performed using the $\chi 2$ test or Fisher's exact test. Significance of 0.05 was considered for determining statistical significance if the two-tailed p-value was less than 0.05. Variables that were statistically significant in one-way analyses were subjected to ordered regression analyses with a test level of $\alpha = 0.05$.

Results

Comparative analysis of characteristics between PCOS patients and control group

The final analysis encompassed a total of 445 patients (including $n = 312$ in the PCOS group, $n = 113$ in the control group), all of whom were subjected to scrutiny. The distribution of individual ABO blood types and relevant characteristics between PCOS patients and healthy controls was presented in Table S1. There was no statistically significant difference in the distribution of blood types between the PCOS group and the control group. Furthermore, significant statistical differences were noted between the PCOS group and the control group in terms of age, BMI, menstrual regularity, serum TG levels, LH, LH/FSH, E2, T, A2, scores on SAS, SDS and PSS. As shown in Table S1, compared to the control group, patients in the PCOS group exhibited higher BMI, irregular menstrual cycles, heightened plasma TG levels,

elevated LH, E2, T, and A2 levels, as well as lower FSH levels. Additionally, a higher prevalence of depression and anxiety was manifest among them. These discernible differences above are consistent with the established clinical attributes of PCOS patients.

Association between blood groups and characteristics in PCOS participants

The distribution of blood types among PCOS patient group across various parameters was next examined. The statistical findings demonstrated significant differences in BMI, present duration of menstruation, present level of menstruation, FSH, LH, and E2 among different blood types within the PCOS patient group (Table 1). Blood type O was associated with a relatively higher BMI, lower levels of FSH and LH, as well as elevated E2 levels.

One-way ANOVA and χ2 test indicated that BMI, present regularity of menstruation and blood types were statistically different among different groups of present level of menstruation, with P-values of 0.033, 0.007, and 0.036, respectively (Table 2). Subsequently, we utilized an ordered logistic regression model with present level of menstruation as the outcome variable, incorporating body mass index (BMI) and menstrual regularity as covariates, to investigate the association between blood group and menstrual status. Results of ordered logistic regression was shown in Table 3, demonstrating that blood type emerges as an independent correlate of menstrual bleeding level among patients diagnosed in PCOS patients.

Association between blood groups and level of menstruation

Distribution of ABO blood groups among PCOS patients was shown in Table 4. From Table 4, there were significant differences in the distribution of A and O blood types between the Light and Heavy groups, as well as in the distribution of AB and O blood types between the Light and Normal groups, and the distribution of B and O blood types between the Light and Heavy groups. Noteworthy tendency emerged from the data: blood type A, B, and AB had relatively higher frequencies in the Light and Normal groups, while blood type O comprised a larger proportion within the Heavy group (Fig. 1).

Table 1 Distribution of blood groups for the characteristics of PCOS participants

Variables	Blood Type				*P*-value[a]
	A	AB	B	O	
Age	29 (27,32)	30 (27,32)	28 (26,31)	29 (27,32)	0.54
BMI	23 (20.25,27.25)	23.9 (21.7,26.5)	25.2 (22.2,28.9)	25.7 (22.3,29.3)	0.033
Present regularity of menstruation					0.665
Irregular	45 (75%)	28 (80%)	81 (81.82%)	71 (75.53%)	
Regular	15 (25%)	7 (20%)	18 (18.18%)	23 (24.47%)	
Present duration of menstruation					0.033
< 10 days	56 (94.92%)	31 (88.57%)	95 (97.94%)	86 (98.85%)	
≥ 10 days	3 (5.08%)	4 (11.43%)	2 (2.06%)	1 (1.15%)	
Present level of menstruation					0.036
Light	19 (32.2%)	17 (47.22%)	32 (31.68%)	20 (22.22%)	
Normal	38 (64.41%)	16 (44.44%)	65 (64.36%)	59 (65.56%)	
Heavy	2 (3.39%)	3 (8.33%)	4 (3.96%)	11 (12.22%)	
TG	1.06 (0.8,1.5)	1.14 (0.88,1.92)	1.34 (0.88,1.85)	1.45 (0.92,2.04)	0.09
HDL	1.31 (1.08,1.54)	1.27 (1.14,1.36)	1.21 (1.02,1.38)	1.19 (1,1.41)	0.148
HOMA.IR	2.04 (1.34,3.09)	2.12 (1.52,3.46)	2.45 (1.64,3.76)	2.41 (1.69,3.42)	0.392
PRL	11.7 (8,15.8)	11.05 (8.2,13.1)	10.9 (7.95,14.25)	10.2 (8.28,13.32)	0.773
FSH	6.13 (5.38,6.73)	6.52 (5.25,7.33)	6.3 (5.44,7.74)	5.16 (4.14,6.14)	< 0.001
LH	7.13 (3.46,12.38)	7.66 (5.07,12.75)	7.2 (4.31,11.9)	5.11 (2.94,8.79)	0.022
LH/FSH	1.17 (0.64,1.98)	1.37 (0.91,1.94)	1.03 (0.64,1.79)	1.14 (0.56,1.71)	0.464
E2	174 (128,222)	161 (119,216.5)	159 (122,192)	219 (168.5,304)	< 0.001
T	1.02 (0.69,1.45)	1.25 (0.69,1.57)	0.95 (0.69,1.39)	1.15 (0.74,1.64)	0.177
A2	13.4 (9.42,16.7)	13.65 (9.31,15.37)	13.05 (9.1,17.6)	13.1 (9.01,18.72)	0.949
SAS	45 (41.25,51.25)	43.75 (38.75,51.88)	43.75 (40,50)	45 (40,48.75)	0.739
SDS	45 (40,56.88)	43.75 (36.25,53.12)	47.5 (38.75,56.25)	45 (38.75,52.5)	0.448
PSS	25.91 ± 7.56	23.33 ± 7.79	24.29 ± 7.35	24.35 ± 7.63	0.341

[a]Univariate analysis included the one-way ANOVA, the Kruskal-Wallis test and χ2 test or Fisher's exact test

*BMI, body mass index; TG, triglyceride; HDL, high density lipoprotein; HOMA-IR: Homeostasis model assessment of insulin resistance, calculated by using the formula: [FINS (μU/mL) × FPG (mmol/L)]/22.5; PRL, prolactin; FSH, follicle-stimulating hormone; LH, luteinizing hormone; E2, estradiol; T, testosterone; A2, androstenedione; SAS, self-rating anxiety scale; SDS, self-rating depressive scale; PSS, perceived stress scale

Table 2 Distribution of present level of menstruation for the characteristics of PCOS participants

Variables	Present level of menstruation			*P*-value[a]
	Light (*N* = 88)	Normal (*N* = 178)	Heavy (*N* = 20)	
age	28 (26,32)	29 (26,32)	28.5 (27,31)	0.728
BMI	25.15 (21.5,28.05)	23.9 (21.2,28.05)	27.7 (25.3,31.02)	0.033
Present regularity of menstruation				0.007
No	76 (89.41%)	128 (72.73%)	14 (70%)	
Yes	9 (10.59%)	48 (27.27%)	6 (30%)	
Blood Type				0.036
A	19 (21.59%)	38 (21.35%)	2 (10%)	
AB	17 (19.32%)	16 (8.99%)	3 (15%)	
B	32 (36.36%)	65 (36.52%)	4 (20%)	
O	20 (22.73%)	59 (33.15%)	11 (55%)	
TG	1.36 (0.86,2.15)	1.27 (0.87,1.69)	1.65 (0.9,2.8)	0.233
HDL	1.19 (1.04,1.4)	1.26 (1.04,1.46)	1.12 (1.04,1.33)	0.359
HOMA.IR	2.64 (1.7,3.98)	2.19 (1.45,3.17)	2.43 (1.99,3.37)	0.074
PRL, ng/mL	9.64 (7.42,13.03)	10.9 (8.22,14.2)	11.95 (7.23,17.35)	0.188
FSH, mIU/mL	6.14 (5.15,7.3)	5.81 (4.61,6.94)	5.49 (4.82,6.17)	0.354
LH, mIU/mL	7.66 (4.33,12.53)	6.54 (3.75,10.5)	3.86 (2.13,7.54)	0.057
LH/FSH	1.21 (0.7,2.19)	1.11 (0.67,1.73)	0.69 (0.38,1.29)	0.077
E2, pmol/L	169.5 (132.5,216.5)	187.5 (133.75,247.25)	194 (138.25,272)	0.202
T, nmol/L	1.12 (0.69,1.5)	1.06 (0.69,1.45)	0.96 (0.69,1.22)	0.639
A2, nmol/L	13.2 (9.28,16.7)	13 (9.07,17.4)	13.95 (9.11,18.17)	0.821
SAS	45 (40,51.25)	45 (40,50)	42.5 (39.69,50)	0.803
SDS	46.88 (40,56.56)	45 (38.75,53.75)	44.38 (38.75,52.81)	0.569
PSS	25.49 ± 7.19	24.68 ± 7.58	21.7 ± 8.58	0.128

[a]Univariate analysis included the one-way ANOVA, the Kruskal-Wallis test and χ2 test or Fisher's exact test

*BMI, body mass index; TG, triglyceride; HDL, high density lipoprotein; HOMA-IR: Homeostasis model assessment of insulin resistance, calculated by using the formula: [FINS (μU/mL) × FPG (mmol/L)]/22.5; PRL, prolactin; FSH, follicle-stimulating hormone; LH, luteinizing hormone; E2, estradiol; T, testosterone; A2, androstenedione; SAS, self-rating anxiety scale; SDS, self-rating depressive scale; PSS, perceived stress scale

Table 3 Ordered regression analysis for factors associated with the present level of menstruation

Factors	B	Std. Error	*p* value	OR(95% CI)
Blood Type O	Ref.			
Blood Type A	-0.7	0.36	**0.049**	0.49(0.24 ~ 0.99)
Blood Type B	-0.58	0.31	0.059	0.56(0.3 ~ 1.02)
Blood Type AB	-1.07	0.42	**0.010**	0.34(0.15 ~ 0.78)
BMI	0.01	0.02	0.624	1.01(0.96 ~ 1.06)
present regularity of menstruation	0.9	0.31	**0.004**	2.46(1.35 ~ 4.59)
Intercepts of light| normal	-0.86	0.69	0.211	/
Intercepts of normal| heavy	2.73	0.72	**0.000**	/

Blood Type O is used as the reference group; when the independent variable is a continuous variable, the continuous variable is directly included in the binary logistic regression model

Table 4 Distribution by ABO blood types for present level of menstruation

Present level of menstruation	*N*	Blood Type				*P*-value*	
		A(%)	AB(%)	B(%)	O(%)		
PCOS						0.036	
Light	88	21.6	19.3	36.4	22.7	$P_{11} = 0.308$	$P_{12} = 0.034$
Normal	178	21.3	9	36.5	33.1	$P_{21} = 0.007$	$P_{22} = 0.110$
Heavy	20	10	15	20	55	$P_{31} = 0.267$	$P_{32} = 0.017$

* P_{1*} = A vs. O, P_{2*} = AB vs. O, P_{3*} = B vs. O, P_{*1} = Light vs. Normal, P_{*2} = Light vs. Heavy

Univariate analysis included the one-way ANOVA, the Kruskal-Wallis test and χ2 test

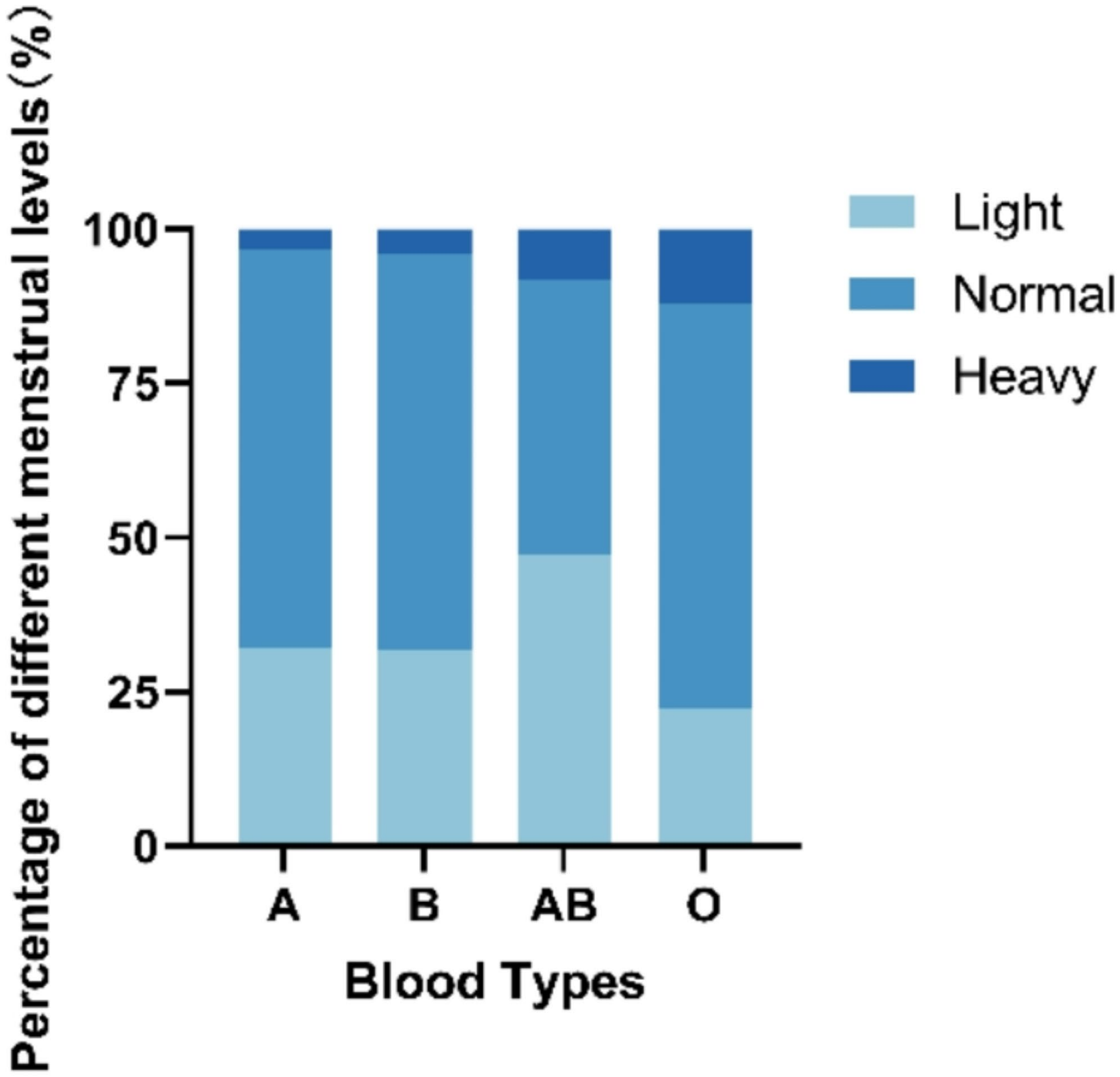

Fig. 1 Percentage of different menstrual levels

Menstrual characteristics variations among PCOS patients with blood type O versus non-O blood types

Furthermore, we categorized the participants into those with blood type O and those with non-O blood types, and described the different distributions of menstrual characteristics, including present regularity of menstruation, duration of menstruation, and level of menstruation (Table 5)**.** Although the results lacked statistical significance, they suggested a potential tendency towards relatively less proportion of menstrual duration with more than ten days and higher menstrual bleeding levels among PCOS patients with blood type O in contrast to their counterparts with other blood types.

Discussion

The strengths of our study are primarily attributed to its relatively large sample size, comprising 312 participants with PCOS, and the rigorous methodology employed. Our cross-sectional design allows for an initial exploration of the association between ABO blood type and menstrual function in PCOS patients, and the use of detailed clinical measurements of hormone levels, BMI, and menstrual level increases the robustness of the findings. Blood type exerts its effects through the differential expression of antigens, impacting the body's endocrine and metabolic processes, and holding significant connections to physiological functions and disease

Table 5 Distribution by O and other blood types for present menstruation

Variables	Blood Type		*P*-value*
	O	Others	
Present regularity of menstruation			0.459
No	71 (75.53%)	154 (79.38%)	
Yes	23 (24.47%)	40 (20.62%)	
Present duration of menstruation			0.258
< 10 days	86 (98.85%)	182 (95.29%)	
≥ 10 days	1 (1.15%)	9 (4.71%)	
Present level of menstruation			0.014
Light	20 (22.22%)	68 (34.69%)	
Normal	59 (65.56%)	119 (60.71%)	
Heavy	11 (12.22%)	9 (4.59%)	

*Univariate analysis included χ2 test or Fisher's exact test

susceptibilities. ABO blood types play a pivotal role in pathogenesis of systemic conditions such as infectious, cardiovascular and reproductive system disease [19, 23, 24]. In this study, we discovered variations in blood type among PCOS patients with different menstrual bleeding levels. PCOS patients with blood type O exhibited a tendency towards greater menstrual bleeding and less proportion of menstrual duration, suggesting a lower possibility of menstrual disorder. The results also indicated statistically significant variations in BMI, FSH, LH, and E2 levels among PCOS patients, stratified across distinct blood type categories. Specifically, individuals with blood type O had relatively higher BMI, lower FSH and LH levels, as well as elevated E2 levels.

Abnormal menstrual bleeding in PCOS patients may be linked to coagulation dysfunction. The hemostatic and coagulation systems of the endometrium are essential for regulating menstrual blood loss, as menstruation involves vascular rupture and platelet adhesion, which triggers the coagulation cascade [12]. Blood type O individuals have been shown to have lower levels of von Willebrand factor (vWF) and factor VIII (FVIII), which are critical in coagulation processes, making them more susceptible to bleeding tendencies [25–27]. In the general population, studies have established a relationship between blood type O and increased menstrual bleeding, likely due to these coagulation-related mechanisms. Specifically, individuals with blood type O typically have lower plasma levels of vWF, leading to decreased FVIII levels and a heightened susceptibility to bleeding [25, 28, 29]. However, this relationship has not been thoroughly explored in the context of PCOS. Our study extends this finding by demonstrating that PCOS patients with blood type O also tend to have heavier menstrual bleeding, suggesting that the same coagulation mechanisms may be at play in this population, which highlights the potential role of coagulation dysfunction in the complex etiology of abnormal menstrual blood loss in PCOS.

Abnormal menstrual bleeding may also be influenced by endocrine factors, as hormonal imbalances can significantly affect menstrual bleeding level and cycle characteristics. The menstrual cycle is regulated by gonadotropin-releasing hormone (GnRH) pulses from the hypothalamus, which stimulate the pituitary gland to release FSH and LH. These gonadotropins facilitate the development of a dominant follicle [30, 31]. LH promotes the production of androgens, while FSH stimulates the conversion of androgens into estradiol (E2) by granulosa cells, with E2 levels rising during the follicular phase. Level of E2 triggers an LH surge, leading to ovulation and the subsequent rise in progesterone levels [32]. Endocrine disturbances can lead to menstrual disorders of PCOS, and in PCOS, there are often altered levels of FSH, LH, and sex hormones, with prolonged estrogen exposure in the absence of progesterone withdrawal. This hormonal imbalance contributes to menstrual irregularities and may lead to heavy bleeding [33, 34].

In addition to increased bleeding, the duration of menstruation is another critical aspect of menstrual irregularities in PCOS. Studies suggest that excessive LH secretion in PCOS patients can lead to the overproduction of ovarian androgens, which are subsequently converted into estradiol, contributing to prolonged menstrual cycles [35]. Interestingly, our study found that PCOS patients with blood type O tend to experience heavier menstrual bleeding and shorter durations, with relatively lower FSH and LH levels, as well as elevated E2 levels, suggesting that in PCOS patients, the above endocrine mechanisms are reflected in individuals with different blood groups.

Thus, in the context of the endocrine dysfunction associated with PCOS, blood type O may be linked to a relatively more favorable endocrine profile, which could contribute to both increased menstrual bleeding and shorter menstrual durations, and these observations underscore the need for further research with larger sample sizes to better elucidate the underlying mechanisms and their role in menstrual irregularities in PCOS. Due

to limitations in the data from cross-sectional studies and inadequate sample sizes, our research lacks precise determinations regarding the exploration of its underlying mechanisms, causal relationships among relevant factors, specific markers of ovarian function. Additionally, the existence of analogous distribution deviations in other comparable illnesses, along with potential interconnections between the mechanistic underpinnings of these conditions remain uncertain. Moreover, exploring blood type antigens as potential biomarkers for PCOS and their clinical application with immunotherapy holds significant significance. The potential association between ABO blood types and menstrual irregularities in PCOS offers a guiding direction for molecular biology research into the occurrence of PCOS.

From a public health perspective, this research could have profound implications for the early screening and prevention of PCOS-related complications. It will facilitate the identification of high-risk blood type populations, enabling timely adjustments to their lifestyles and health behaviors. For gynecologists, the ability to identify high-risk blood type groups could facilitate the timely identification of patients susceptible to menstrual irregularities associated with PCOS.

Conclusion

The study findings substantiate the proposed hypothesis regarding the association between menstrual bleeding level and ABO blood type among individuals with PCOS. Notably, those with blood type O exhibit a predisposition to heightened menstrual bleeding with more favorable endocrine status in contrast to individuals with non-O blood types within the cohort. However, it is imperative to acknowledge the presence of considerable individual diversity within the clinical sample. Therefore, it remains imperative to conduct more expansive investigations encompassing larger participant cohorts to comprehensively elucidate the intricate interplay between blood types and both menstrual and ovarian functionality in the context of PCOS.

Abbreviations

PCOS	Polycystic ovary syndrome
BMI	Body mass index
TG	Triglycerides
HDL	High-density lipoprotein cholesterol
LH	Luteinizing hormone
FSH	Follicle-stimulating hormone
A2	Androstenedione
E2	Estradiol
OGTT	Oral Glucose Tolerance Test
AMH	Anti-Müllerian hormone
OR	Ovarian reserve
DOR	Diminished ovarian reserve
vWF	Von Willebrand factor

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12902-025-01898-0.

Supplementary Material 1

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Author contributions

SHY, HZ and LS contributed equally to this work. HLZ, WW, HZ and LS designed and organized the study, collected study objects, provided data management and wrote this manuscript. SHY, YY and YHL conducted the statistical analysis, took responsibility for the integrity and accuracy of this analysis, interpreted the data and drafted the manuscript. WYQ participated in study design, methodology and statistical analysis. WW, IF and LFZ were responsible for patient recruitment and data collection; XYX and ND provided scientific advice regarding the development of the intervention; LYL acquired the patient data and administered the treatments. HLZ revised the paper, supervised this project and contributed to the expert review and survey instrument. All authors read and approved the final manuscript.

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Data availability

Data supporting the findings of this study are not publicly available due to privacy or ethical restrictions. The datasets used and/or analysed in the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics

Study protocol was approved by the Medical Science Research Ethics Committee of Peking University Third Hospital (No. 2016-212-02) and registered on ClinicalTrial.gov (NCT04264832, website: https://clinicaltrials.gov). All methods were carried out in accordance with relevant guidelines and regulations.

Patient consent

All participants provided written informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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