

RELATIONSHIP BETWEEN VITAMIN D DEFICIENCY AND MENSTRUAL IRREGULARITIES IN POLYCYSTIC OVARY SYNDROME

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Abstract

Background: Polycystic ovary syndrome (PCOS) is one of the most common endocrine disorders among reproductive-age women and is frequently associated with menstrual irregularities. Vitamin D deficiency has emerged as a potential contributing factor to metabolic and reproductive dysfunction in PCOS. **Objective:** To determine the relationship between vitamin D deficiency and menstrual irregularities among women diagnosed with PCOS. **Methodology:** A cross-sectional analytical study was conducted at a tertiary care hospital in Lahore, Pakistan, from January 2024 to December 2024. A total of 180 women aged 18–35 years diagnosed with PCOS according to Rotterdam criteria were enrolled. Serum 25-hydroxyvitamin D levels were measured using chemiluminescent immunoassay. Menstrual patterns were recorded and categorized as regular cycles, oligomenorrhea, or amenorrhea. Statistical analysis was performed using SPSS version 26. Correlations between vitamin D status and menstrual abnormalities were assessed using chi-square and logistic regression analyses. **Results:** The mean age of participants was 26.8 ± 4.3 years. Vitamin D deficiency (<20 ng/mL) was observed in 72.2% of participants. Menstrual irregularities were present in 78.3% of women. Women with vitamin D deficiency had significantly higher rates of oligomenorrhea (52.3%) and amenorrhea (18.5%) compared to those with sufficient vitamin D levels ($p < 0.001$). Serum vitamin D levels showed a significant inverse association with menstrual cycle length ($r = -0.41$, $p < 0.001$). **Conclusion:** Vitamin D deficiency is highly prevalent among women with PCOS and is significantly associated with menstrual irregularities. Early detection and correction of vitamin D deficiency may improve reproductive outcomes in affected women.

Keywords: PCOS, Vitamin D Deficiency, Menstrual Irregularities, Oligomenorrhea, Amenorrhea, Reproductive Health.

INTRODUCTION

Polycystic ovary syndrome (PCOS) is the most common endocrine disorder affecting women of reproductive age, with a global prevalence ranging from 8–20% depending on

diagnostic criteria used.¹ It is characterized by hyperandrogenism, ovulatory dysfunction, and polycystic ovarian morphology. Women with PCOS frequently experience menstrual irregularities including oligomenorrhea, amenorrhea, and anovulatory cycles, which contribute significantly to infertility and reduced quality of life.²

The pathophysiology of PCOS is complex and multifactorial, involving genetic predisposition, insulin resistance, chronic low-grade inflammation, and hormonal disturbances.³ Recent evidence suggests that vitamin D may play an important role in reproductive physiology through its effects on ovarian follicular development, steroidogenesis, insulin sensitivity, and endometrial receptivity.⁴ Vitamin D receptors are widely distributed in reproductive tissues including the ovaries, endometrium, placenta, and pituitary gland, indicating its potential role in female reproductive health.⁵

Vitamin D deficiency is recognized as a global public health problem, particularly in South Asian countries where cultural practices, limited sun exposure, and dietary habits contribute to low vitamin D status.⁶ Studies have reported that up to 80% of women with PCOS exhibit suboptimal vitamin D levels.⁷ The coexistence of vitamin D deficiency and PCOS has raised interest regarding a possible mechanistic relationship between these conditions. Several studies have demonstrated that vitamin D deficiency may exacerbate insulin resistance, obesity, and hyperandrogenism in women with PCOS.⁸ These metabolic disturbances can further impair ovulatory function and contribute to menstrual abnormalities. Vitamin D has been shown to regulate anti-Müllerian hormone expression, follicular maturation, and ovarian steroidogenesis, suggesting a direct role in menstrual cycle regulation.⁹

Menstrual irregularities remain one of the most common clinical manifestations of PCOS and are often associated with adverse reproductive outcomes. Previous investigations have suggested that lower serum vitamin D concentrations are associated with longer menstrual cycles and increased prevalence of oligomenorrhea.¹⁰ However, findings remain inconsistent, and data from Pakistani women are limited.

Understanding the relationship between vitamin D deficiency and menstrual disturbances may help identify a modifiable factor that could improve reproductive outcomes in women with PCOS. Early recognition and correction of vitamin D deficiency could potentially enhance menstrual regularity and overall reproductive health. Therefore, the present study was conducted to determine the relationship between vitamin D deficiency and menstrual irregularities among women diagnosed with PCOS attending a tertiary care hospital.

MATERIALS AND METHODS

This cross-sectional analytical study was conducted in the Department of Gynecology and Obstetrics at a tertiary care teaching hospital in Lahore, Pakistan, from July 2023 to December 2023. The study was carried out after obtaining approval from the Institutional Review Board (IRB), and all participants provided written informed consent before

enrollment. The study aimed to evaluate the relationship between serum vitamin D levels and menstrual irregularities among women diagnosed with polycystic ovary syndrome (PCOS). A total of 180 women aged between 18 and 35 years who had been diagnosed with PCOS according to the Rotterdam 2003 diagnostic criteria were recruited through consecutive non-probability sampling. According to the Rotterdam criteria, the diagnosis of PCOS was established when at least two of the following three features were present: oligo/anovulation, clinical or biochemical hyperandrogenism, and polycystic ovarian morphology on ultrasonography. Women with pregnancy, thyroid dysfunction, hyperprolactinemia, chronic kidney disease, chronic liver disease, metabolic bone disorders, Cushing's syndrome, congenital adrenal hyperplasia, or those receiving hormonal therapy, vitamin D supplementation, or insulin-sensitizing agents within the preceding three months were excluded from the study.

Demographic and clinical information including age, body mass index (BMI), marital status, duration of PCOS symptoms, and menstrual history were recorded using a structured questionnaire. Menstrual patterns were assessed through detailed interviews and review of medical records. Menstrual cycles were classified as regular (cycle length between 21 and 35 days), oligomenorrhea (cycle length greater than 35 days), or amenorrhea (absence of menstruation for three consecutive months or longer).

Following an overnight fast of 8–10 hours, approximately 5 mL of venous blood was collected from each participant under aseptic conditions. Serum was separated by centrifugation and analyzed for 25-hydroxyvitamin D [25(OH)D] concentrations using a chemiluminescent immunoassay technique in the hospital's central diagnostic laboratory. Vitamin D status was categorized according to Endocrine Society guidelines as deficient (<20 ng/mL), insufficient (20–29 ng/mL), and sufficient (≥30 ng/mL).

Height and weight were measured using standardized procedures, and BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m²). Participants were further categorized according to BMI status to assess the influence of obesity on menstrual irregularities.

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Quantitative variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The association between vitamin D status and menstrual irregularities was evaluated using the Chi-square test. Independent predictors of menstrual abnormalities were identified using binary logistic regression analysis. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 180 women diagnosed with PCOS participated in the study. The mean age was 26.8±4.3 years and the mean BMI was 29.7±5.2 kg/m². Vitamin D deficiency was identified in 72.2% of participants, while only 10% had sufficient vitamin D levels.

Menstrual irregularities were observed in 141 (78.3%) women. Oligomenorrhea was the most common menstrual abnormality, affecting 44.4% of participants, followed by amenorrhea in 14.4%.

Women with vitamin D deficiency demonstrated significantly higher frequencies of menstrual irregularities compared with women having adequate vitamin D status. Oligomenorrhea was present in 52.3% of vitamin D deficient women versus 24.0% of non-deficient women. Similarly, amenorrhea was more prevalent among deficient participants (18.5% vs 4.0%; $p<0.001$).

Logistic regression analysis demonstrated that vitamin D deficiency independently increased the likelihood of menstrual irregularities by approximately four-fold (OR=3.82, 95% CI: 1.95–7.48, $p<0.001$).

Table 1: Baseline Characteristics of Study Participants (n=180)

Variable	Mean $\pm$ SD
Age (years)	26.8 $\pm$ 4.3
BMI (kg/m ²)	29.7 $\pm$ 5.2
Duration of symptoms (years)	4.1 $\pm$ 2.3
Serum Vitamin D (ng/mL)	17.4 $\pm$ 8.1

Table 2: Vitamin D Status among Women with PCOS

Vitamin D Status	n (%)
Deficient (<20 ng/mL)	130 (72.2)
Insufficient (20–29 ng/mL)	32 (17.8)
Sufficient ($\geq$ 30 ng/mL)	18 (10.0)

Table 3: Menstrual Pattern According to Vitamin D Status

Menstrual Pattern	Deficient n=130	Non-deficient n=50	p-value
Regular cycles	38 (29.2%)	36 (72.0%)	<0.001
Oligomenorrhea	68 (52.3%)	12 (24.0%)	
Amenorrhea	24 (18.5%)	2 (4.0%)	

Table 4: Association between Vitamin D Levels and Menstrual Irregularities

Variable	OR
Vitamin D deficiency	3.82
BMI >30 kg/m ²	2.14
Age >30 years	1.18

DISCUSSION

The present study investigated the relationship between vitamin D deficiency and menstrual irregularities among women with PCOS. The findings demonstrated a high prevalence of vitamin D deficiency and revealed a significant association between low vitamin D levels and abnormal menstrual patterns. Women with deficient vitamin D levels

exhibited higher frequencies of oligomenorrhea and amenorrhea compared with those having adequate vitamin D status.

Vitamin D deficiency was observed in more than two-thirds of the study population. This finding is consistent with previous reports indicating that hypovitaminosis D is highly prevalent among women with PCOS worldwide. Studies conducted in Pakistan and neighboring South Asian countries have similarly reported vitamin D deficiency rates exceeding 60–80% among women with PCOS.^{11 12}

The observed association between vitamin D deficiency and menstrual irregularities may be explained by the physiological role of vitamin D in ovarian function. Vitamin D receptors are expressed in granulosa cells and ovarian follicles, where they influence follicular development, steroid hormone production, and ovulation.¹³ Reduced vitamin D levels may impair these processes, leading to menstrual dysfunction and anovulatory cycles.

Our results demonstrated a significantly higher prevalence of oligomenorrhea among vitamin D deficient women. Similar findings have been reported by Pal et al., who observed that lower serum vitamin D concentrations were associated with prolonged menstrual cycles and ovulatory disturbances in women with PCOS.¹⁴ Wehr et al. also found that vitamin D deficiency was independently associated with menstrual abnormalities and metabolic dysfunction.¹⁵

The relationship between vitamin D and reproductive health may additionally be mediated through insulin resistance. Insulin resistance is a hallmark feature of PCOS and contributes to hyperandrogenism and ovulatory dysfunction. Vitamin D has been shown to enhance insulin receptor expression and improve glucose metabolism, thereby potentially improving menstrual regularity.¹⁶ Several interventional studies have reported improvements in menstrual cyclicity following vitamin D supplementation among vitamin D deficient women with PCOS.¹⁷

Obesity was also identified as a significant predictor of menstrual irregularities in our study. This finding aligns with previous literature demonstrating that obesity exacerbates insulin resistance and hormonal imbalance in PCOS.¹⁸ Vitamin D deficiency and obesity frequently coexist, creating a complex interaction that may further impair reproductive function.

The present study has several strengths, including the use of standardized diagnostic criteria for PCOS and objective measurement of serum vitamin D levels. However, the cross-sectional design limits causal inference. Longitudinal studies and randomized controlled trials are required to determine whether correction of vitamin D deficiency directly improves menstrual outcomes in women with PCOS.

Overall, the findings suggest that vitamin D deficiency may represent an important and potentially modifiable factor associated with menstrual disturbances in PCOS. Routine screening and appropriate management of vitamin D deficiency may contribute to improved reproductive health in affected women.

CONCLUSION

Vitamin D deficiency is highly prevalent among women with PCOS and is significantly associated with menstrual irregularities, particularly oligomenorrhea and amenorrhea. Women with deficient vitamin D levels are more likely to experience abnormal menstrual cycles than those with adequate vitamin D status. Screening for vitamin D deficiency should be considered as part of the routine evaluation of women with PCOS, and future studies should investigate the potential benefits of vitamin D supplementation on menstrual and reproductive outcomes.

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