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Impact of Body Mass Index on Serum 25-Hydroxyvitamin D Levels in Women with PCOS: A Rural Bangladeshi Study

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Abstract **Original Research Article**

Background: Polycystic ovary syndrome (PCOS) is a common endocrine disorder among women of reproductive age and is frequently associated with metabolic abnormalities, including obesity and vitamin D deficiency. Increasing evidence suggests that low vitamin D levels may contribute to the pathophysiology and severity of PCOS. However, data exploring the relationship between body mass index (BMI) and vitamin D status among Bangladeshi women with PCOS remain limited. ***Methods:*** This case–control study was conducted at the Department of Internal Medicine, Shaheed Syed Nazrul Islam Medical College Hospital, Kishoreganj, Bangladesh, from July 2021 to June 2023. A total of 202 women of reproductive age were enrolled, comprising 101 women diagnosed with PCOS according to the Rotterdam criteria and 101 age-matched women without PCOS as controls. Anthropometric measurements were recorded and BMI was calculated and categorized. ***Results:*** The mean age of participants was comparable between cases (24.27 ± 6.49 years) and controls (24.30 ± 6.54 years). Mean serum vitamin D level was significantly lower in PCOS women (19.28 ± 6.10 ng/mL) compared with controls (27.45 ± 5.87 ng/mL). Vitamin D deficiency was observed in 69.3% of PCOS women versus 19.8% of controls. Overweight was more prevalent among PCOS women (48.5%) and vitamin D deficiency was highest among overweight PCOS participants (48.6%). ***Conclusion:*** Vitamin D deficiency is highly prevalent among women with PCOS and is strongly associated with higher BMI. Routine screening and targeted interventions addressing both vitamin D status and weight management may improve clinical outcomes in women with PCOS.

Keywords: Polycystic ovary syndrome, Vitamin D deficiency, Body mass index, Reproductive-aged women.

INTRODUCTION

Polycystic ovary syndrome (PCOS) is one of the most common endocrine disorders affecting women of reproductive age [1]. It is characterized by ovulatory dysfunction, hyperandrogenism and polycystic ovarian morphology and is frequently associated with metabolic abnormalities such as obesity, insulin resistance and dyslipidaemia [2]. These metabolic disturbances not only worsen reproductive outcomes but also increase long-term risks of type 2 diabetes mellitus and cardiovascular disease [3].

Vitamin D, a fat-soluble secosteroid hormone, plays an important role in calcium homeostasis, immune regulation, insulin sensitivity and reproductive function [4]. Growing evidence suggests that vitamin D deficiency is highly prevalent among women with PCOS and may contribute to the pathophysiology of the syndrome through mechanisms involving insulin resistance, chronic low-grade inflammation and altered ovarian steroidogenesis [5]. Low serum 25-hydroxyvitamin D [25(OH)D] levels have been linked to menstrual irregularities, hyperandrogenism and impaired follicular development in women with PCOS [6].

Body mass index (BMI) is a key determinant of vitamin D status, as vitamin D is sequestered in adipose tissue, reducing its bioavailability in individuals with higher body fat [7]. Obesity, which is common

among women with PCOS, may therefore exacerbate vitamin D deficiency and further worsen metabolic and reproductive abnormalities [8]. Several studies have reported an inverse relationship between BMI and serum 25(OH)D levels in PCOS populations; however, findings remain inconsistent across different ethnic and geographic settings [9].

Vitamin D deficiency is widely prevalent despite abundant sunlight, particularly among women, due to factors such as limited outdoor exposure, cultural clothing practices, dietary insufficiency and low awareness regarding supplementation [10]. Rural populations may be especially vulnerable because of nutritional constraints and limited access to healthcare services. Data examining the combined effects of BMI and vitamin D status among women with PCOS in rural Bangladeshi settings are scarce [11].

Understanding the relationship between BMI and vitamin D status in women with PCOS is essential for developing targeted preventive and therapeutic strategies. Therefore, this study aimed to assess serum 25-hydroxyvitamin D levels and their association with body mass index among women with PCOS compared with age-matched controls attending a rural healthcare facility in Bangladesh.

METHODOLOGY & MATERIALS

This case–control study was carried out at the Department of Internal Medicine, Shaheed Syed Nazrul Islam Medical College Hospital, Kishoreganj, Bangladesh, over a two-year period from July 2021 to June 2023. A total of 202 women of reproductive age were enrolled in the study. The participants were divided into two equal groups: 101 women diagnosed with polycystic ovary syndrome (PCOS) serving as cases and 101 age-matched women without PCOS serving as controls.

The diagnosis of PCOS was established based on the Rotterdam criteria, which require the presence of at least two of the following features after exclusion of other related disorders: oligo- or anovulation (defined as oligomenorrhoea with a menstrual interval of 35–182 days or amenorrhoea characterized by absence of menstruation for more than 182 days), clinical and/or biochemical evidence of hyperandrogenism and polycystic ovarian morphology on ultrasonographic examination [12].

Control participants were recruited from the same outpatient clinic and were confirmed to have regular menstrual cycles, no clinical or biochemical signs of hyperandrogenism and no ultrasonographic evidence of polycystic ovaries using the same screening protocol.

Detailed medical, reproductive and family histories were obtained from all participants. Anthropometric measurements including height and weight were recorded and body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. BMI was categorized as underweight (<18 kg/m²), normal (18.10–22.90 kg/m²), overweight (23–29.90 kg/m²) and obese (≥30 kg/m²).

Venous blood samples were collected from all participants to measure serum 25-hydroxyvitamin D [25(OH)D] levels using an immunoassay method. Vitamin D status was classified according to Endocrine Society guidelines as deficient (<20 ng/mL), insufficient (21–29 ng/mL), or sufficient (≥30 ng/mL) [13].

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26. Comparisons of proportions between groups were conducted using the chi-square test. Statistical significance was determined by calculating p-values, with a p-value of less than 0.05 considered statistically significant.

RESULTS

Table I: Age distribution of the Study Participants

Age (years)	PCOS		Controls	
	n	%	n	%
<20	28	27.7	27	26.7
21-30	51	50.5	52	51.5
>30	22	21.8	22	21.8
Total	101	100	101	100

A total of 101 PCOS patients and 101 controls were included in the analysis. Most of the women belongs to 21-30 years of age (50.5%) with the mean age of 24.27 ±6.49 years in case and 24.30 ±6.54 in control group (Table I).

Table II: Vitamin D level of the Study Participants

Vitamin D (ng/ml)	PCOS		Controls		*p*-value
	n	%	n	%	
<20	70	69.3	20	19.8	<0.001
21-30	19	18.8	49	48.5	
>30	12	11.9	32	31.7	
Total	101	100.0	101	100	

Mean vitamin D status among PCOS patient was 19.28±6.10 ng/ml, whereas the mean vitamin D status among control patient was 27.45±5.87 ng/ml which was significantly higher. About 18.8% of PCOS women showed insufficient vitamin D level, 69.3% were deficient whereas only 11.9 % showed normal level of vitamin D. In comparison, 19.8% of control women showed deficient vitamin D level, 48.5% were insufficient and 31.7 % showed normal level of vitamin D. The highest proportion of vitamin D deficiency was observed in the 21–30-year age group (48.5%) (Table II).

Table III: BMI of the Study Participants

BMI (kg/m^2)	PCOS		Controls		*p*-value
	n	%	n	%	
<18 UNDER WEIGHT	9	8.9	19	18.8	<0.001
18.10-22.90 NORMAL	40	39.6	71	70.3	
23-29.90 OVER WEIGHT	49	48.5	11	10.9	
>30 OBESE	3	3	0	0	
Total	**101**	**100.0**	**101**	**100**	

Table III shows, among 101 PCOS women 8.9 % were of underweight, 39.6 % belongs to normal weight, 48.5 % were overweight and 3% were obese. Mean BMI of all women included was 22 (15-32 kg/m^2), whereas mean BMI in control population was 20.5 which is significantly different (p<.001).

Table IV: BMI Vs Vitamin D level of the PCOS women (n=101)

	Level Of Vitamin D (ng/ml)			
BMI (kg/m^2)	**<20 DEFICIENT**	**21-29 INSUFFICIENT**	**>30 SUFFICIENT**	**Total**
<18 UNDER WEIGHT	3	5	1	9
18.10-22.90 NORMAL	29	4	1	40
23-29.90 OVER WEIGHT	34	14	1	49
>30 OBESE	3	0	0	3
Total	**70**	**19**	**12**	**101**

Table IV shows the level of Vitamin D among PCOS women (case) according to BMI categories. Vitamin D deficiency was highest (48.6%) in over weight PCOS women.

DISCUSSION

The present case–control study evaluated the relationship between body mass index (BMI) and serum 25-hydroxyvitamin D levels among women with polycystic ovary syndrome (PCOS) in a rural Bangladeshi setting. The findings demonstrate a significantly higher prevalence of vitamin D deficiency among women with PCOS compared with age-matched controls, along with a clear association between higher BMI and lower vitamin D levels within the PCOS group.

In this study, the mean serum vitamin D level among PCOS women was 19.28 ± 6.10 ng/mL, which was significantly lower than that of controls (27.45 ± 5.87 ng/mL). Nearly two-thirds (69.3%) of PCOS women were vitamin D deficient, whereas only 19.8% of controls fell into the deficient category. These findings are consistent with the observations of Krul-Poel *et al*., who reported a high prevalence of vitamin D deficiency among women with PCOS and highlighted its association with metabolic disturbances [14]. Similarly, Ng *et al*. and Lumme *et al*. found significantly lower serum 25(OH)D levels in PCOS women compared to non-PCOS counterparts in cross-sectional population-based studies [15, 16].

The high burden of vitamin D deficiency observed in the present study aligns with reports from South Asian and Middle Eastern populations, where cultural practices, limited sun exposure and dietary insufficiency contribute to suboptimal vitamin D status. Gokosmanoglu *et al*. and Arslan *et al*. also demonstrated a significantly higher prevalence of vitamin D deficiency in women with PCOS, reinforcing the notion that PCOS itself may predispose individuals to lower vitamin D levels independent of geographic location [17, 18].

Body mass index emerged as an important determinant of vitamin D status in this study. Among PCOS women, 48.5% were overweight and 3% were obese, compared with a predominance of normal BMI in controls. Vitamin D deficiency was most pronounced among overweight PCOS women, accounting for 48.6% of deficient cases. This inverse association between BMI and serum vitamin D levels has been well documented. Krul-Poel *et al*. and Kumar *et al*. reported that higher adiposity is associated with lower circulating vitamin D levels, likely due to sequestration of vitamin D in adipose tissue, reducing its bioavailability [14, 19].

The relationship between vitamin D deficiency and metabolic dysfunction in PCOS has been extensively explored. Mesinovic *et al*. and Li *et al*. demonstrated associations between low vitamin D levels, hyperandrogenism and impaired glucose homeostasis in women with PCOS [20, 21]. These mechanisms may partly explain why overweight PCOS women in the present study exhibited the highest prevalence of vitamin D deficiency. Furthermore, Maidana *et al*. reported significant associations between vitamin D levels, inflammatory markers and metabolic parameters in PCOS, suggesting a multifactorial role of vitamin D in disease severity [22].

Interventional studies further support the clinical relevance of these findings. Seyyed Abootorabi *et al*. and Jamilian *et al*. showed that vitamin D supplementation improved insulin resistance, visceral fat and metabolic profiles in vitamin D–deficient PCOS women [23, 24]. Chehsmazar *et al*. also demonstrated beneficial effects of vitamin D supplementation on metabolic parameters in overweight and obese individuals, emphasizing the importance of addressing vitamin D deficiency alongside weight management [25].

The age distribution in this study showed that most participants were aged 21–30 years, the peak reproductive period, highlighting the potential reproductive implications of vitamin D deficiency in PCOS. Previous studies by Pal *et al*. and Omran *et al*. have linked low vitamin D levels to poorer reproductive outcomes in PCOS, including reduced fertility and assisted reproductive technique success rates [26, 27].

Limitations of the study

Despite its strengths, this study has limitations, including its single-center design and cross-sectional nature, which precludes causal inference. The small number of obese PCOS women also limits subgroup analysis.

CONCLUSION

In conclusion, this study confirms a high prevalence of vitamin D deficiency among women with PCOS, particularly among those with higher BMI. Routine screening for vitamin D deficiency and integrated lifestyle interventions focusing on weight management may be beneficial components of PCOS management in rural settings.

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