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Original Research Article

Study of the effect of vitamin D supplementation on the clinical, metabolic, and hormonal profile of women with polycystic ovary syndrome in walled city of Delhi

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ABSTRACT

Background: Polycystic ovary syndrome (PCOS) is a ubiquitous endocrine disorder often associated with vitamin D deficiency, which may contribute to reproductive and metabolic disturbances. This work gauged the influence of vitamin D supplementation on the clinical, metabolic, hormonal, and sonographic profiles of women having PCOS.
Methods: A hospital-based case control study initially included 60 women diagnosed with PCOS. The final sample size was 56, as two participants in the case group conceived, one in the control group conceived, and another control participant was lost to follow-up. The remaining 56 women were equally divided into two groups: cases (receiving metformin 500 mg BD for 12 weeks + vitamin D 60,000 IU once weekly for 12 weeks with advice for lifestyle and dietary modification) and controls (receiving metformin 500 mg BD for 12 weeks with advice for lifestyle and dietary modification). Clinical symptoms, menstrual patterns, and metabolic, hormonal, and sonographic parameters were evaluated before and after the intervention.
Results: Vitamin D supplementation significantly improved infrequent menses (78.6% to 46.4%, p=0.027) and scanty menses (50% to 21.4%, p=0.048) compared to controls. Weight gain reduced markedly in cases (71.4% to 25%, p=0.0013). Significant reductions were observed in fasting glucose (p=0.001) and postprandial glucose (p=0.022), with high density lipoprotein (HDL) showing a significant rise (p<0.001). Hormonal parameters showed no significant changes. Right ovarian volume decreased modestly (p=0.046).
Conclusion: Vitamin D supplementation in PCOS women improved menstrual regularity, weight-related symptoms, glycaemic control, HDL cholesterol, and ovarian morphology, but had limited effects on hormonal parameters.

Keywords: PCOS, Vitamin D, Menstrual irregularities, Metabolic profile, Ovarian morphology

INTRODUCTION

Polycystic ovary syndrome (PCOS) is a ubiquitous endocrine disorder, affecting 8–13% of women of reproductive age.[1,2] It is marked by chronic anovulation, hyperandrogenism, and polycystic ovarian morphology, and is often linked with insulin resistance (IR), obesity, dyslipidaemia, and higher risks of type 2 diabetes and cardiovascular disease.[3] Beyond reproductive issues, PCOS is now recognized as a complex metabolic condition with significant long-run health consequences. Vitamin D deficiency is greatly ubiquitous across women having PCOS, reported in up to 70–80% of cases, and has been implicated as a potential contributor to both reproductive and metabolic disturbances.[4] Vitamin D receptors are expressed inside pancreatic β-cells, ovarian granulosa cells, and adipose tissue, suggesting a plausible role in glucose metabolism, insulin sensitivity, steroidogenesis, and follicular development. Several observational along with interventional studies have indicated that, vitamin D supplementation may improve IR, menstrual irregularities, and certain metabolic threat aspects in women having

PCOS.[5,6] However, results across studies remain inconsistent, partly due to differences in baseline vitamin D status, supplementation dose, treatment duration, and PCOS phenotype. The study aims to gauge the effect of vitamin D supplementation, in addition to metformin, on the clinical (menstrual irregularities, hirsutism, acne), hormonal (serum testosterone, luteinizing hormone (LH), follicle-stimulating hormone (FSH), prolactin, thyroid-stimulating hormone (TSH), and metabolic (fasting blood sugar, lipid profile) profiles of women with PCOS.

METHODS

This hospital-grounded CCS was done inside the Department of Obstetrics and Gynaecology, Kasturba Hospital, Daryaganj, Delhi, between 01 July 2024 and 31 July 2025.

Study population

Sixty women diagnosed with PCOS as per Rotterdam's criteria (any two of oligo/anovulation, clinical hyperandrogenism, or polycystic ovarian morphology) were recruited from the Gynaecology OPD and randomly allocated into two groups. Out of the initial 60 participants, the final analysis included 56 women, as two participants in the case group and one in the control group conceived during the study, while another control participant was lost to follow-up.

Inclusion criteria

Women being of reproductive age meeting Rotterdam's criteria, defined by the existence of any two of the following, were included: oligo/anovulation (cycle length >35 days), clinical hyperandrogenism (acne or hirsutism with modified Ferriman-Gallwey score ≥6), or polycystic ovarian morphology on ultrasound (>12 follicles of 2–9 mm and/or ovarian volume >10 cc).

Exclusion criteria

Women who were pregnant or lactating, using oral contraceptives, statins, or glucocorticoids, or with known diabetes, thyroid, or pituitary disorders were excluded. Those with congenital adrenal hyperplasia, Cushing's syndrome, neoplasms, systemic illnesses (liver, cardiac, or renal), or a history of tobacco or alcohol use were also not included.

Intervention and study design

Cases (n=30) received metformin twice daily (Metformin dose 500 mg BD for 12 weeks) + vitamin D 60,000 IU for 12 weeks; once weekly, along with lifestyle and dietary advice and controls (n=30) received metformin twice daily (Metformin dose 500 mg BD for 12 weeks) + lifestyle and dietary advice.

Vitamin D status was categorized as sufficient (>30 ng/ml), insufficient (being 20–30 ng/ml), deficient (being 10–20 ng/ml), and severely deficient (being <10 ng/ml).

Data collection

Data were collected at baseline and after 12 weeks. Outcomes assessed included the following.

Clinical profile

Menstrual irregularities, hirsutism, acne and weight gain.

Metabolic profile

Fasting and postprandial blood sugar, lipid profile (HDL, LDL, triglycerides, total cholesterol), body mass index (BMI) and waist–hip ratio.

Hormonal profile

Testosterone, LH, FSH, LH/FSH ratio, prolactin and TSH.

Ultrasonographic profile

Ovarian volume and endometrial thickness.

Statistical analysis

Data was gauged utilizing statistical package for the social sciences (SPSS) software. Also, continuous variables demarcated as mean±SD along with categorical variables as percentages. A two-sided $p<0.05$ was statistically noteworthy.

RESULTS

The study included 56 women having PCOS, equally divided into cases and controls. The mean age was comparable between groups (26.10±4.50 versus 25.89±4.95 years), with most participants in the 21-30-year range, highlighting the reproductive age predominance of PCOS. Baseline factors such as religion and socioeconomic status were similar, minimizing confounders. A family history of PCOS was noted in 21.4% of cases and 10.7% of controls, though the difference was not significant.

Table 1 demonstrate the vitamin D deficiency was more prevalent among cases than controls. Severe deficiency (being <10 ng/ml) was noted in 32.1% of cases versus 14.3% of controls, while about one-third in both groups fell within the deficient range (10–20 ng/ml). Also, insufficiency (being 20–30 ng/ml) was seen in roughly one-fourth of participants, while sufficient levels (being >30 ng/ml) were more frequent in controls (21.4%) compared to cases (7.1%). Although mean vitamin D levels were slightly lower inside cases (16.93±7.95 ng/ml) than controls (18.50±7.85 ng/ml), the variance wasn't statistically noteworthy (p=0.46).

Following supplementation, women receiving vitamin D plus metformin showed greater improvement inside menstrual irregularities than those on metformin alone. Infrequent menses declined significantly in the case group (78.6% to 46.4%, p=0.027), whereas no noteworthy variation occurred in controls. Scanty menses also improved more in cases (50% to 21.4%), with a noteworthy post-treatment difference across groups (p=0.048).

Other menstrual abnormalities, including frequent cycles and heavy bleeding, showed only minor, non-significant changes. Overall, these results suggest that vitamin D supplementation significantly benefits menstrual regulation particularly in reducing infrequent and scanty menses while its impact on other irregularities remains limited.

Table 1: Level of vitamin D in cases and controls.

Vitamin D level (ng/ml)	Cases (tab metformin 500 mg BD + vitamin D 60000 IU once weekly) (%)	Control (tab metformin 500 mg BD) (%)
<10	9 (32.1)	4 (14.3)
10-20	9 (32.1)	11 (39.3)
20-30	8 (28.6)	7 (25.0)
>30	2 (7.1)	6 (21.4)
Mean±SD	16.93±7.95	18.50±7.85

Independent t test; p=0.46 not significant

Figures 1 and 2, demonstrate that vitamin D supplementation led to significant improvements in glycaemic control among women with PCOS. In the case group, fasting blood sugar decreased notably from 101.64±9.43 to 94.78±9.14 mg/dl (p=0.001), while the control group showed a smaller, borderline reduction (97.11±4.79 to 91.64±5.26 mg/dl, p=0.05). Similarly, postprandial blood sugar levels declined significantly in the vitamin D–supplemented group (141.96±17.05 to 140.32±15.93 mg/dl, p=0.022), with no significant change observed in controls (p=0.339). These findings indicate that vitamin D, when combined with metformin, enhances glycaemic control more effectively than metformin alone.

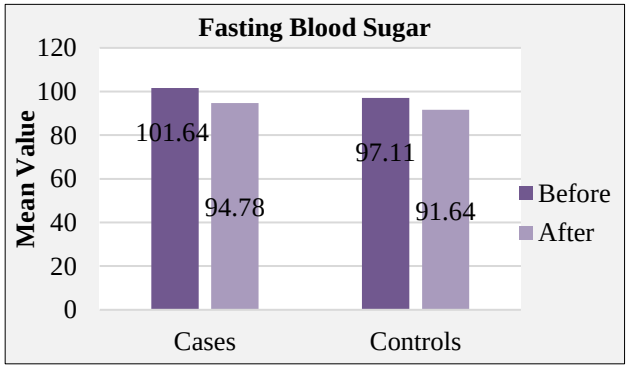

Figure 1: Fasting blood sugar before and after in cases and controls.

Table 2 shows that menstrual irregularities improved more inside the vitamin D–supplemented group compared to controls. In cases, infrequent cycles reduced significantly from 78.6% to 46.4% (p=0.027), while the change in controls was not significant (p=0.106). Scanty menses also improved more in cases (50% to 21.4%), with a noteworthy post-treatment difference across groups (p=0.048). However, frequent cycles and heavy menstrual bleeding showed only minor improvements in both groups, and none reached statistical significance.

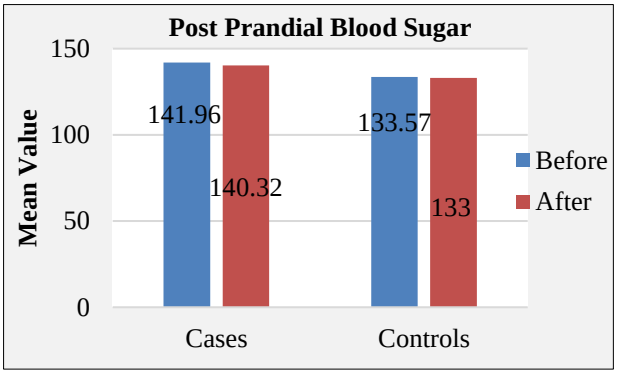

Figure 2: Post-prandial blood sugar before and after in cases and controls.

Table 3 and Figure 3 indicate that, vitamin D supplementation with metformin led to a noteworthy drop in weight gain among cases (71.4% to 25%, p=0.0013), while no such benefit was seen in controls. Other symptoms such as acne, acanthosis nigricans, and alopecia showed no significant changes in either group. These findings propose the primary benefit of vitamin D in PCOS lies in improving weight-related symptoms, whereas dermatological and androgenic features may need longer treatment or additional interventions.

Table 4 highlights the effect of vitamin D supplementation on the metabolic profile of women with PCOS. In the case group, fasting blood sugar showed a significant reduction from 101.64±9.43 to 94.78±9.14 mg/dl (p=0.001), while in controls the decline was smaller and borderline significant (p=0.05). Postprandial blood sugar also decreased significantly in cases (p=0.022) but not in controls. Among lipid parameters, HDL increased significantly in the vitamin D group from 38.96±5.77 to

41.07±5.53 mg/dl (p<0.001), whereas no noteworthy variance was grasped in controls. Total cholesterol, triglycerides, and LDL levels remained largely unchanged in both groups.

Table 5 shows vitamin D supplementation with metformin did not produce any statistically noteworthy changes in the hormonal profile of women with PCOS over the study period. Testosterone levels showed a slight reduction in both cases (0.84 to 0.81 ng/ml) and controls (0.86 to 0.82 ng/ml), but the differences were not significant.

Similarly, LH values decreased modestly in cases (10.98 to 10.16 mIU/ml) and remained nearly unchanged in controls, while FSH levels showed negligible change in both groups. The LH: FSH ratio showed a minor decline in cases (2.38 to 2.24) and remained stable in controls, without significance. Prolactin levels remained essentially unchanged in both groups, while TSH showed only minimal variation.

Table 6 findings show that vitamin D supplementation along with metformin was associated with a modest reduction in ovarian volume, particularly in the right ovary. In the case group, right ovarian volume decreased significantly from 12.78±4.17 cm^3 to 12.54±3.86 cm^3 (p=0.046), while the reduction in controls was not significant.

For the left ovary, cases showed a non-significant decline (14.18±2.40 to 13.60±2.16 cm^3, p=0.063), whereas controls showed a slight, non-significant increase. Between-group comparisons at baseline and after treatment were not significant. Overall, the results propose vitamin D may contribute to improving ovarian morphology, with a more noticeable effect on the right ovary.

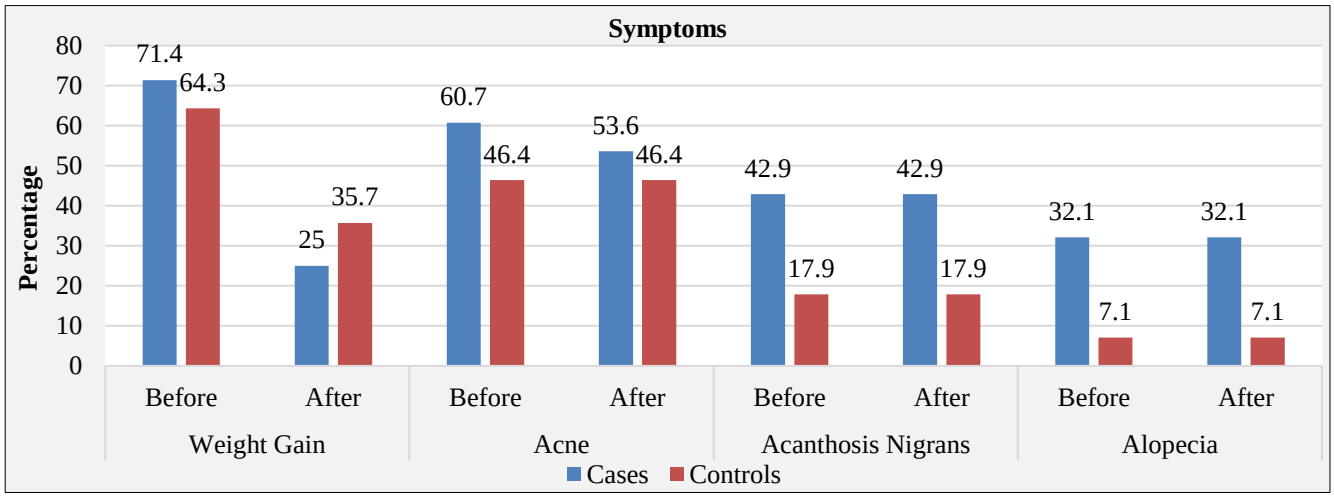

Figure 3: Comparison of symptoms before and after in cases and controls.

Table 2: Menstrual irregularities before and then after Vit. D supplementation in cases and controls.

Menstrual irregularity		Cases (tab metformin 500 mg BD + vitamin D 60000 IU once weekly)		Controls (tab metformin 500 mg BD)		P value (independent t test)
		N	%	N	%	
Infrequent menses	Before	22	78.6	19	67.9	0.299
	After	13	46.4	12	42.9	0.788
	P value (paired t test)	0.027*		0.106		
Scanty menses	Before	14	50.0	16	57.1	0.592
	After	6	21.4	13	46.4	0.048
	P value (paired t test)	0.051		0.59		
Frequent menses	Before	1	3.6	5	17.9	0.084
	After	0	0.0	3	10.7	0.075
	P value (paired t test)	0.99		0.69		
Heavy menstrual bleeding	Before	6	21.4	4	14.3	0.485
	After	4	14.3	1	3.6	0.160
	P value (paired t test)	0.729		0.348		

Chi- square test; *p<0.05 significant

Table 3: Comparison of symptoms before and after in cases and controls.

Symptoms	P value	Cases (tab metformin 500 mg BD + vitamin D 60000 IU once weekly)		Controls (tab metformin 500 mg BD)		P value (individual t test)
		N	%	N	%	
H/O weight gain	Before	20	71.4	18	64.3	0.624
	After	7	25.0	10	35.7	
	P value	0.0013*		0.06		
Acne	Before	17	60.7	13	46.4	0.951
	After	15	53.6	13	46.4	
	P value	0.42		1.00		
Acanthosis Nigricans	Before	12	42.9	5	17.9	1.0
	After	12	42.9	5	17.9	
	P value	1.00		1.00		
Alopecia	Before	9	32.1	2	7.1	1.0
	After	9	32.1	2	7.1	
	P value	1.00		1.00		

Chi-square test; *p<0.05 significant.

Table 4: Metabolic profile before and after in cases and controls.

Characteristics		Cases (tab metformin 500 mg BD + Vitamin D 60000 IU once weekly)		Controls (tab metformin 500 mg BD)		P value (independent t test)
		Mean	SD	Mean	SD	
Fasting blood sugar	Before	101.64	9.43	97.11	4.79	0.066
	After	94.78	9.14	91.64	5.26	0.172
	Mean difference	6.86	1.78	5.46	3.26	
	P value	0.001*		0.05		
PPBS	Before	141.96	17.05	133.57	20.44	0.101
	After	140.32	15.93	133.00	18.55	0.119
	Mean difference	1.64	3.57	5.71	3.10	
	P value	0.022*		0.339		
Total cholesterol	Before	159.10	17.99	166.14	26.59	0.251
	After	158.57	17.34	165.78	26.83	0.246
	Mean difference	0.53	1.42	0.35	2.66	
	P value (paired t test)	0.057		0.485		
Triglycerides	Before	134.36	19.00	126.75	29.54	0.257
	After	133.78	18.99	125.63	28.14	0.221
	Mean difference	0.57	1.83	1.11	2.39	
	P value (paired t test)	0.111		0.06		
HDL	Before	38.96	5.77	41.92	4.41	0.036
	After	41.07	5.53	42.16	4.02	0.404
	Mean difference	-2.10	1.93	-0.23	1.32	
	P value (paired t test)	<0.001*		0.364		
LDL	Before	86.63	17.85	84.43	16.46	0.633
	After	86.50	16.40	84.37	15.64	0.621
	Mean difference	0.133	2.148	0.06	1.58	
	P value (paired t test)	0.744		0.832		

Paired t test; *p<0.05 significant.

Table 5: Hormonal profile before and after in cases and controls.

Hormones		Cases (tab metformin 500 mg BD + vitamin D 60000 IU once weekly)		Controls (tab metformin 500 mg BD)		P value (independent t test)
		Mean	SD	Mean	SD	
Testosterone	Before	0.84	0.49	0.86	0.82	0.879

Continued.

Hormones		Cases (tab metformin 500 mg BD + vitamin D 60000 IU once weekly)		Controls (tab metformin 500 mg BD)		P value (independent t test)
		Mean	SD	Mean	SD	
	After	0.81	0.48	0.82	0.76	0.930
	Mean difference	0.02	0.07	0.04	0.19	
	P value	0.055		0.06		
LH	Before	10.98	6.43	10.37	5.63	0.07
	After	10.16	5.62	10.14	5.42	0.202
	Mean difference	0.81	1.50	0.23	0.38	
	P value	0.08		0.06		
FSH	Before	4.85	1.71	5.40	1.69	0.233
	After	4.75	1.57	5.29	1.62	0.210
	Mean difference	0.10	0.34	0.11	0.29	
	P value	0.121		0.154		
LH: FSH ratio	Before	2.38	1.47	1.93	0.99	0.187
	After	2.24	1.34	1.95	1.05	0.370
	Mean difference	0.13	0.43	-0.021	0.11	
	P value	0.110		0.343		
Prolactin	Before	16.19	4.06	14.59	4.18	0.153
	After	16.28	3.89	14.24	3.54	0.446
	Mean difference	-0.09	1.05	0.35	1.66	
	P value	0.66		0.27		
TSH	Before	2.37	0.66	2.25	0.72	0.499
	After	2.35	0.61	2.19	0.62	0.370
	Mean difference	0.02	0.12	0.05	0.16	
	P value	0.31		0.14		

Paired t test; p>0.05 not noteworthy

Table 6: USG ovarian volume before and after in cases and controls.

Ovarian volume	Time-point	Cases (metformin + vitamin D) (mean±SD)	Controls (metformin only) (mean±SD)	P value (independent t test)	Mean difference (cases)	P value (paired t test, cases)	Mean difference (controls)	P value (paired t test, controls)
Right ovary	Before	12.78±4.17	13.52±3.59	0.480				
	After	12.54±3.86	13.37±3.39	0.393	0.24±0.60	0.046*	0.146±0.55	0.171
Left ovary	Before	14.18±2.40	12.11±3.00	0.070				
	After	13.60±2.16	12.68±3.07	0.202	0.57±1.43	0.063	0.57±3.17	0.343

*p<0.05 significant

DISCUSSION

Vitamin D deficiency is greatly ubiquitous inside women having PCOS and is linked to adverse metabolic along with reproductive outcomes, counting IR, menstrual irregularities, and altered ovarian morphology.[12] Adequate vitamin D levels are believed to support glucose metabolism, folliculogenesis, and hormonal balance. However, evidence from clinical studies remains mixed, with some demonstrating clear benefits of supplementation, while others report minimal impact.[4,5] This hospital-based randomized case–control study assessed the effect of adding high-dose vitamin D (60,000 IU weekly for 12 weeks) to metformin in women having PCOS. Supplementation led to noteworthy improvements in menstrual regularity, fasting glucose, HDL cholesterol, systolic blood pressure, and right ovarian volume. However, changes in testosterone, LH, FSH, prolactin, and TSH were minimal and not statistically significant.

Our finding of improved menstrual cyclicity aligns with earlier reports. Wehr et al observed improved menstrual frequency after vitamin D supplementation, while Gupta et al also demonstrated benefits in menstrual and metabolic outcomes.[4] Similarly, Garg and Makhija reported significant improvement in menstrual abnormalities and ovarian morphology with combined metformin and vitamin D therapy.[6] These conclusions are further supported by systematic reviews and international guidelines, which suggest vitamin D supplementation can promote menstrual regulation in vitamin D deficient women having PCOS.[7,13,15]

Metabolic improvements observed in this study are consistent with prior literature. Li et al reported

associations across vitamin D deficiency and IR in PCOS.[12] Gupta et al showed significant reductions in fasting insulin and HOMA-IR after vitamin D supplementation, while Trummer et al and Miao et al also highlighted modest improvements in glycaemic outcomes.[5,8,9] Our findings of increased HDL levels parallel reports from Wen et al though effects on total cholesterol, triglycerides, and LDL remain inconsistent across studies.[10]

A modest but significant reduction in right ovarian volume was observed, suggesting that vitamin D may act through local ovarian pathways. Experimental studies support this by showing that vitamin D, via VDR expression, can modulate follicular development and down-regulate pro-inflammatory pathways such as TGF-β1. VDRs have also been identified inside the ovary, and endometrium, along with placenta, indicating a broader role of vitamin D in the female reproductive tract, although its exact impact on oocyte competence and lifespan remains unclear.[16]

Conversely, no significant changes were seen in hormonal markers (testosterone, LH, FSH, prolactin, TSH), consistent with other RCTs.[4,11,12] Some evidence suggests hormonal benefits may be more likely with combined calcium–vitamin D supplementation or when treating women with severe baseline deficiency.[13]

Limitations

Limitations include the modest sample size, short follow-up (12 weeks), and heterogeneity in baseline vitamin D status, which may have influenced treatment response. This study highlights vitamin D supplementation as a safe, low-cost adjunct in PCOS care, showing benefits for menstrual regularity, glycaemic control, and HDL cholesterol. However, its impact on androgen levels and long-term reproductive outcomes remains uncertain. Current guidelines recommend supplementation in deficient women, and further great-scale RCTs are needed to define optimal dosing, duration, and target subgroups.[14]

CONCLUSION

Hence the study concludes that vitamin D supplementation, when added to metformin, provides clear benefits in women with PCOS. It significantly improves menstrual regularity, weight-related symptoms, fasting and postprandial glucose levels, HDL cholesterol, and reduces ovarian volume, while hormonal changes remain minimal. Overall, vitamin D is a safe, cost-effective strong supportive therapy in PCOS management, though larger and longer studies are needed to confirm long-term benefits.

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