

Content available at: <https://www.ipinnovative.com/open-access-journals>

Indian Journal of Obstetrics and Gynecology Research

Journal homepage: www.ijogr.org

Original Research Article

Hypo-vitaminosis D and its role in PCOS: A prospective observational study at tertiary care centre in north Indian population

Shalini Mishra¹✉, Namrata Sinha¹, Neelam Swaroop¹, Anima Prasad^{1*}, Annu Mallik¹¹Dept. of Obstetrics and Gynecology, T.S.M. Medical College and Hospital, Lucknow, Uttar Pradesh, India

Abstract

Background: Polycystic ovary syndrome (PCOS) is a prevalent endocrine disorder affecting women of reproductive age, characterized by oligo-menorrhea, hyper-androgenism, and metabolic disturbances. Vitamin D deficiency is common in PCOS patients and may exacerbate symptoms. This study aims to investigate the relationship between body mass index (BMI) and vitamin D levels in PCOS patients in a North Indian population.

Materials and Methods: A prospective observational study was conducted at T.S. Mishra Medical College and Hospital from November 2023 to November 2024. A total of 156 patients aged 18-45 years with PCOS were enrolled based on modified Rotterdam criteria. Blood samples were analyzed for metabolic parameters, including serum vitamin D levels, and BMI was calculated. Statistical analysis was performed using SPSS 25.0.

Results: The mean age of participants was 23.3 ± 1.4 years, with a mean BMI of 26.72 ± 1.6 kg/m². Vitamin D deficiency (<20 ng/ml) was observed in 67.9% of patients, while 8.3% had sufficient levels (>30 ng/ml). No significant association was found between BMI categories and vitamin D levels ($p=0.06719$). However, significant differences were noted in metabolic parameters, with higher fasting insulin, DHEAS, and testosterone levels in vitamin D deficient patients ($p<0.05$).

Conclusion: This study highlights a high prevalence of vitamin D deficiency among PCOS patients, with significant correlations between vitamin D levels and metabolic parameters, but not with BMI. These findings suggest the need for vitamin D assessment and potential supplementation in managing PCOS, particularly in the Indian population.

Keywords: PCOS, Hyper-androgenism, BMI, DHEAS, Vitamin D, Fasting insulin.

Received: 13-03-2025; **Accepted:** 14-10-2025; **Available Online:** 18-11-2025

This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprint@ipinnovative.com

1. Introduction

Polycystic ovary syndrome (PCOS) is one of the commonest endocrine disorder among women of reproductive age. PCOS affects up to one-sixth of reproductive age women with a prevalence that may reach or even exceed from 5 to 15%, depending on the diagnostic criteria applied and the populations studied in different geographical areas worldwide.^{1,2} It is a multisystem disorder characterized by oligo-ovulation or anovulation, and consequently lead to the development of biochemical and clinical hyper-androgenism, resulting from circulating luteinizing hormone (LH) levels and the altered ratio of LH to FSH.³ Morphologically, the ovaries of PCOS women may appear polycystic (polycystic

ovarian morphology, PCOM). PCOS is also associated other metabolic changes like with hyperinsulinemia, impaired glucose tolerance, and sometimes type 2 diabetes mellitus (T2DM).⁴ Factors such as insulin resistance (IR) dyslipidemia, endothelial dysfunction, and systemic inflammation are other elements that add to this set of signs and symptoms and predispose patients to a higher risk of cardiovascular disease than women without PCOS.⁵ Several mechanisms have been proposed to explain the relationship between vitamin D and PCOS. Vitamin D plays a physiologic role in reproduction including ovarian follicular development and luteinization via altering anti-müllerian hormone (AMH)

*Corresponding author: Anima Prasad
Email: shalini.shalu15@gmail.com

signaling, follicle-stimulating hormone sensitivity and progesterone production in human granulosa cells.⁶ The prevalence of vitamin D deficiency in women with PCOS is about 67-85 per cent, with serum concentrations of 25(OH) D <20 ng/ml.⁷ This study aims to establish the relation of body mass index (BMI) with vitamin D levels in PCOS patients and to correlate with other metabolic parameters and effectiveness of its supplementation in PCOS. Since, Most of the existing studies till now are not directly establishing the relationship between Body mass index and vitamin D relation specific to Asian /Indian population.

1.1. Vitamin D(VD) deficiency and PCOS

Vitamin D regulates calcium metabolism and bone mineralization. VD exists in our body in two forms: ergocalciferol (VD2) and cholecalciferol (VD3). VD3 is of animal origin and is synthesized endogenously in the human body. Ultraviolet radiation from the sun rays acts on the skin and converts 7-dehydrocholesterol to a pre-vitamin form that is subsequently converted to VD. For VD activation, two different hydroxylations are required: the first occurs in the liver where the enzyme 25-hydroxylase metabolizes VD to 25-hydroxyvitamin D (25-OH-D). Subsequently, 25-OH-D is transported to the kidneys where it undergoes the second hydroxylation; thus 1, 25-dihydroxyvitamin D (1,25-OH-D) or calcitriol, the biologically active form of Vitamin D, is formed.

It has been shown that low Vitamin D levels may worsen PCOS symptoms, so that an inverse correlation has been reported between serum VD level and metabolic and hormonal disturbances of PCOS.⁹ (Figure 1) Few studies investigated the relationship between VD deficiency and PCOS phenotypes. Davis et al. analyzed PCOS women, grouped into three diagnostic phenotypes according to the Rotterdam criteria and found higher prevalence of VD deficiency in PCOS cases with androgen excess.¹⁰ Maktabi et

al. performed a placebo-controlled trial on VD-deficient (serum concentrations < 20 ng/mL) women with phenotype B-PCOS according to the Rotterdam criteria. After the 12-week intervention, VD supplementation significantly decreased fasting plasma glucose, insulin, HOMA-IR index, and increased quantitative insulin sensitivity.¹¹

1.2. Vitamin D, insulin resistance & obesity

Insulin resistance (IR) is one of the more specific traits of PCOS, and is mainly marked in obese women, suggesting that PCOS and obesity have a synergistic effect on the magnitude of the insulin disorder, leading to increased insulin secretion by pancreatic β -cells and compensatory hyperinsulinemia.¹² IR and related hyper-insulinemia have been linked to all symptoms of the syndrome, such as reproductive disorders, hyper-androgenism, acne, hirsutism, and metabolic disturbances. Finally, insulin resistance in PCOS may be considered a risk factor for gestational diabetes. To this regard, one theory relies on the regulatory effect of Vitamin D on the intra-cellular and extracellular calcium level that is essential for insulin-mediated intra-cellular processes and may have impact on insulin secretion.¹³ Another hypothesis involves the stimulatory effect of Vitamin D on the expression of insulin receptors leading to the increase insulin sensitivity. Indeed, Vitamin D activates the transcription of the VD response element (VDRE) of the human insulin gene.

However, the association of Vitamin D deficiency with insulin resistance may also be explained by mechanisms other than obesity. First of all, it has been reported that Vitamin D may improve insulin activity by stimulating VDR gene expression. Vitamin D has immune-modulatory effect. So, low levels of VD may induce an inflammatory response, which is again associated with insulin resistance.¹⁴ (Figure 2)

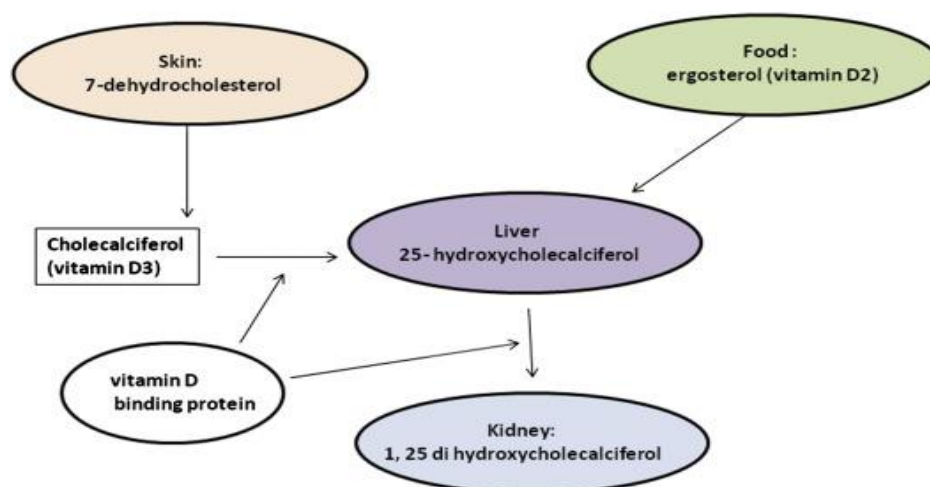


Figure 1: Metabolism of vitamin D⁸

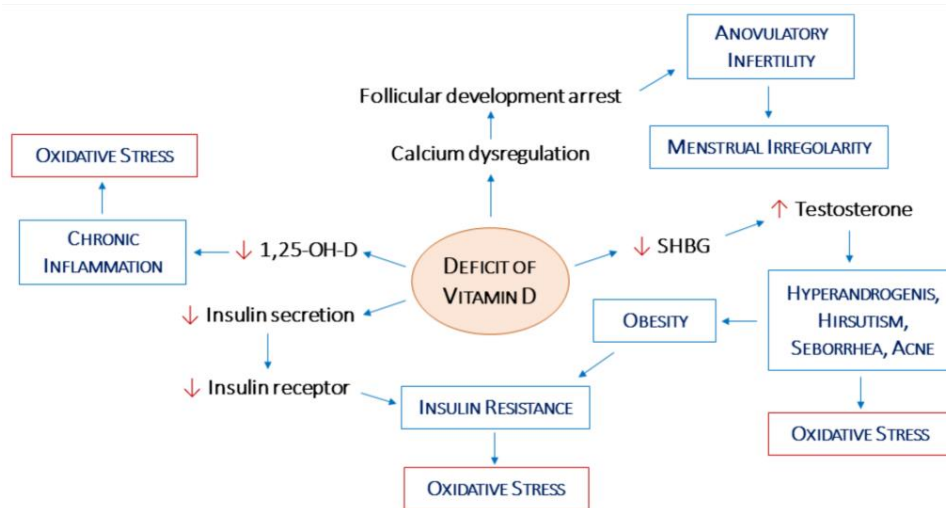


Figure 2: Effect of vitamin D deficiency on multisystem parameters. (1,25-OH-D: 1,25-hydroxyvitamin D; SHBG: Sex Hormone Binding Globulin)¹²

2. Materials and Methods

This is a prospective cross-sectional study. The study was conducted in T.S. Mishra Medical College and Hospital from November 2023 to November 2024. Total 156 patients out of 250 patients, who attended the OPD endocrine clinic in dept. of Obstetrics & Gynecology of T.S. Mishra Hospital, of 18-45 year were enrolled in the study. Patients who had complains of irregular menses/amenorrhea or features of clinical and biochemical hyperandrogenism, were included in the study. Known cases of Type 2 DM, metabolic disorders, thyroid disease, CAH, auto immune diseases or patients not willing to participate were excluded from the study. The criteria used for diagnosis of PCOS was the modified Rotterdam criteria.¹⁴ Baseline characteristics were noted. BMI was calculated as body weight (kg) divided by height (m²). Subjects were classified as normal-weight if they had a BMI of <25.0 kg/m², overweight if the BMI was 25-29.9 kg/m², or obese in cases where BMI was ≥30 kg/m². Blood sugar testing done with 2-hr post oral glucose tolerance test (OGTT). All blood investigations were done including Follicle stimulating hormone (FSH), Luteinizing hormone (LH), Thyroid stimulating hormone(TSH), S. Prolactin (PRL), Testosterone (T), S. DHEAS, S.AMH and 25 hydroxy-vitamin D[(25-OH) D]. Vitamin D levels with <20 ng/ml were taken as deficient, between 20-30 ng/ml as insufficient and >30ng/ml were taken as sufficient levels.

The primary outcome of the study was to evaluate the relation of vitamin D level with BMI in PCOS women. The secondary outcomes was to study the correlation between serum 25(OH) D concentration and metabolic risk factors in PCOS women.

2.1. Statistical analysis

Data was analyzed using statistical package for the social sciences 25.0(SPSS). Continuous data were presented as **Table 2:** Mean value of vitamin D in different BMI status

mean± standard deviation (SD) and assessed by Fisher’s exact test. One way-ANOVA test and Linear regression analysis was used for comparison between mean of parameters. P value less than 0.05 considered statistically significant.

3. Result

The data from 156 PCOS cases were analyzed in this study. The patient’s baseline characteristics were summarized in **Table 1.**

Table 1: Baseline characteristics

Parameters/Variabile	Mean value
Women’s Age(years)	23.3 ± 1.4
BMI (kg/m ²)	26.72 ± 1.6
S.TSH (µIU/mL)	2.16 ± 0.9
S. Prolactin (ng/mL)	18.14 ± 2.2
S.AMH (ng/mL)	6.38 ± 2.3
S. Vit. D level (ng/mL)	15.0 ± 2.08
S. Testosterone(ng/ml)	53.4 ± 22.9
S. DHEAS(ng/dl)	221 ± 38.07

Table 2 showed the relation of BMI and Vitamin D. Mean concentration of serum vitamin D was seen as 14.2 ±1.64, 21.89± 0.32, 27.2± 0.34, 10.7±0.4 in under-weight, patients with normal range of BMI, over-weight and obese respectively. There were no patients with vitamin D toxicity level.

Since the p-value is greater than 0.05, we fail to reject the null hypothesis. This means there is no statistically significant association between BMI categories and vitamin D levels in this data-set. (**Table 3**)

BMI(kg/m ²)	Frequency(n=156)	Vitamin D (mean± SD level)
Underweight	18(11.5%)	14.2 ± 1.64
Normal	60(38.4%)	21.89 ± 0.32
Overweight	39(25%)	27.2 ± 0.34
Obese	39(25%)	10.7 ± 0.4

Table 3: Relation of vitamin D and BMI

Variable	Insufficiency (20-<30 ng/mL) (n=37) (23.7%)	Deficient (<20 ng/mL) (n=106) (67.9%)	Sufficiency (30-100 ng/mL) (n=13) (8.3%)	p value
BMI		Frequency		
<i>Underweight</i> (<18.5)	5	10	3	
<i>Normal</i> (18.5-24.9)	16	38	6	0.06719
<i>Overweight</i> (25-29.9)	3	34	2	
<i>Obese</i> (>=30)	7	16	2	
<i>Morbidly obese</i> (>= 40)	5	8	1	

Fisher's exact test

Table 4: Metabolic parameters among different vitamin D status in PCOS

Metabolic Parameters	Insufficiency (20-<30 ng/mL) (n=37)	Deficient (<20 ng/mL) (n=106)	Sufficiency (30-100 ng/mL) (n=13)	p value
<i>BMI</i>	25	25.8	25.6	0.00
<i>S. Fasting Insulin</i>	18.10 ± 5.82	43.10 ± 0.82	9.8 ± 2.3	<0.05
<i>S.DHEAS</i>	226 ± 99.9	394 ± 98.9	173 ± 42.2	<0.05
<i>S.Testosterone</i>	61.6 ± 5.59	87.4 ± 10.8	41.5 ± 11.2	<0.05

One way-annova test

Here are the p-values for each metabolic parameter based on the ANOVA test:

1. BMI: $p=0.0$ (Each group had a constant value, making the F-statistic undefined.)
2. S. Fasting Insulin: $p \approx 9.82 \times 10^{-96}$ (Highly significant difference between groups.)
3. S. DHEAS: $p \approx 5.87 \times 10^{-24}$ (Highly significant difference between groups.)
4. S. Testosterone: $p \approx 9.61 \times 10^{-43}$ (Highly significant difference between groups.) (**Table 4**)

As we can see that in our finding, BMI does not significantly differ between the three groups, but S. Fasting Insulin, S. DHEAS, and S. Testosterone show highly significant differences between groups, suggesting that metabolic insufficiency/deficiency affects these parameters strongly. S. Fasting Insulin: The Deficiency group has much higher insulin levels, indicating possible insulin resistance. S. DHEAS: The Deficiency group again shows the highest levels, while the Sufficiency group has the lowest. S. Testosterone: The Deficiency group has the highest testosterone levels, suggesting a hormonal imbalance compared to the other groups. (**Figure 3**)

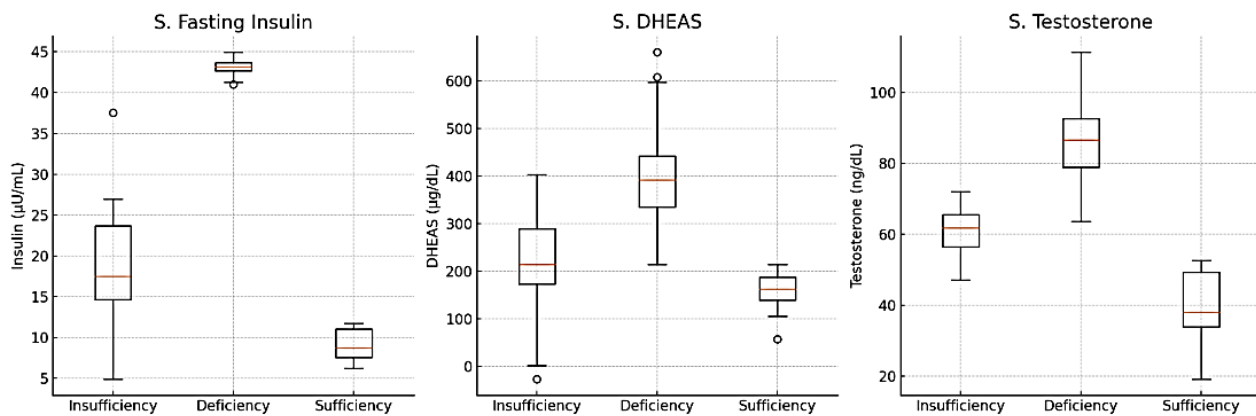


Figure 3: Box plots for S. Fasting Insulin, S. DHEAS, and S. Testosterone across the three groups. ($p < 0.5$)

Linear regression (Figure 4)

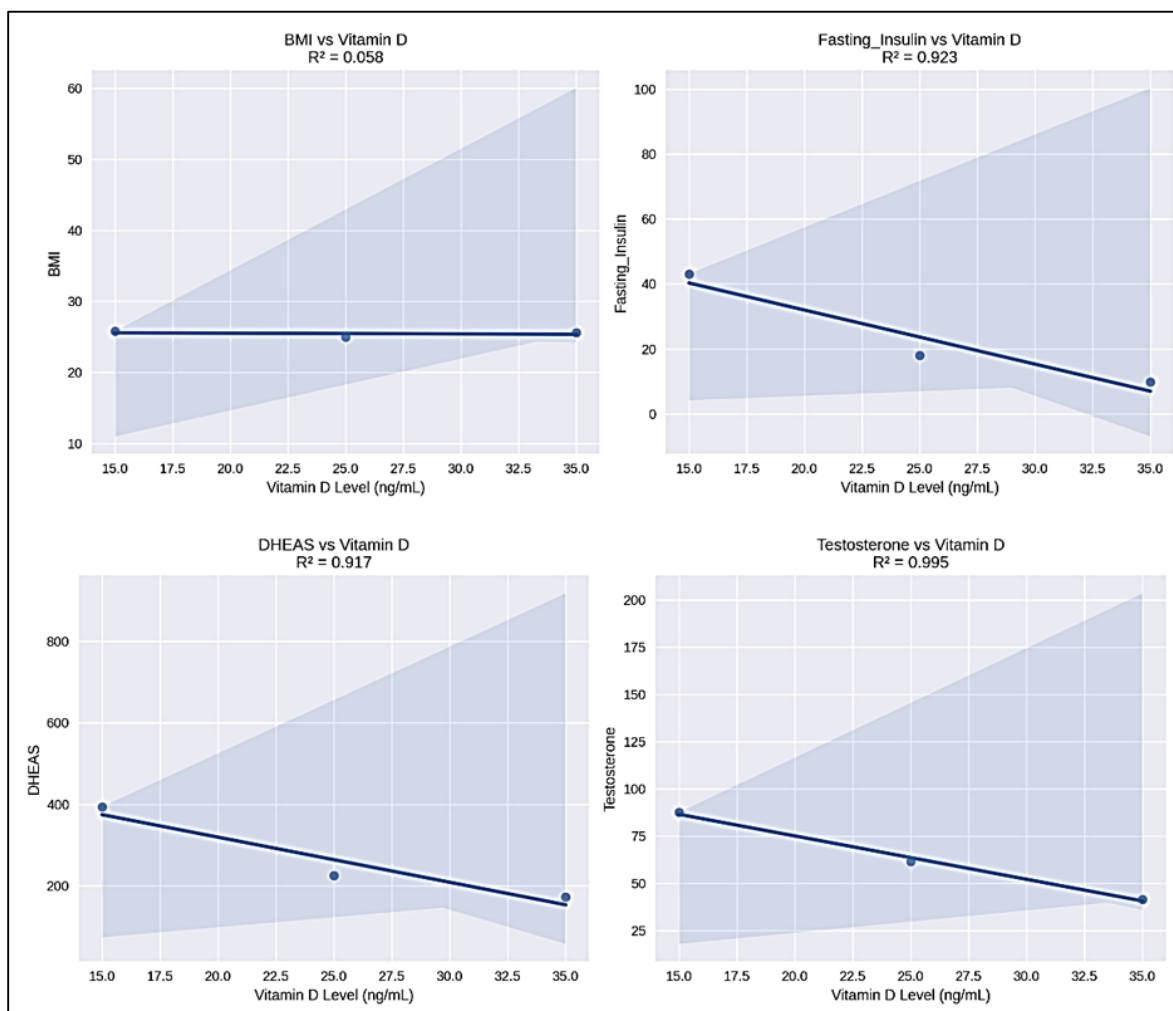


Figure 4: Linear regression analysis of metabolic parameters

Key findings from linear regression:

1. Strong negative correlation between Vitamin D and hormonal parameters (Testosterone: $R^2 = 0.995$, DHEAS: $R^2 = 0.917$, Fasting Insulin: $R^2 = 0.923$).
2. BMI shows weak relationship with Vitamin D ($R^2 = 0.058$).

4. Discussion

Vitamin D deficiency is the current pandemic, especially, in developing countries like India. Vitamin D deficiency plays an important role in various metabolic pathways. PCOS women manifest a relatively high prevalence of vitamin D deficiency than healthy women, and vitamin D deficiency is

associated with ovulatory dysfunction, IR and hyperandrogenism. A strong correlation exists between PCOS and Insulin resistance (IR) which is further exacerbated by vitamin D deficiency. This finding is substantiated by our study as vitamin D deficient PCOS patient have higher fasting insulin levels (43.10 ± 0.82). In PCOS patient, Vitamin D deficiency causes calcium (Ca^{+2}) dys-regulation which leads to arrest of follicular development and high testosterone levels. Also vitamin D deficiency causes low sex hormone binding globulin (SHBG) which causes increase in free testosterone and DHEAS and clinically leading to Acne/Hirsutism In recent years, many studies have been performed to analyze vitamin D status and PCOS women. Our study showed that serum 25(OH) D concentration has no direct relation with BMI levels in PCOS women (p value >0.5).

Table 5: Relation of BMI and fasting insulin level

BMI	Fasting insulin (Mean level)	p-value
Underweight	11.75 ± 5.69	
Normal	15.05 ± 8.79	<0.5
Obese	39.9 ± 2.79	

One way annova test

This finding has been supported by multiple observational studies. Our study further emphasizes the same finding as DHEAS (394 ± 98.9) and free testosterone (87.4 ± 10.8) was higher in deficient group (p value <0.05)

4.1. Vitamin D deficiency and BMI

Vitamin D is a fat soluble vitamin and is sequestered in adipose tissue causing reduced bio-availability. Obese individuals are more likely to be sedentary and spend less time outdoor, in sunlight, which could be a cause of vitamin deficiency in obese individuals. In a genetic study, by Dasgupta and cols.¹⁸ They, evaluated the correlation between VDR and PCOS in Indian population and found significant correlation between the genotypes of VDR and some PCOS manifestations.

In our study, we did not find any significant association between BMI levels and vitamin D deficiency (p value $=0.62$). Which was supported by similar study of Ghadimi et al.¹⁹ that hypo-vitaminosis D was common in PCOS patient, it did not differ with PCOS phenotypes. A retrospective study done in china by Maryam et al.¹¹ on 169 PCOS patients, also supported the fact that there was no significant difference in vitamin D levels among PCOS phenotype (lean vs obese PCOS). Research has found a correlation between PCOS and other metabolic problems, including high blood pressure, depression and anxiety, dyslipidemia and chronic inflammation & it has also been verified that metabolic disorders are common in women with PCOS.

Therefore, with our study, the relation between BMI and Vitamin D, becomes clearly evident; further, this relation, in Indian population, has not been addressed in prior researches.

5. Conclusion

Vitamin D deficiency leads to adverse metabolic changes and poor reproductive health. As, our study highlights the fact, that vitamin D deficiency is not directly linked with obesity in PCOS. Bias, arising from confounding factors like, sun exposure, socioeconomic strata, dietary habits, needs to be eliminated. Thus, there is need for a collaborative and multi-centric trial focused on Indian/Asian population, as the physiological parameters and metabolic status are different in Indian scenario.

6. Limitations

This study could be beneficial as its done in Indian setup, it can be concluded that Vitamin could be an add-on factor but not directly responsible for various adverse outcome associated with PCOS. As majority of Indian population belong to lower-socio-economic strata and poor nutrition, so vitamin D levels are not very much differ among different BMI level individuals. However, most of the unmarried girls and reproductive age female used to woke up late in morning and works in household and offices where direct sunlight is not available The study is an observational study with limited no. of size and study was done in tertiary care Centre with class of people mainly belong to urban areas, who are confined to their homes. Therefore, a multi-centric and interventional study on Indian population is needed for the generalized data.

7. Data Availability Statement

All data-set generated for this study are included in article/supplementary material.

8. Author Contributions

SM and NS conceived the study and wrote the manuscript. SM collected data. SM and NS analyzed data. All authors have given final approval of the article to be published.

9. Source of Funding

This research received no external funding

10. Conflict of Interest

No potential conflict of interest relevant to this article

11. Institutional Review Board Statement

Not applicable

12. Informed Consent Statement

No applicable.

13. Ethical Approval

Ethical No. As there were no intervention or drug trial was done on participants, therefore ethical consideration was not required.

References

- Azziz R. Introduction: Determinants of polycystic ovary syndrome (PCOS). *Fertil Steril*. 2016;106(1):4–5. <https://doi.org/10.1016/j.fertnstert.2016.05.009>.
- Bozdag G, Mumusoglu S, Zengin D, Karabulut E, Yildiz BO. The prevalence and phenotypic features of polycystic ovary syndrome (PCOS): a systematic review and meta-analysis. *Hum Reprod*. 2016;31(12):2841–55. <https://doi.org/10.1093/humrep/dew218>.
- De Leo V, Musacchio MC, Cappelli V, Massaro MG, Morgante G, Petraglia F. Genetic, hormonal and metabolic aspects of PCOS: an update. *Reprod Biol Endocrinol*. 2016;14(1):38. <https://doi.org/10.1186/s12958-016-0173-x>.
- Ali AT. Polycystic ovary syndrome and metabolic syndrome. *Ceska Gynkol*. 2015;80(4):279–89.
- Sangaraju SL, Yopez D, Grandes XA, Manjunatha RT, Habib S. Cardio-Metabolic Disease and Polycystic Ovarian Syndrome (PCOS): A Narrative Review. *Cureus*. 2022;14(5):e25076. <https://doi.org/10.7759/cureus.25076>.
- Irani M, Merhi Z. Role of vitamin D in ovarian physiology and its implication in reproduction: a systematic review. *Fertil Steril*. 2014;102(2):460–8.e3. <https://doi.org/10.1016/j.fertnstert.2014.04.046>.
- Thomson RL, Spedding S, Buckley JD. Vitamin D in the aetiology and management of polycystic ovary syndrome (PCOS). *Clin Endocrinol (Oxf)*. 2012;77(3):343–50. <https://doi.org/10.1111/j.1365-2265.2012.04434.x>.
- Galliera E, Corsi Romanelli MM. Molecular Basis of Bone Diseases. In: Coleman WB, Tsongalis GJ, editors. *Molecular Pathology*. 2nd ed. Academic Press; 2018. p. 627–49. <https://doi.org/10.1016/B978-0-12-802761-5.00028-6>.
- Grzesiak M. Vitamin D3 action within the ovary—an updated review. *Physiol Res*. 2020;69(3):371–8. <https://doi.org/10.33549/physiolres.934266>.
- Davis EM, Peck JD, Hansen KR, Neas BR, Craig LB. Associations between vitamin D levels and polycystic ovary syndrome (PCOS) phenotypes. *Minerva Endocrinol*. 2019;44(2):176–84. <https://doi.org/10.23736/S0391-1977.18.02824-9>.
- Maktabi M, Chamani M, Asemi Z. The effects of Vitamin D supplementation on metabolic status of patients with Polycystic Ovary Syndrome (PCOS): A randomized, double-blind, placebo-controlled trial. *Horm Metab Res*. 2017;49(7):493–8. <https://doi.org/10.1055/s-0043-107242>.
- Morgante G, Darino I, Spanò A, Luisi S, Luddi A, Piomboni, et al. PCOS Physiopathology and Vitamin D Deficiency: Biological Insights and Perspectives for Treatment. *J Clin Med*. 2022;11(15):4509. <https://doi.org/10.3390/jcm11154509>.
- Lerchbaum E, Rabe T. Vitamin D and female fertility. *Curr Opin Obstet Gynecol*. 2014;26(3):145–50. <https://doi.org/10.1097/GCO.0000000000000065>.
- Bikle D. Nonclassic actions of vitamin D. *J Clin Endocrinol Metab*. 2009;94(1):26–34. <https://doi.org/10.1210/jc.2008-1454>.
- Chen ZJ, Shi Y, Sun Y, Zhang B, Liang X, Cao Y, et al. Fresh versus frozen embryos for infertility in the polycystic ovary syndrome (PCOS). *N Engl J Med*. 2016;375(6):523–33. <https://doi.org/10.1056/NEJMoa1513873>.
- Eftekhari M, Mirhashemi ES, Molaei B, Pourmasumi S. Is there any association between vitamin D levels and polycystic ovary syndrome (PCOS) phenotypes? *Arch Endocrinol Metab*. 2020;64(1):11–6. <https://doi.org/10.20945/2359-399700000177>.
- Wang L, Lv S, Li F, Yu X, Bai E, Yang X. Vitamin D deficiency is associated with metabolic risk factors in women with polycystic ovary syndrome (PCOS): A cross-sectional study in Shaanxi China. *Front Endocrinol*. 2020;11:171. <https://doi.org/10.3389/fend.2020.00171>.
- Dasgupta S, Dutta J, Annamaneni S, Kudugunti N, Battini MR. Association of vitamin D receptor gene polymorphisms with polycystic ovary syndrome (PCOS) among Indian women. *Indian J Med Res*. 2015;142(3):276–85. <https://doi.org/10.4103/0971-5916.166587>.
- Ghadimi R, Esmailzadeh S, Firoozpour M, Ahmadi A. Does vitamin D status correlate with clinical and biochemical features of polycystic ovary syndrome (PCOS) in high school girls? *Caspian J Intern Med*. 2014;5(4):202–8.

Cite this article: Mishra S, Sinha N, Swaroop N, Prasad A, Mallik A. Hypo-vitaminosis D and its role in PCOS: A prospective observational study at tertiary care centre in north Indian population. *Indian J Obstet Gynecol Res*. 2025;12(4):762–768.