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Original Research Article

VITAMIN D STATUS IN A SUN-RICH POPULATION: A CROSS-SECTIONAL STUDY OF ITS ASSOCIATION WITH SERUM CALCIUM, ALBUMIN, AND TOTAL PROTEIN

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ABSTRACT

Background: Vitamin D plays a vital role in Calcium homeostasis, protein synthesis, and bone metabolism. Despite abundant sunlight in India, Vitamin D deficiency remains highly prevalent, warranting investigation into its biochemical correlations. **Objectives:** To assess the serum levels of 25-hydroxyVitamin D [25(OH)D] in adults and evaluate its association with biochemical parameters—namely, serum Calcium, Total Protein, and Albumin. **Materials and Methods:** A cross-sectional study was conducted at a tertiary care hospital in Bareilly, Uttar Pradesh, enrolling 150 adults aged 20–50 years. Serum 25(OH)D concentrations were categorized as deficient (<12 ng/mL), insufficient (12–20 ng/mL), or sufficient (>20 ng/mL). Biochemical markers were analyzed, and group differences were evaluated using one-way ANOVA. **Results:** Among the participants, 18% were Vitamin D deficient and 24.7% were insufficient. Mean 25(OH)D levels were similar between females (28.28 ± 20.71 ng/mL) and males (28.19 ± 20.83 ng/mL). Although no statistically significant differences were observed across Vitamin D categories, the deficient group consistently exhibited lower mean levels of serum Calcium, protein, and Albumin.
Conclusion: A substantial proportion of the study population had suboptimal Vitamin D levels, accompanied by modest biochemical alterations. Our study suggest that routine screening and preventive strategies may be warranted even in asymptomatic individuals, given Vitamin D's broader implications on health.
Keywords: Vitamin D Status, Sun-Rich Population, Biochemical Parameters.

INTRODUCTION

Vitamin D plays a crucial endocrine role in Calcium and phosphorus homeostasis, influencing skeletal health, muscle function, and cellular activity.[1,2] It is synthesized in the skin through UV light exposure (Vitamin D_3) or obtained from dietary sources (Vitamin D_2), and both forms are biologically inert until hydroxylated in the liver and kidneys.[3,4] The most stable and clinically useful indicator of Vitamin D status is 25-hydroxyVitamin D [25(OH)D].[5] Despite ample sunlight, Vitamin D deficiency is highly prevalent in India due to lifestyle factors, limited outdoor activity, darker skin pigmentation, and minimal dietary fortification.[6,7] Global analyses reports suggest that nearly half of the world's population may have suboptimal levels of Vitamin D.[8,9]

In the Indian context, cultural clothing practices, indoor occupations, and geographic variability also contribute significantly to widespread hypovitaminosis D.[6,10] Studies show that even sun-abundant regions exhibit high prevalence of deficiency.[3,11] To address this, the present study we evaluated serum 25(OH)D levels and their relationship with bone-related biochemical parameters (Calcium, Albumin, Total Protein)

among adults in Uttar Pradesh. By stratifying individuals into deficient, insufficient, and sufficient Vitamin D categories, this study was planned to explored subtle biochemical trends that could serve as early indicators of deficiency-related metabolic changes.

MATERIALS AND METHODS

A descriptive, cross-sectional observational study was conducted at Shri Ram Murti Smarak (SRMS) Institute of Medical Sciences (IMS), a tertiary care super-specialty hospital located in the Rohilkhand region of Uttar Pradesh, India. The study period spanned from 1st May to 30th October 2024, and it was approved by the Institutional Ethics Committee (Ref No.: SRMS IMS/ECC/2024/156).

Data were retrieved from the institution's Health Information System (HIS) and Laboratory Information System (LIS), both developed by SRMS College of Engineering, Technology & Research, Bareilly. A total of 150 adult participants aged 20–50 years were included. Exclusion criteria were: Age <20 or >50 years, postmenopausal women, known cases of Vitamin D deficiency receiving treatment, or those diagnosed with metabolic bone diseases or conditions affecting Calcium/protein metabolism.

After informed written consent, 5.0 mL of peripheral venous blood was collected aseptically from each participant in plain vacutainers. Samples were transported immediately to the central laboratory, centrifuged at 3000 rpm for 10 minutes, and serum was separated. Samples were analyzed on the same day.

Biochemical Analysis

Table 1: Shows analytical details of all Biochemical parameters included in our study

Table 1: Analytical details of all Biochemical Parameters

Sr. No.	Biochemical parameter	Method of estimation	Analyser	Reference Range
1.	Vitamin D3 (25 OH Vitamin D total)	Enzyme Linked Flourescence Assay (ELFA) -Enzyme linked fluorescent assay	Backmen Access 2 Immunoassay Analyzer	Deficient (< 12 ng/mL) Insufficient (12–20 ng/mL) Sufficient (> 20 ng/mL)
2.	Calcium	Arsenazo -|||	Au 480 Bechman Coulter Chemistry Analyzer	8.5-11 mg/d
3.	Total protein	Biuret	Au 480 Bechman Coulter Chemistry Analyzer	6.6-8.3 g/dl
4.	Albumin	BCG-bromcresol green	Au 480 Bechman Coulter Chemistry Analyzer	3.5-5 g/dl

(OH – Hydroxy, ng – Nano Gram, mL – Mili Liter, AU – Automatic, g – Gram, dl – Deci liter)

All reagents, calibrators, and controls were sourced from certified kits, and assays were performed as per the Standard Operating Procedure (SOP) of our Laboratory. All results of analysis were validated through Internal and External Quality Control System.

Participants were categorized into three groups based on serum 25(OH)D concentration: Deficient (<12 ng/mL), Insufficient (12–20 ng/mL) or Sufficient: (>20 ng/mL).

Statistical analysis was performed using International Business Machines (IBM) Corporation's Statistical Package for the Social Sciences (SPSS) Statistics, version 27.0 (Armonk, New York (NY), United States of America (USA). Continuous data were reported as mean ± Standard Deviation (SD). Between-group differences in biochemical parameters were assessed using One-Way Analysis of Variance (ANOVA). A p-value <0.05 was considered statistically significant.

RESULTS

Table 2 shows the distribution of gender and Vitamin D status r among 150 study participants.

Table 2: Distribution According to Gender and Vitamin D Status Among Study Participants

Gender	Frequency	Percent	Mean (Vitamin D)	Standard Deviation (Vitamin D)
Female	84	56.00%	28.27509091	20.71441299
Male	66	44.00%	28.18969325	20.8261201
Total	150	100.00%		

A total of 150 participants were enrolled in the study. Of these, 84 (56%) were female and 66 (44%) were male, with comparable mean serum Vitamin D levels: No significant gender-based differences in Vitamin D concentration were observed.

Figure 1 shows age distribution of study population.

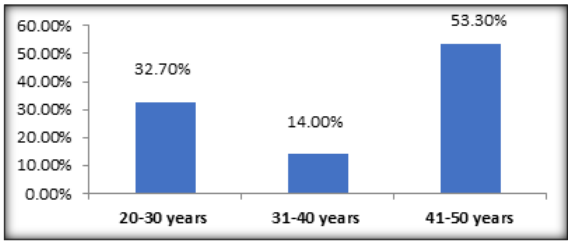
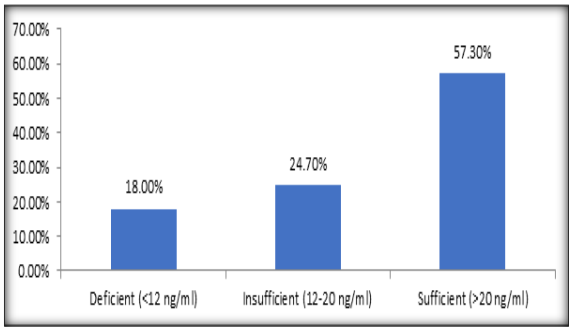


Figure 1: Age distribution of study population

The majority of participants (53.3%) were aged 41–50 years, followed by 32.7% in the 20–30 years group and 14.0% in the 31–40 years group.

Figure 2 shows the percentage distribution of study participants as per their Vitamin D levels.



(ng/ml NanoGram per MiliLiter)

Figure 2: Percentage Distribution of Study participants as per their Vitamin D Levels

Based on Vitamin D levels 18.0%, 24.7% and 57.3% were classified as deficient (<12 ng/mL), insufficient (12–20 ng/mL) and sufficient (>20 ng/mL) respectively. Despite a majority exhibiting sufficient levels, 42.7% of individuals demonstrated suboptimal Vitamin D status.

Table 3 summarizes the mean serum Calcium, Total Protein, and Albumin levels across the categories based on Vitamin D status.

Although none of the differences were statistically significant ($p > 0.05$), a consistent trend was observed where individuals with Vitamin D deficiency exhibited lower mean values across all three parameters. Serum Calcium showed a ~1 mg/dL reduction in the deficient group compared to the sufficient group. Total Protein and Albumin levels were also lower in deficient participants, potentially reflecting subclinical inflammatory or nutritional shifts. [Table 3]

Table 3: Details of Biochemical Parameters Across the Categories of Study Population Based on Their Vitamin D Status

Variable	Vitamin D Status (Mean ± SD)			
	Deficient (<12 ng/ml)	Insufficient (12-20 ng/ml)	Sufficient (>20 ng/ml)	p-value
Calcium	8.18 ± 2.23	9.30 ± 0.82	9.28 ± 1.07	0.18
Total Protein	6.93 ± 1.14	7.46 ± 1.17	7.51 ± 0.73	0.187
Albumin	3.76 ± 0.84	4.12 ± 0.61	4.13 ± 0.67	0.283

(ng/ml NanoGram per MiliLiter)

DISCUSSION

The present cross-sectional study conducted at a tertiary care hospital in Bareilly, Uttar Pradesh, revealed that 18% of adult participants were Vitamin D deficient and 24.7% were insufficient, despite residing in a region with ample sunlight. This finding echo national trends reported in various population groups across India, where Vitamin D deficiency has been documented in 41–100% of individuals, with serum 25(OH)D levels ranging widely from 10–28.86 ng/mL.[3,10,12] The persistence of hypovitaminosis D in sun-rich populations may reflect multifactorial influences including skin pigmentation, air pollution, cultural practices, and increased indoor lifestyles.[7,13,14]

In the present cohort, the mean serum 25(OH)D levels were comparable between females (28.28 ± 20.71 ng/mL) and males (28.19 ± 20.83 ng/mL), suggesting no significant gender difference in Vitamin D status. This is contrary to findings by Sanghera et al,[4] who reported significantly lower Vitamin D levels in males, attributing differences to hormonal and lifestyle factors. Interestingly, in our study population, diet type, physical activity, or presumed sunlight exposure did not appear to significantly influence Vitamin D status—possibly due to infrequent consumption of Vitamin D-rich foods and genetic variability in Vitamin D metabolism.[5,15]

Although the biochemical parameters (serum Calcium, Total Protein, and Albumin) did not differ significantly across Vitamin D categories ($p>0.05$), a consistent trend of lower mean values in the Vitamin D–deficient group was observed. This aligns with the physiological understanding that Vitamin D promotes Calcium absorption and regulates protein synthesis via activation of nuclear VDR pathways.[2,6,16]

Despite the assumption that brief midday sun exposure is adequate to maintain 25(OH)D levels, our findings reaffirm that geographic and ethnic factors, such as higher melanin content, could impair cutaneous synthesis.[7,13,17,18] In addition, our participants' dietary habits may have otherwise contributed to adequate Vitamin D levels.[3,19]

The clinical implications of Vitamin D deficiency extend beyond skeletal health. Emerging evidence links hypovitaminosis D to cardiometabolic disease, immune dysregulation, cancer, and impaired physical productivity.[8,9,20,21] Given that 42.7% of our study population had suboptimal Vitamin D levels, early screening, especially in asymptomatic individuals, may be warranted.

This study is not without limitations. The cross-sectional design restricts causal inferences, and the modest sample size (n=150) may limit generalizability. Additionally, seasonal variation, sunlight exposure quantification, and bone density assessments (e.g., DEXA) were not evaluated. Future studies incorporating these variables, as well as prospective interventional data, are required to determine optimal reference ranges and define appropriate supplementation strategies for Indian populations.[22-25]

CONCLUSION

This cross-sectional study highlights a notable prevalence of Vitamin D insufficiency and deficiency among adults aged 20–50 years in northern India, despite abundant natural sunlight. Although differences in Calcium, Total Protein, and Albumin levels across Vitamin D categories were not statistically significant, a consistent downward trend in these markers was observed in deficient individuals—suggesting possible early biochemical alterations that warrant clinical attention.

Given the extra skeletal roles of Vitamin D and its potential association with systemic health risks, these findings reinforce the need for early screening, lifestyle-based interventions, and dietary education. Establishing population-specific reference ranges and incorporating Vitamin D assessment into routine health evaluations, particularly in asymptomatic individuals, may contribute to improved preventive strategies and long-term health outcomes.

REFERENCES

1. Holick MF. Vitamin D deficiency. N Engl J Med. 2007;357(3):266–81. https://doi.org/10.1056/NEJMra070553
2. Christakos S, Dhawan P, Verstuyf A, Verlinden L, Carmeliet G. Vitamin D: metabolism, molecular mechanism of action, and pleiotropic effects. Physiol Rev. 2016;96(1):365–408. https://doi.org/10.1152/physrev.00014.2015
3. Ritu G, Gupta A. Vitamin D deficiency in India: prevalence, causalities and interventions. Nutrients. 2014;6(2):729–75. https://doi.org/10.3390/nu6020729
4. Sanghera DK, Sapkota BR, Aston CE, Blackett PR. Vitamin D status, gender differences, and cardiometabolic health disparities. Ann Nutr Metab. 2017;70(2):79–87. https://doi.org/10.1159/000457952
5. Cheng JB, Levine MA, Bell NH, Mangelsdorf DJ, Russell DW. Genetic evidence that the human CYP2R1 enzyme is a key Vitamin D 25-hydroxylase. Proc Natl Acad Sci U S A. 2004;101(20):7711–5. https://doi.org/10.1073/pnas.0402490101
6. Mendes MM, Botelho PB, Ribeiro H. Vitamin D and musculoskeletal health: outstanding aspects to be considered in the light of current evidence. Endocr Connect. 2022;11(10):e210596. https://doi.org/10.1530/EC-21-0596
7. Matsuoka LY, Wortsman J, Haddad JG, Kolm P, Hollis BW. Racial pigmentation and the cutaneous synthesis of Vitamin D. Arch Dermatol. 1991;127(4):536–8. https://doi.org/10.1001/archderm.1991.01680040080022
8. Manson JE, Cook NR, Lee IM, Christen WG, Bassuk SS, Mora S, et al. Vitamin D supplements and prevention of cancer and cardiovascular disease. N Engl J Med. 2019;380(1):33–44. https://doi.org/10.1056/NEJMoa1809944
9. Giampazolias E, Pereira da Costa M, Lam KC, et al. Vitamin D regulates microbiome-dependent cancer immunity. Science. 2023;380(6649):eadh7954. https://doi.org/10.1126/science.adh7954
10. Cui A, Zhang T, Xiao P, Fan Z, Wang H, Zhuang Y. Global and regional prevalence of Vitamin D deficiency: a pooled analysis of 7.9 million participants. Front Nutr. 2023;10:1070808. https://doi.org/10.3389/fnut.2023.1070808
11. Rana G, Abraham RA, Sachdev HS, et al. Prevalence and correlates of Vitamin D deficiency among Indian children and adolescents: CNNS 2016–18. Indian Pediatr. 2023;60(1):23–30. https://doi.org/10.1007/s13312-023-2693-4
12. Mukherjee A, Chaudhry A, Khatwani L, et al. Roadmap to address Vitamin D deficiency in India. ICRIER Health Policy Report. 2025 Apr 8. [DOI not available]
13. Hanel A, Carlberg C. Skin colour and Vitamin D: an update. Exp Dermatol. 2020;29(8):864–75. https://doi.org/10.1111/exd.14188
14. Webb AR, Alghamdi R, Kift R, Rhodes LE. Dose–response for change in 25-hydroxyVitamin D after UV exposure: a systematic review. Endocr Connect. 2021;10(10):R248–66. https://doi.org/10.1530/EC-21-0326
15. Cashman KD. Global differences in Vitamin D status and dietary intake: a review of the data. Endocr Connect. 2022;11(1):e210282. https://doi.org/10.1530/EC-21-0282
16. Hilger J, Friedel A, Herr R, et al. A systematic review of Vitamin D status in populations worldwide. Br J Nutr. 2014;111(1):23–45. https://doi.org/10.1017/S0007114513001840
17. Holick MF, MacLaughlin JA, Doppelt SH. Regulation of cutaneous preVitamin D3 photosynthesis in man: skin pigment is not an essential regulator. Science. 1981;211(4482):590–3. https://doi.org/10.1126/science.6256855
18. Clemens TL, Adams JS, Henderson SL, Holick MF. Increased skin pigment reduces the capacity of skin to synthesize Vitamin D3. Lancet. 1982;319(8263):74–6. https://doi.org/10.1016/S0140-6736(82)90214-8
19. Bikle DD. Vitamin D metabolism, mechanism of action, and clinical applications. Chem Biol. 2014;21(3):319–29. https://doi.org/10.1016/j.chembiol.2013.12.016
20. Mendes MM, Botelho PB, Ribeiro H. Vitamin D and musculoskeletal health: outstanding aspects to be considered. Endocr Connect. 2022;11(10):e210596. https://doi.org/10.1530/EC-21-0596
21. Chowdhury R, Kunutsor S, Vitezova A, et al. Vitamin D and risk of cause-specific death: systematic review and meta-analysis. BMJ. 2014;348:g1903. https://doi.org/10.1136/bmj.g1903
22. Muldowney S, Kiely M. Vitamin D and cardiometabolic health: a review of the evidence. Nutr Res Rev. 2011;24(1):1–20. https://doi.org/10.1017/S0954422410000226
23. Mirza AA, Rathi H, Dakshinamurthy S, et al. Assessment of Vitamin D levels and bone-related biochemical markers in rural Uttarakhand. Indian J Clin Biochem. 2023;38(2):316–23. https://doi.org/10.1007/s12291-022-01066-7
24. Couchman L, Moniz CF. Analytical considerations for the biochemical assessment of Vitamin D status. Ther Adv Musculoskelet Dis. 2017;9(4):97–104. https://doi.org/10.1177/1759720X17698764
25. Ross AC, Manson JE, Abrams SA, et al. The 2011 report on dietary reference intakes for Calcium and Vitamin D. J Clin Endocrinol Metab. 2011;96(1):53–8. https://doi.org/10.1210/jc.2010-2704.