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# CORRELATION OF SERUM VITAMIN D LEVELS WITH AGE, GENDER, AND BIOCHEMICAL PARAMETERS: A RETROSPECTIVE STUDY IN A TERTIARY CARE HOSPITAL

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ABSTRACT

**Background:** This study aimed to investigate the correlation of Vitamin D levels with age, gender, and biochemical parameters among adults undergoing Master Health checkup in a tertiary care hospital.

**Materials and Methods:** This retrospective study included 265 adult outpatients (≥18 years) of both gender who attended master health checkups between January and August 2024. The biochemical assay of vitamin D was measured using CLIA, and other biochemical parameters were analysed on Beckman coulter AU480 following standard procedures. Biochemical vitamin D level <20ng/ml is deficient, 20-30ng/ml being insufficient and above 30ng/ml as sufficient. Statistical analysis done using SPSS22.

**Results:** Among 265 patients, 57% were male and 43% were female. Mean age was higher in males. Vitamin D showed positive correlation with age (r = 0.129, p =0.03), creatinine (r=0.125, p=0.04), and uric acid (r=0.144, p=0.01), while negative correlations were observed with total cholesterol (r= –0.148, p=0.01) and HDL (r= –0.147, p=0.01). Gender-wise analysis showed significant differences in vitamin D (p<0.05).

**Conclusion:** Vitamin D levels significantly vary with gender and show correlation with age, creatinine, uric acid and Total cholesterol. Screening and early intervention are recommended, particularly in females and dyslipidemic patients.

**Keywords:** Vitamin D deficiency, Vitamin D Insufficiency, Gender differences.

## INTRODUCTION

Vitamin D, a secosteroid hormone, not only plays key role in calcium and phosphate homeostasis, but also has many physiological functions and is associated with many pathological conditions. Its receptors are distributed widely, indicating roles in immune modulation, insulin sensitivity, and cardiovascular health.[1] Despite India's abundance of sunlight, Vitamin D insufficiency (VDD) is quite common in all age groups and is attributable to multiple factors, including urbanization, indoor lifestyles, skin pigmentation, and inadequate food.[1,2] Recent findings indicate that demographic factors, including age and gender, have an impact on serum vitamin D levels.[3,4] Aging reduces the capacity for cutaneous synthesis of Vitamin D, while hormonal and behavioral differences contribute to variability between males and females.[3] Furthermore, Vitamin D status has well-established biochemical

associations with markers of bone metabolism, including serum calcium, phosphate, alkaline phosphatase (ALP), and parathyroid hormone (PTH).[2,5] Additional evidence links low Vitamin D with derangements in metabolic parameters such as serum glucose and lipid profiles.[2] Vitamin D deficiency is prevalent worldwide. This deficiency has many consequences which are still being explored, apart from the well-known skeletal complications. The majority of the studies reported a prevalence of 80% to 90%, however the incidence of vitamin D deficiency varied from 40% to 99%.[6] Considering the studies on the consequences of vitamin D insufficiency, including autoimmune disorders, heart conditions, cancer, and tuberculosis, we can only fathom the burden it would place on our nation. The public and medical professionals need to be made aware of the significance of vitamin D and the negative effects of a deficiency. Our Indian diet generally fails to satisfy the daily requirement of Vitamin D for a normal adult. Several studies have addressed the global prevalence of Vitamin D deficiency, but there is a paucity of hospital-based retrospective data from Indian populations that assess the combined influence of age, gender, and biochemical markers on Vitamin D levels.[2,4] Addressing this gap is critical for guiding screening strategies and nutritional interventions in routine clinical practice. Therefore, the present study aimed to evaluate the correlation of serum Vitamin D status with age, gender, and selected biochemical parameters among patients attending a tertiary care hospital.

## MATERIALS AND METHODS

This retrospective, hospital-based study was conducted in the Central biochemistry laboratory, Sree Mookambika Institute of Medical Sciences (SMIMS), using laboratory records of adult outpatients who attended health checkups and were referred for Vitamin D testing. The study period spanned eight months from January 2024 to August 2024. Ethical clearance for the study was obtained from the Institutional Ethics Committee of SMIMS (IEC Ref No.:19/2024)

**Study Participants**

The study included all adult patients above 18 years of age of both genders who underwent routine health checkups and were referred for serum 25(OH) Vitamin D testing, with complete biochemical data available. Patients were excluded if they were 18 years of age or younger, presented with acute infections, had a history of chronic renal, cardiac, or liver failure, were pregnant or lactating, had biochemically confirmed thyroid disorders, or if their laboratory records were incomplete or missing. As this was a retrospective study based on anonymized lab records, the requirement for individual informed consent was waived by the IEC. The sample size was calculated to be 195, based on a similar study conducted by Alfawaz H et al., 2014[7], considering a 99% confidence interval and 1% Type I error. All eligible patient records from the specified period were included.

**Biochemical Assays**

Serum 25-hydroxy Vitamin D [25(OH)D] levels were estimated using Chemiluminescent Immunoassay (CLIA) on the Snibe Maglumi 4000 analyzer. Other biochemical parameters such as FBS, lipid profile. LFT, RFT, serum calcium, phosphate were analyzed using Beckman Coulter AU480 autoanalyzer, following manufacturer's instructions and standard operating procedures. All kits used were commercially sourced and quality-controlled.

**Data Analysis**

Data were entered in Microsoft Excel and analyzed using IBM SPSS version 22.0. Study subjects were grouped based on age categories and Vitamin D status. The following ranges were suggested for the classification of 25 OH- Vitamin D status- deficiency - < 20 ng/ml; insufficiency – 20-30 ng/ml and sufficiency – 30-100 ng/ml as described by Sunil Jamwal et al., 2018 [8]. Descriptive statistics such as mean, standard deviation, frequency, and percentage were calculated for demographic and biochemical variables. Comparison of continuous variables across Vitamin D groups was performed using the Kruskal-Wallis test. The correlation between Vitamin D levels and biochemical parameters was analyzed using Pearson's correlation. A p-value < 0.05 was considered statistically significant.

## RESULTS

A total of 265 adult subjects were included in the study, comprising 152 males (57%) and 113 females (43%) (Table-1), with a mean age of 49.1 ± 13.51 years (Figure-1). The mean Vitamin D level was significantly higher in males (26.20 ± 6.85 ng/mL) than in females (22.61 ±8.13 ng/mL), with a highly significant p-value (< 0.001). Vitamin D deficiency (<20 ng/mL) was more prevalent among females (40.7%) than males (19.1%), while a greater proportion of males had sufficient Vitamin D levels (>30 ng/mL) compared to females (23.7% vs. 14.2%) (Table-2). Serum Vitamin D showed a statistically significant positive correlation with age ($r = 0.129$, $p = 0.03$), creatinine ($r = 0.125$, $p = 0.04$), and uric acid ($r = 0.144$, $p = 0.01$). Negative correlations were observed with total cholesterol ($r = –0.148$, $p = 0.01$) and HDL cholesterol ($r = –0.147$, $p = 0.01$). No significant correlation was found between Vitamin D levels and fasting blood sugar, urea, SGOT, SGPT, calcium, or thyroid hormones ($p > 0.05$) (Table-3). A significant association was observed with gender, where males had higher Vitamin D sufficiency (69.2%) compared to females ($P< 0.001$). Although serum calcium did not show a significant linear correlation with vitamin D levels, its distribution differed significantly across vitamin D categories. Serum creatinine and calcium levels also showed

significant associations with Vitamin D status (P = 0.030 and P = 0.032, respectively), with higher sufficiency observed in individuals with normal creatinine (0.7–1.3 mg/dL) and calcium levels (8.6–10.3 mg/dL). Age, fasting blood sugar, HbA1c, lipid profile, thyroid function, and liver enzymes did not show statistically significant associations with Vitamin D status (P>0.05) (Table-4). These findings indicate that serum Vitamin D status is significantly associated with age, gender, and biochemical markers including creatinine, uric acid, and lipid profile components.

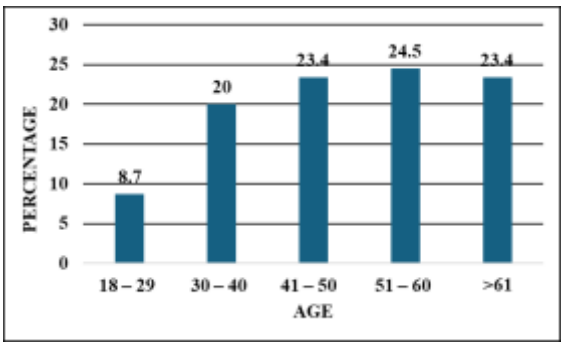


**Figure-1: Percentage of different age groups**

**Table-1: Frequency and percentage of gender**

| S No | Gender | Frequency | Percentage |
|---|---|---|---|
| 1 | Male | 152 | 57.4 |
| 2 | Female | 113 | 42.6 |

**Table-2: Association between Vitamin D levels and gender**

| Vitamin D | Gender | | P value |
|---|---|---|---|
| | Male | Female | |
| **Deficient** | 29 (19.1%) | 46 (40.7%) | <0.001* |
| **Insufficient** | 87 (57.2%) | 51 (45.1%) | |
| **Sufficient** | 36 (23.7%) | 16 (14.2%) | |
| **Mean Vitamin D level** | 26.20±6.85 | 22.61±8.13 | <0.001* |

*(*p<0.05 statistically significant)*

**Table-3: Correlation between biochemical parameters and Vitamin D level**

| Variable | r value | P value |
|---|---|---|
| **Age** | 0.129 | 0.036* |
| **Fasting blood sugar** | -0.046 | 0.460 |
| **HbA1c** | -0.008 | 0.897 |
| **Urea** | 0.025 | 0.688 |
| **Creatinine** | 0.125 | 0.042* |
| **Serum uric acid** | 0.144 | 0.019* |
| **Sodium** | -0.028 | 0.649 |
| **Potassium** | 0.107 | 0.082 |
| **Chloride** | -0.103 | 0.095 |
| **Bicarbonate** | 0.069 | 0.266 |
| **Phosphorous** | 0.035 | 0.574 |
| **Calcium** | 0.112 | 0.068 |
| **Total Bilirubin** | 0.071 | 0.248 |
| **Direct Bilirubin** | 0.086 | 0.162 |
| **Indirect Bilirubin** | 0.047 | 0.447 |
| **SGOT/AST** | 0.086 | 0.163 |
| **SGPT/ALT** | 0.092 | 0.137 |
| **ALP** | -0.060 | 0.329 |
| **GGT** | 0.097 | 0.117 |
| **Total Protein** | 0.069 | 0.260 |
| **Albumin** | -0.001 | 0.984 |
| **Globulin** | 0.071 | 0.250 |
| **Albumin Globulin ratio** | -0.049 | 0.431 |
| **Serum Cholesterol** | -0.148 | 0.016* |
| **Triglycerides** | -0.068 | 0.269 |
| **HDL** | -0.147 | 0.017* |
| **LDL** | -0.115 | 0.061 |
| **VLDL** | -0.068 | 0.269 |
| **Free T3** | 0.011 | 0.859 |
| **Free T4** | -0.008 | 0.899 |
| **TSH** | -0.033 | 0.598 |

*(*p<0.05 – statistically significant)*

**Table-4: Association between Vitamin D levels and biochemical parameters**

| Variable | Deficient | | Insufficient | | Sufficient | | P value |
|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | |
| **Age** | | | | | | | |
| 18 – 29 | 10 | 13.3 | 10 | 7.2 | 3 | 5.8 | |
| 30 – 40 | 16 | 21.3 | 31 | 22.5 | 6 | 11.5 | |
| 41 – 50 | 19 | 25.3 | 34 | 24.6 | 9 | 17.3 | 0.141 |
| 51 – 60 | 18 | 24 | 32 | 23.2 | 15 | 28.8 | |
| >61 | 12 | 16 | 31 | 22.5 | 19 | 36.5 | |
| **Gender** | | | | | | | |
| Male | 29 | 38.7 | 87 | 63 | 36 | 69.2 | <0.001* |
| Female | 46 | 61.3 | 51 | 37 | 16 | 30.8 | |
| **FBS** | | | | | | | |
| <100 | 33 | 44 | 69 | 50 | 22 | 42.3 | |
| 100-125 | 21 | 28 | 30 | 21.7 | 15 | 28.8 | 0.767 |
| ≥ 126 | 21 | 28 | 39 | 28.3 | 15 | 28.8 | |
| **HbA1c** | | | | | | | |
| ≤ 6.5 | 49 | 65.3 | 90 | 65.2 | 31 | 59.6 | 0.749 |
| > 6.5 | 26 | 34.7 | 48 | 34.8 | 21 | 40.4 | |
| **Urea** | | | | | | | |
| <15 | 14 | 18.7 | 20 | 14.5 | 7 | 13.5 | 0.521 |
| 15 – 39 | 59 | 78.7 | 117 | 84.8 | 43 | 82.7 | |
| >39 | 2 | 2.7 | 1 | 0.7 | 2 | 3.8 | |
| **Creatinine** | | | | | | | |
| <0.7 | 40 | 53.3 | 46 | 33.3 | 18 | 34.6 | |
| 0.7-1.3 | 33 | 44 | 91 | 65.9 | 33 | 63.5 | 0.030* |
| >1.3 | 2 | 2.7 | 1 | 0.7 | 1 | 1.9 | |
| **Serum uric acid** | | | | | | | |
| <3.5 | | | | | | | |
| 3.5 – 7.2 | 6 | 8 | 18 | 13 | 4 | 7.7 | |
| >7.2 | 67 | 89.3 | 110 | 79.7 | 46 | 88.5 | 0.338 |
| | 2 | 2.7 | 10 | 7.2 | 2 | 3.8 | |
| **Sodium** | | | | | | | |
| <136 | 7 | 9.3 | 18 | 13 | 8 | 15.4 | 0.570 |
| 136 – 145 | 68 | 90.7 | 120 | 87 | 44 | 84.6 | |
| **Potassium** | | | | | | | |
| <3.5 | 1 | 1.3 | 1 | 0.7 | 0 | 0 | 0.693 |
| 3.5 – 7.2 | 74 | 98.7 | 137 | 99.3 | 52 | 100 | |
| **Chloride** | | | | | | | |
| <96 | 0 | 0 | 2 | 1.4 | 0 | 0 | |
| 96- 107 | 72 | 96 | 134 | 97.1 | 51 | 98.1 | 0.511 |
| >107 | 3 | 4 | 2 | 1.4 | 1 | 1.9 | |
| **Bicarbonate** | | | | | | | |
| <21 | 5 | 6.7 | 9 | 6.5 | 2 | 3.8 | 0.760 |
| 21-31 | 70 | 93.3 | 129 | 93.5 | 50 | 96.2 | |
| **Phosphorous** | | | | | | | |
| <2.5 | 0 | 0 | 1 | 0.7 | 1 | 1.9 | 0.525 |
| 2.5-4.5 | 72 | 96 | 125 | 90.6 | 47 | 90.4 | |
| >4.5 | 3 | 4 | 12 | 8.7 | 4 | 7.7 | |
| **Calcium** | | | | | | | |
| <8.6 | 8 | 10.7 | 8 | 5.8 | 2 | 3.8 | 0.032* |
| 8.6 -1 0.3 | 67 | 89.3 | 129 | 93.5 | 47 | 90.4 | |
| >10.3 | 0 | 0 | 1 | 0.7 | 3 | 5.8 | |
| **Total Bilirubin** | | | | | | | |
| 0.3-1 | | | | | | | |
| >1 | 70 | 93.3 | 122 | 88.4 | 46 | 88.5 | 0.492 |
| | 5 | 6.7 | 16 | 11.6 | 6 | 11.5 | |
| **Direct Bilirubin** | | | | | | | |
| 0-0.2 | | | | | | | |
| >0.2 | 69 | 92 | 129 | 93.5 | 44 | 84.6 | 0.149 |
| | 6 | 8 | 9 | 6.5 | 8 | 15.4 | |
| **Indirect Bilirubin** | | | | | | | |
| 0.2-0.8 | | | | | | | |
| >0.8 | 70 | 93.3 | 123 | 89.1 | 48 | 92.3 | 0.552 |
| | 5 | 6.7 | 15 | 10.9 | 4 | 7.7 | |
| **SGOT/AST** | | | | | | | |
| <35 | 64 | 85.3 | 115 | 83.3 | 43 | 82.7 | 0.905 |
| >35 | 11 | 14.7 | 23 | 16.7 | 9 | 17.3 | |
| **SGPT/ALT** | | | | | | | |
| <35 | 69 | 92 | 129 | 93.5 | 49 | 94.2 | 0.872 |
| >35 | 6 | 8 | 9 | 6.5 | 3 | 5.8 | |
| **ALP** | | | | | | | |
| 30-120 | 70 | 93.3 | 133 | 96.4 | 50 | 96.2 | 0.574 |
| >120 | 5 | 6.7 | 5 | 3.6 | 2 | 3.8 | |
| **GGT** | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| <55 | 69 | 92 | 119 | 86.2 | 45 | 86.5 | 0.440 |
| >55 | 6 | 8 | 19 | 13.8 | 7 | 13.5 | |
| **Total Protein** | | | | | | | |
| <6 | 3 | 4 | 1 | 0.7 | 2 | 3.8 | |
| 6-8 | 70 | 93.3 | 130 | 99.3 | 49 | 94.2 | 0.156 |
| >8 | 2 | 2.7 | 0 | 0 | 1 | 1.9 | |
| **Albumin** | | | | | | | |
| <3.5 | 2 | 2.7 | 6 | 4.3 | 0 | 0 | |
| 3.5-5 | 73 | 97.3 | 130 | 94.2 | 51 | 98.1 | 0.441 |
| >5 | 0 | 0 | 2 | 1.4 | 1 | 1.9 | |
| **Globulin** | | | | | | | |
| <2.5 | 20 | 26.7 | 42 | 30.4 | 17 | 32.7 | |
| 2.5-3.5 | 52 | 69.3 | 91 | 65.9 | 33 | 63.5 | 0.963 |
| >3.5 | 3 | 4 | 5 | 3.6 | 2 | 3.8 | |
| **AG ratio** | | | | | | | |
| <1.2:1 | 6 | 8 | 11 | 8 | 4 | 7.7 | 0.933 |
| 1.2 – 1.8 :1 | 55 | 73.3 | 96 | 69.9 | 39 | 75 | |
| >1.8:1 | 14 | 18.7 | 31 | 22.5 | 9 | 17.3 | |
| **Serum Cholesterol** | | | | | | | |
| <200 | | | | | | | |
| 200-239 | 33 | 44 | 79 | 57.2 | 28 | 53.8 | |
| >240 | 27 | 36 | 32 | 23.2 | 14 | 26.9 | 0.338 |
| | 15 | 20 | 27 | 19.6 | 10 | 19.2 | |
| **Triglycerides** | | | | | | | |
| <150 | 46 | 61.3 | 93 | 67.4 | 35 | 67.3 | 0.648 |
| >150 | 29 | 38.7 | 45 | 32.6 | 17 | 32.7 | |
| **HDL** | | | | | | | |
| <35 | 8 | 10.7 | 13 | 9.4 | 6 | 11.5 | |
| 35-75 | 66 | 88 | 123 | 89.1 | 46 | 88.5 | 0.919 |
| >75 | 1 | 1.3 | 2 | 1.4 | 0 | 0 | |
| **LDL** | | | | | | | |
| <60 | 1 | 1.3 | 7 | 5.1 | 2 | 3.8 | |
| 60-150 | 53 | 70.7 | 100 | 72.5 | 39 | 75 | 0.610 |
| >150 | 21 | 28 | 31 | 22.5 | 11 | 21.1 | |
| **VLDL** | | | | | | | |
| 10-33 | 50 | 68.5 | 107 | 79.3 | 39 | 79.6 | 0.182 |
| >33 | 23 | 31.5 | 28 | 20.7 | 10 | 20.4 | |
| **Free T3** | | | | | | | |
| 2.5-3.9 | 74 | 98.7 | 129 | 93.5 | 49 | 94.2 | 0.234 |
| >3.9 | 1 | 1.3 | 9 | 6.5 | 3 | 5.8 | |
| **Free T4** | | | | | | | |
| <0.6 | 4 | 5.3 | 3 | 2.2 | 3 | 5.8 | 0.360 |
| 0.6-1.1 | 71 | 94.7 | 135 | 97.8 | 49 | 94.2 | |
| **TSH** | | | | | | | |
| <0.34 | 0 | 0 | 0 | 0 | 1 | 1.9 | |
| 0.34-5.2 | 74 | 98.7 | 137 | 99.3 | 51 | 98.1 | 0.305 |
| >5.2 | 1 | 1.3 | 1 | 0.7 | 0 | 0 | |

*(*p<0.05 – statistically significant)*

## DISCUSSION

This retrospective study evaluated the correlation between serum Vitamin D status and age, gender, and selected biochemical parameters among adults. We observed that Vitamin D deficiency was more prevalent among younger individuals, with 43.5% of those aged 18–29 years deficient, compared to only 19.4% in those aged above 61 years. This age-related trend aligns with the findings of Saikia et al., who reported lower deficiency among older individuals in Guwahati, possibly due to increased awareness or supplementation in the elderly population.[9] Similar patterns were observed in Korea by Choi et al., who noted that younger adults had higher rates of deficiency, attributed to indoor lifestyles and less sun exposure.[10] Conversely, Jayashri et al. conducted a study in urban South India and reported a high prevalence of vitamin D deficiency, with rates reaching up to 84% across different population subgroups, highlighting regional and lifestyle-related variations in vitamin D synthesis and intake.[11] A significant gender difference was also noted in our study, with 40.7% of females deficient compared to 19.1% of males. This is consistent with the findings of Al-Othman et al., who observed lower Vitamin D levels among females due to limited sun exposure and cultural clothing practices in Saudi Arabia.[12] Zargar et al. from Kashmir Valley also reported significantly lower 25(OH)D levels among females, despite residing in a high-altitude region with sufficient UV exposure.[13] Conversely, Zoya et al. from Norway observed that serum 25(OH)$D_3$ levels decreased significantly with increasing BMI across both sexes and age groups, indicating that body composition and seasonal factors play a crucial role in vitamin D status.[14] We found a significant positive correlation between Vitamin D levels and age ($r = 0.129$, $p = 0.03$), which is in agreement with earlier Indian data from Zargar et al.[13] and Saikia et al.[9] Vitamin D also showed a positive correlation with serum uric acid ($r = 0.144$, $p = 0.01$) and serum creatinine ($r = 0.125$, $p = 0.04$). Similar associations

were reported by Chen et al. from eastern China observed a significant association between serum vitamin D levels and uric acid, suggesting that vitamin D status may influence the risk of hyperuricemia in this population, suggesting a potential interaction in purine metabolism[15], and by Li et al., who proposed a renal-modulated effect of Vitamin D on metabolic homeostasis.[16]

A negative correlation was found between Vitamin D levels and both total cholesterol ($r = –0.148$, $p = 0.01$) and HDL cholesterol ($r = –0.147$, $p = 0.01$). These findings are supported by AlQuaiz et al. from Saudi Arabia observed that low levels of HDL cholesterol in men and high TG levels in women were associated with vitamin D deficiency, suggesting gender-specific differences in lipid profiles related to vitamin D status.[17] Moreover, a meta-analysis by Jorde and Grimnes confirmed the inverse relationship between 25(OH)D and serum lipids, particularly LDL and total cholesterol, across multiple populations.[18] Similarly, Radkhah et al. concluded that vitamin D supplementation alone may not significantly alter lipid parameters, highlighting the multifactorial nature of lipid metabolism.[19] In our study, the mean serum Vitamin D level was 24.5 ng/mL, and approximately 30% of participants were deficient. These results are relatively better compared to the national data presented by Harinarayan et al., who reported that over 70% of healthy Indians had suboptimal Vitamin D levels, likely due to dietary patterns rich in phytates, low calcium intake, and limited sun exposure despite tropical climates.[20] In summary, our findings reinforce that Vitamin D deficiency remains prevalent, especially among young adults and females. The observed correlations with serum lipids, uric acid, and creatinine suggest that Vitamin D may play broader metabolic roles beyond skeletal health. These results support the need for targeted screening and prevention strategies that consider demographic and biochemical risk factors to address hypovitaminosis D effectively in the Indian population.

**Limitations of the study**

Its retrospective design restricts the ability to establish causality between Vitamin D status and biochemical parameters. Additionally, the study population from a tertiary care hospital may limit the generalizability of the findings. The lack of detailed lifestyle information, such as sun exposure and diet, which can influence Vitamin D levels, also limits the analysis. Despite these limitations, the study provides valuable insights into the correlation between Vitamin D status and biochemical parameters.

## CONCLUSION

This study highlights the significant relationship between serum Vitamin D status, age, and gender among adults in a tertiary care hospital. We found that Vitamin D deficiency was more prevalent in younger age groups and females, consistent with regional studies. Additionally, significant correlations were observed between Vitamin D levels and specific clinical markers, such as serum creatinine, cholesterol, and HDL levels. These findings emphasize the need for targeted interventions, particularly among younger individuals and females, to address Vitamin D deficiency through awareness, supplementation, and lifestyle changes. Further studies with larger and more diverse populations are needed to explore the broader role of Vitamin D in various health conditions.

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