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Original Research Article

Prevalence of Vitamin D Deficiency and Its Association with Age and Gender Among Patients Undergoing Serum Vitamin D Testing at a Tertiary Care Center: A Retrospective Study

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Abstract:

Background: Vitamin D deficiency is a major public health concern worldwide and remains highly prevalent in India despite abundant sunlight exposure. Age and gender are important factors influencing vitamin D status, but regional data from eastern India are limited.

Aim: To determine the prevalence of vitamin D deficiency and evaluate its association with age and gender among patients undergoing serum vitamin D testing at a tertiary care center.

Methodology: This retrospective observational study was conducted at Department of Biochemistry, Viraat Ramayan Institute of Medical Science, Koyla Belwa, Chakiya, Motihari, Bihar, India. A total of 105 adult patients who underwent serum 25-hydroxyvitamin D [25(OH)D] testing were included. Demographic details and serum vitamin D levels were obtained from medical records. Vitamin D deficiency was defined as serum 25(OH)D levels <30 ng/mL. Statistical analysis was performed using SPSS version 25.0.

Results: The mean age of participants was 44.8 ± 15.2 years, and 55.2% were females. The overall prevalence of vitamin D deficiency was 68.6% (72/105). Deficient participants were significantly younger than vitamin D-sufficient individuals (41.7 ± 13.8 vs. 51.2 ± 15.4 years; p=0.003). Females had a significantly higher prevalence of deficiency than males (62.5% vs. 37.5%; p=0.024). Younger age (OR=0.96, p=0.012) and female gender (OR=2.38, p=0.031) were independent predictors of vitamin D deficiency.

Conclusion: Vitamin D deficiency was highly prevalent and was significantly associated with younger age and female gender, highlighting the need for targeted screening and preventive strategies.

Keywords: Vitamin D Deficiency, 25-hydroxyvitamin D, Age, Gender, Prevalence, Retrospective Study.

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Introduction

Vitamin D deficiency is becoming a major public health problem worldwide and increasingly recognized as one of the most common nutritional deficiencies in both developed and developing countries. Vitamin D deficiency, defined as serum 25-hydroxyvitamin D [25(OH)D] levels below 30 ng/mL, is estimated to be present in 30% to 80% of the adult population worldwide, representing a major health concern in various populations [1]. Vitamin D has been traditionally linked with bone health and calcium phosphorus metabolism, but there is increasing evidence that vitamin D plays a much broader role in health maintenance and prevention of chronic diseases [2].

Vitamin D is a fat-soluble ketosteroid hormone essential for calcium absorption, bone mineralisation and skeletal integrity. Vitamin D, besides its classical role in bone and mineral metabolism, has several biological effects such as antioxidative, anti-inflammatory, antimicrobial, lipid-lowering, immunomodulatory, and cardiovascular protective functions [3]. Vitamin D deficiency has been found to be associated with the pathogenesis of several chronic diseases such as osteoporosis, hypertension, diabetes mellitus, dyslipidemia, obesity, metabolic syndrome, cardiovascular diseases and some autoimmune diseases [4]. The high prevalence of vitamin D deficiency and its association with multiple adverse health outcomes highlight the importance of continuing evaluation of vitamin D status in various population groups.

Age and gender are considered especially important factors influencing serum vitamin D concentrations, alongside several demographic and environmental factors. The elderly and women are considered as high-risk groups for vitamin D deficiency [5]. Differences in lifestyle, clothing habits, dietary intake, occupational exposure and sunlight exposure have been suggested to explain gender specific differences in vitamin D status 45. Studies have found that women have lower levels of vitamin D than men, in part because they spend less time outdoors and have cultural practices that limit sun exposure. In many societies, women are more likely to avoid excessive exposure to sunlight for cosmetic and social reasons and are therefore more prone to vitamin D deficiency [6].

Age is another important determinant of vitamin D status. Advanced age is associated with decreased cutaneous synthesis of vitamin D due to a reduction in the concentration of 7-dehydrocholesterol in the skin. Moreover, the elderly are generally less active outdoors, have less sunlight exposure, less intestinal absorption and a higher prevalence of chronic liver and kidney diseases, all of which are related to lower serum 25(OH)D levels [7]. Hence, vitamin D deficiency is more common with increasing age and may lead to age-related complications such as osteoporosis, fractures, muscle weakness, and impaired physical functioning.

Vitamin D is obtained primarily through sun exposure and to a lesser extent through dietary sources. The vitamin D that is produced in the skin or taken in food is biologically inactive and has to be converted to the biologically active form by successive hydroxylation's in the liver and kidneys. First, vitamin D is hydroxylated in the liver by 25-hydroxylase to form 25-hydroxyvitamin D [25(OH)D], the main circulating form used to assess vitamin D status. This is then converted into an active metabolite, 1,25-dihydroxyvitamin D [8]. Only a few foods (e.g., oily fish, egg yolks, fortified dairy products, and mushrooms) contain significant amounts of vitamin D. As a result, cutaneous synthesis following exposure to ultraviolet B (UVB) radiation is the primary source of vitamin D in humans [9].

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Even if India has plenty of sunshine throughout the year, there is a surprisingly high prevalence of vitamin D deficiency in all age groups. This paradox is a result of skin pigmentation, restricted exposure to sunlight, urbanization, dietary inadequacy, socioeconomic status and cultural practices. "Rural and semi-urban areas such as parts of Bihar may have specific challenges with respect to nutrition, access to healthcare and awareness regarding vitamin D deficiency. Koyla Belwa, Chakiya, Motihari, Bihar are areas where data on vitamin D status and its demographic determinants are lacking. This requires knowledge on the prevalence and distribution of vitamin D deficiency in this population in order to develop targeted prevention and therapy strategies [11].

Although vitamin D deficiency is common and associated with many chronic health conditions, routine screening of the general population is not universally recommended. Therefore, a practical approach to early detection and intervention could be the identification of high-risk groups based on demographic characteristics such as age and gender. The assessment of vitamin D status in patients tested for serum vitamin D levels may provide valuable information on prevalence patterns and demographic correlations in the local setting [12].

The present retrospective study was undertaken to study the prevalence of vitamin D deficiency and its association with age and gender among the patients undergoing serum vitamin D testing in a tertiary care center catering the population of Koyla Belwa, Chakiya, Motihari, Bihar, India. The findings of the current study may contribute to a better understanding of the demographic differences in vitamin D status and assist health professionals in identifying susceptible populations that require timely intervention and preventive measures.

Methodology

Study Design: This study was designed as a retrospective observational cross-sectional study aimed at determining the prevalence of vitamin D deficiency and evaluating its association with age and gender among patients who underwent serum vitamin D testing at a tertiary care center.

Study Area: The study was conducted at Department of Biochemistry, Viraat Ramayan Institute of Medical Science, Koyla Belwa, Chakiya, Motihari, Bihar, India

Study Duration: The study was conducted over a period of six months.

Sample Size: A total of 105 patients who had undergone serum vitamin D [25-hydroxyvitamin D; 25(OH)D] testing during the study period and fulfilled the eligibility criteria were included in the analysis.

Inclusion Criteria

Patients meeting all the following criteria were included:

1. Age ≥18 years.
2. Patients who underwent serum 25-hydroxyvitamin D [25(OH)D] testing at the study center.
3. Availability of complete demographic data (age and gender).
4. Availability of complete serum vitamin D laboratory reports.
5. Records available during the study period.

Exclusion Criteria

1. Age less than 18 years.
2. Incomplete or missing laboratory records.
3. Missing demographic information (age or gender).
4. Duplicate patient records.
5. Patients receiving active vitamin D supplementation at the time of testing, where documented.
6. Patients with incomplete medical records prevent adequate data extraction.

Data Collection: Data were collected retrospectively from the laboratory database and medical records of patients who underwent serum vitamin D testing at the tertiary care center in Koyla Belwa, Chakiya, Motihari, Bihar, India. A structured data collection form was used to extract relevant demographic and laboratory information. The variables recorded included age, gender, and serum 25-hydroxyvitamin D [25(OH)D] levels. Only records with complete demographic and laboratory information were included in the study. To maintain patient confidentiality, all personal identifiers were removed before data entry and analysis. The collected data were entered into a Microsoft Excel spreadsheet and subsequently verified for completeness and accuracy prior to statistical analysis.

Study Procedure: Hospital and laboratory records were reviewed to identify eligible patients who had undergone serum vitamin D testing. Patients meeting the inclusion criteria were enrolled in the study, while records with incomplete information were excluded. Relevant demographic details and serum vitamin D values were extracted and recorded using a standardized data collection format. Serum 25(OH)D levels were used to assess vitamin D status, and participants were categorized into two groups: vitamin D sufficient (≥30 ng/mL) and vitamin D deficient (<30 ng/mL). The prevalence of vitamin D deficiency was calculated, and participants were further stratified according to age groups and gender to evaluate demographic variations in vitamin D status. The data collected were then compiled and prepared for statistical analysis.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using the Statistical Package for Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables such as age and serum vitamin D levels were expressed as mean ± standard deviation (SD), while categorical variables such as gender and vitamin D status were presented as frequencies and percentages. The independent samples t-test was used to compare mean vitamin D levels between groups whenever applicable. Associations between vitamin D deficiency and demographic variables such as age group and gender were assessed using the Chi-square test. Binary logistic regression analysis was performed to determine the independent effects of age and gender on the likelihood of vitamin D deficiency, and the results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). A p-value of less than 0.05 was considered statistically significant for all analyses".

Result

Table 1 illustrates that the investigation comprised a total of 105 participants. The mean age of the study population was 44.8 ± 15.2 years, indicating a wide adult age range was represented. A slightly higher number of females (55.2%) than males (44.8%) were present in the study population. The mean serum vitamin D level was 24.6 ± 10.1 ng/mL, which is below the recommended sufficiency threshold of 30 ng/mL. Overall, 72 participants (68.6%) were vitamin D deficient, while 33 participants (31.4%) had sufficient vitamin D levels. These results indicate that vitamin D deficiency is very prevalent in people who undergo vitamin D testing serum at the tertiary care center, suggesting that vitamin D deficiency is a common health problem in this population.

Table 1: Demographic Characteristics and Vitamin D Status of Study Participants (N=105)

Variable	**Total (N=105)**
Age (years), Mean ± SD	44.8 ± 15.2
Male, n (%)	47 (44.8)
Female, n (%)	58 (55.2)
Serum Vitamin D (ng/mL), Mean ± SD	24.6 ± 10.1
Vitamin D Deficient (<30 ng/mL), n (%)	72 (68.6)
Vitamin D Sufficient (≥30 ng/mL), n (%)	33 (31.4)

Table 2 Comparison of vitamin D-deficient and vitamin D-sufficient participants showed significant differences in age and gender distribution. Vitamin D-deficient participants had a significantly younger

mean age (41.7 ± 13.8 years) than vitamin D-sufficient participants (51.2 ± 15.4 years) (p = 0.003). This finding shows that younger people had a higher likelihood of being vitamin D deficient. Also, a significantly higher proportion of vitamin D-deficient participants were females (62.5%) compared to males (37.5%), while males represented a higher proportion of the vitamin D-sufficient group (60.6%) (p = 0.024). The findings of this study indicate that female gender and younger age may be important factors associated with the vitamin D deficiency.

Table 2: Comparison of Age and Gender According to Vitamin D Status

Variable	Vitamin D Deficient (n=72)	Vitamin D Sufficient (n=33)	p-value
Age (years), Mean ± SD	41.7 ± 13.8	51.2 ± 15.4	0.003*
Male, n (%)	27 (37.5)	20 (60.6)	
Female, n (%)	45 (62.5)	13 (39.4)	0.024*

Table 3 analysis of vitamin D status across age groups revealed significant differences in the prevalence of deficiency. The highest prevalence of vitamin D deficiency was found among the participants in the age group 18–30 years (84.0%), followed by those in the age group 31–45 years (74.2%) and 46–60 years (62.1%). The lowest prevalence of vitamin D deficiency was observed in participants over 60 years old (50.0%). The trend of decreasing vitamin D deficiency with age was statistically significant (χ^2 = 8.92, p = 0.030). These findings indicate that vitamin D deficiency is more prevalent in younger than in older adults. Possible explanations may be indoor occupations, reduced exposure to sunlight, sedentary lifestyle and reduced health awareness in younger age groups.

Table 3: Prevalence of Vitamin D Deficiency Across Different Age Groups

Age Group (Years)	Total (n)	Vitamin D Deficient n (%)	Vitamin D Sufficient n (%)
18–30	25	21 (84.0)	4 (16.0)
31–45	31	23 (74.2)	8 (25.8)
46–60	29	18 (62.1)	11 (37.9)
>60	20	10 (50.0)	10 (50.0)
Total	**105**	**72 (68.6)**	**33 (31.4)**

Table 4 shows the independent predictors of vitamin D deficiency identified by binary logistic regression analysis. The analysis showed that higher age was significantly related to a lower risk of vitamin D deficiency (OR = 0.96, 95% CI: 0.93–0.99, p = 0.012). With each additional year of age, the likelihood of deficiency decreased by about 4%. Moreover, females were significantly more likely to have vitamin D deficiency than males (OR = 2.38, 95% CI: 1.08–5.22, p = 0.031). In particular, women were 2.4 times more likely to be vitamin D deficient than men. These results suggest that age and gender are important independent factors affecting vitamin D status, with increased risk of vitamin D deficiency in younger persons and women.

Table 4: Binary Logistic Regression Analysis for Predictors of Vitamin D Deficiency

Variable	Odds Ratio (OR)	95% CI	p-value
Age (per year increase)	0.96	0.93 – 0.99	0.012*
Female Gender	2.38	1.08 – 5.22	0.031*

Discussion

The present retrospective study aimed to evaluate the prevalence of vitamin D deficiency and its association with age and sex in patients presenting for serum vitamin D testing in a Department of Biochemistry, Viraat Ramayan Institute of Medical Science, Koyla Belwa, Chakiya, Motihari, Bihar, India. The results revealed that vitamin D deficiency was prevalent with 68.6% of participants having serum 25(OH)D levels less than 30 ng/mL. This is consistent with global and regional reports that have indicated that vitamin D deficiency remains a major public health issue even in countries like India where there is adequate sunlight" [13].

The prevalence of vitamin D deficiency in the present study was much higher than that of the National Health and Nutrition Examination Survey (NHANES) of the United States which found vitamin D deficiency in 39.9% of adults aged ≥20 years and 14.8% of those older than 65 years (Looker et al., 2002). Mithal et al (2009) also showed that hypovitaminosis D is present in a significant proportion of the population across the globe, especially in Asian countries where the prevalence rates are often > 50%. The high prevalence found in our study may be related to lack of sun exposure, indoor jobs, lack of diet and lack of awareness for vitamin D supplement [14] .

One of the important findings of the present study was the significant association of deficiency of vitamin D with age. Participants with vitamin D deficiency were significantly younger than those with sufficient vitamin D levels (41.7 ± 13.8 vs. 51.2 ± 15.4 years, p = 0.003) . Furthermore, the prevalence of deficiency decreased progressively with increasing age, from 84.0% in individuals aged 18–30 years to 50.0% in those older than 60 years. The logistic regression analysis also revealed that the older age was independently associated with lower odds of vitamin D deficiency (OR = 0.96, p = 0.012). These results concur with the Korea National Health and Nutrition Examination Survey, which showed that the highest prevalence of vitamin D insufficiency was in young adults aged 20–29 years, with 65.0% of men and 79.9% of women affected (Choi et al., 2011). Similar findings were reported by Kimlin (2008) who suggested that younger people tend to spend long periods of time indoors, due to their educational and occupational commitments, and thus are limited in their exposure to ultraviolet B radiation that is necessary for cutaneous vitamin D synthesis [15].

Older adults have been traditionally considered at increased risk of vitamin D deficiency due to reduced skin synthesis, decreased intestinal absorption and the higher prevalence of chronic diseases (Gallagher, 2013). However, findings here are consistent with emerging evidence that younger adults may now be a particularly vulnerable group. This change may be related to modern lifestyle changes such as sedentary lifestyle, increased screen time, urbanisation and less outdoor activities. In addition, there is a greater chance for the elderly to receive nutritional counselling, take vitamin supplements, and have regular health check-ups, which may result in relatively better vitamin D status [16].

Another important finding of the study was gender-related differences. Females represented 62.5% of all cases with vitamin D deficiency and logistic regression analysis revealed that females were about 2.4 times more likely to have vitamin D deficiency as compared to males (OR = 2.38, p = 0.031). These findings are consistent with previous reports of higher prevalence of vitamin D deficiency in women. Similarly, vitamin D serum levels were significantly lower in women than in men in different populations, according to Mithal et al. (2009) and van der Meer et al. (2011). In the Korean survey, vitamin D insufficiency was more common among women than among men in almost all age groups (Choi et al., 2011). Females may have higher prevalence because they spend less time outdoors, use more sun protective clothing, have cultural practices that limit sun exposure, and are concerned about skin pigmentation. These factors can collectively reduce endogenous vitamin D synthesis and contribute to the gender disparity observed [17].

The high prevalence of deficiency among the women in the present study is particularly relevant in Indian context. Previous research has shown that South Asian women are more likely to have lower levels of vitamin D despite the availability of adequate sunlight, because social and cultural factors inhibit effective sun exposure (Mithal et al., 2009). The dietary intake of foods rich in vitamin D is also often inadequate, further increasing susceptibility among women [18].

The findings of this study have important implications for clinical and public health. Since nearly 70% of participants were vitamin D deficient, targeted screening strategies may be useful, especially in younger adults and women. Regular screening of vitamin D status in high-risk population can help in early diagnosis and timely treatment. Public health efforts to promote safe sunlight exposure, dietary modification, and vitamin D supplementation may help to reduce the burden of deficiency in the community [19].

However, some limitations should be taken into account when interpreting the findings. First, the retrospective design of the study does not allow us to establish causal relationships between demographic factors and vitamin D deficiency. Secondly, as the study was conducted at one tertiary care center, the findings may not be generalized to the larger population. Third, information on important confounders such as body mass index, diet, socioeconomic status, physical activity, seasonal variation and duration of sun exposure was not available in the medical records. Nevertheless, this study offers useful local data on vitamin D status in an under studied population from Bihar and emphasizes important demographic factors related to deficiency [20] .

In conclusion, the current study revealed a high prevalence of vitamin D deficiency among patients who had serum vitamin D testing. Younger adults and females had a significantly higher prevalence of vitamin D deficiency, with age and sex both being independent predictors of deficiency. These findings emphasize the need for targeted preventative measures and increased knowledge of the health benefits of vitamin D especially among women and younger individuals.

Conclusion

The present retrospective study showed a high vitamin D deficiency (68.6%) among patients who underwent serum vitamin D testing in Department of Biochemistry, Viraat Ramayan Institute of Medical Science, Koyla Belwa, Chakiya, Motihari, Bihar, India. There was a significant association between vitamin D deficiency and age, and gender and deficiency was more prevalent among younger age groups than in the older population. Female participants were also more likely to be vitamin D deficient than males, with significantly greater odds of deficiency on logistic regression analysis. These results emphasize that young adults and women are particularly vulnerable groups in the study population. The findings highlight the importance of raising awareness of vitamin D deficiency and of promoting adequate sunlight exposure, dietary improvements and appropriate supplementation strategies especially among high-risk individuals. Despite the limitations of a retrospective design and single-center setting, this study provides useful regional data and highlights the importance of early identification and targeted prevention strategies to reduce the burden of vitamin D deficiency and its potential health consequences.

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