Derna Academy Journal for Applied Sciences

E-ISSN: 3006-3159

DAJAS

Vitamin D Deficiency Relationship with Age and Gender

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Volume: 3 **Issue: 2** **Page Number: 153- 160**

Keywords:
Vitamin D, Deficiency, Gender, Ages, Relationship

Received: 15\01\2025
Accepted: 11\02\2025
Published: 18\02\2025
DOI: https://doi.org/10.71147/xacd4k36

ABSTRACT

Vitamin D deficiency is a widespread public health concern, influencing various physiological processes, including bone health and immune function. This cross-sectional study evaluates the relationship between Vitamin D levels, age, and gender among 1,416 individuals (708 males and 708 females). Data collection involved structured questionnaires and laboratory assessments of serum 25-hydroxyvitamin D (25(OH)D) concentrations. The results indicate a high prevalence of severe Vitamin D deficiency in both genders, affecting 238 males and 244 females. Normal Vitamin D levels were observed in 402 individuals, with a slightly higher prevalence in females. Correlation analysis revealed a weak but statistically significant negative relationship between gender and Vitamin D levels (R = -0.081, P = 0.002), whereas no significant correlation was found between age and Vitamin D levels (R = -0.025, P = 0.356). The findings suggest that gender may influence Vitamin D status, while age does not significantly impact deficiency levels. These results highlight the need for public health interventions focusing on dietary habits, sun exposure, and Vitamin D supplementation to mitigate deficiency risks, particularly among vulnerable populations.

1. INTRODUCTION

The world population is aging, and there is a growing interest in understanding the physiological changes associated with advanced age. The skin undergoes intrinsic age associated natural changes, such as telomere shortening, reduced DNA repair, oxidative damage to biomolecules, hormonal changes, immunosenescence, inflammation, and damage to ECM components. (Ambagaspitiya et al., 2025), itamin D, a crucial micronutrient, plays a pivotal role in bone health and immune function, being involved in fundamental biological processes such as cell proliferation, differentiation, and apoptosis, (Chen et al., 2024), Vitamin D (VD) deficiency is a growing epidemiological problem, affecting a large number of individuals.

It is estimated that more than 50% of the world's elderly do not have satisfactory VD levels and more than 1 billion people worldwide have VD insufficiency or deficiency, (Câmara & Brandão, 2019)42.9% of children with cerebral palsy had low vitamin D levels. Older children with cerebral palsy or those with varied diets were at a higher risk for low vitamin D.(Paker et al., 2023), A high percentage of vitamin D deficiency in the participants requires more attention to this public health entity. A direct relationship between serum vitamin D levels and the age of healthy individuals requires further investigation.(, Zaher Khazaei 2018.). Atopic dermatitis (AD) is a chronic relapsing skin disease characterized by a defective skin barrier that affects mainly children, and less commonly adults with environmental, genetic, and immunologic factors(Ahmed Mohamed et al., 2021), Vitamin D deficiency is a critical public health issue worldwide, primarily stemming from insufficient sunlight exposure. This study decisively evaluates the prevalence of vitamin D deficiency among the Saudi population residing at different altitudes.(Alqahtani, 2022), Vitamin D deficiency was highly prevalent, particularly among young adults and those with central obesity. Proper fortification policy, health education, and regular screening PHCCs may help prevent and treat vitamin D deficiency.(AlQuaiz et al., 2018), Vitamin D deficiency is prevalent in Niğde province, particularly among women, and remains a significant public health concern. We advocate for the adoption of a unified clinical decision threshold and the expansion of the national vitamin D supplementation program to encompass adolescents and adults.(Bayram et al., 2024), the optimal values of 25(OH) D were defined for the first time in a North Algerian adult population. The optimal value is 25.0 ng/ml in men and 30.0 ng/ml in women.(Bennouar et al., 2022), their relationship between, age, gender, skin color, smoking, nutrition, expose to sun, sporting, diabetes, hypertension, different type of diseases, and other type of vitamins, there is also a direct proportion between vitamin D deficiency and S. Ca+ deficiency.(Eljamay et al., 2022), The vitamin D supply is both exogenous and endogenous, with the latter representing the principal source. The most notable dietary sources of vitamin D are fish liver oils (especially cod), fatty fish (i.e. salmon, herring), egg yolk, mushrooms and some dairy products (i.e. butter, whole and fortified milk, cheese and yogurt).(Galeazzi et al., 2023), vitamin D deficiency in elderly people, particularly men as well as in select ethnic groups such as Blacks may contribute to higher morbidity and mortality in these populations due to COVID19. ACE2 may be a common denominator in the susceptibility of these individuals, although further investigation in this regard is warranted. Nonetheless, supplement with vitamin D may be of particular benefit against COVID-19 in select populations where the risk of vitamin D deficiency is high.(Getachew & Tizabi, 2021), vitamin D insufficiency is common in patients with COPD. Men had significantly lower levels of vitamin D but took vitamin D-containing supplements less frequently compared to women(Minter et al., 2023), Vitamin D deficiency and older age are both associated with higher risk of depression, while older age is a protective factor for vitamin D deficiency.(Mo et al., 2023), the relationship between vitamin D and the intestinal microbiome with the immune system and the diseases associated with it, emphasizing the effect mediated by sexual hormones and aging.(Murdaca et al., 2024), Physical exercise and vitamin D were associated with NKA in a genderand age-dependent manner. Age was a major risk factor of very low NKA in men but not in women.(Oh et al., 2021), Women face additional challenges in the aging process due to hormonal shifts after menopause or premenopausal, which are associated with osteoporosis and lower vitamin D levels.(Trifan et al., 2023), Adherence of giving children aged 0–4 years the recommended vitamin D supplementation was very low(Trollfors, 2022), vitamin D deficiency is unlikely to be detected. However, this study revealed that people living in Cizre have serious levels of vitamin D deficiency in all seasons, especially in winter, and in both sexes, especially in women(Veysel Tahiroğlu, 2023),

2. METHOD

Study Design

This investigation employed a cross-sectional design to evaluate the prevalence of Vitamin D levels across different age groups and genders within a sample of 1,416 individuals. The primary objective was to assess the distribution of Vitamin D levels and their correlations with demographic variables, specifically age and gender. Prior to data collection, the study received ethical approval from the institutional review board (IRB), ensuring adherence to ethical research guidelines.\

Participants

The participant sample comprised 1,416 individuals, evenly divided between genders, with 708 males and 708 females, thus ensuring a balanced demographic representation. Participants were recruited via various community health centers and clinics, allowing for a diverse population sample. Inclusion criteria included individuals aged 10 years and older who provided informed consent. Exclusion criteria encompassed individuals with chronic illnesses affecting Vitamin D metabolism, those on long-term Vitamin D supplementation, and pregnant or lactating women.

Data Collection

Data collection was conducted through a structured questionnaire and laboratory assessments. The questionnaire gathered demographic information, including age, gender, and lifestyle factors such as dietary habits and sun exposure. Participants were categorized into specific age groups for analysis, ranging from 10-15 years to over 71 years.

Vitamin D Assessment

Vitamin D levels were quantified through serum 25-hydroxyvitamin D (25(OH)D) concentration, the standard biomarker for assessing Vitamin D status. Blood samples were collected and analyzed in a certified laboratory. Vitamin D levels were classified based on established cut-off values: Normal (≥ 30 ng/mL), Low (20-29 ng/mL), Severely Low (< 20 ng/mL), High (> 50 ng/mL), and Moderately Low (21-29 ng/mL).

Laboratory Procedures

Blood samples were drawn by trained phlebotomists and processed following standard laboratory protocols. Serum was separated and stored at -80°C until analysis. The 25(OH)D levels were determined using a competitive enzyme-linked immunosorbent assay (ELISA) method, known for its sensitivity and specificity in measuring Vitamin D concentrations. Quality control measures were implemented, including standardized reference samples and regular calibration of laboratory equipment.

Data Analysis

Data were analyzed using statistical software (e.g., SPSS, version 27.0). Descriptive statistics were calculated for demographic variables, including frequencies and percentages for age groups and gender. The distribution of Vitamin D levels was examined across different age categories and genders, with results presented in tabular format.

Correlation Analysis

Pearson correlation coefficients were computed to assess the relationship between Vitamin D levels and demographic variables (age and gender). A significance level of $p < 0.01$ was established for determining statistically significant correlations. Correlation coefficients were interpreted to indicate the strength of relationships, with values ranging from weak to strong correlations.

3. ETHIC APPROVAL

Informed consent was obtained from all participants prior to data collection. Participants were assured of the confidentiality of their responses and the anonymity of their data. They were informed of their right to withdraw from the study at any time without repercussions.

The study protocol was reviewed and approved by the local ethics committee, ensuring compliance with ethical research standards.

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4. RESULT

The table presents the distribution of Vitamin D levels across male and female participants in a total sample of 1,416 individuals (708 males and 708 females). The data indicate that the most prevalent category for both genders is the **severely low Vitamin D level**, affecting 238 males and 244 females (482 individuals in total). This suggests a widespread Vitamin D deficiency across the sample. The second most common category is the **normal Vitamin D level**, found in 402 individuals (179 males and 223 females), highlighting that a considerable portion of the sample maintains adequate levels. The **low and moderate low Vitamin D levels** are also notable, with slightly higher frequencies in males for moderate deficiency (132 vs. 95 in females), while the low category appears almost balanced (152 males, 141 females). The **high Vitamin D category** is the least frequent, comprising only 12 individuals (7 males, 5 females), indicating that excessive Vitamin D levels are rare in this population. The gender distribution does not show significant variation, as the trends are relatively similar in both male and female groups. However, the predominance of **severe deficiency** raises concerns about potential health risks associated with inadequate Vitamin D, which may warrant further investigation into dietary habits, sun exposure, and supplementation practices.

Table 1 percentage and frequency of age group

Age	N	%
10 - 15 years	48	3.4
16 - 20 years	117	8.3
21 - 25 years	134	9.5
26 - 30 years	157	11.1
31 - 35 years	179	12.6
36 - 40 years	156	11.0
41 - 45 years	137	9.7
46 - 50 years	134	9.5
51 - 55 years	100	7.1
56 - 60 years	80	5.6
61 - 65 years	57	4.0
66 - 70 years	46	3.2
More than 71	71	5.0
Total	**1416**	**100.0**

The table provides a detailed breakdown of the sample's age distribution across different age groups. The largest age group is **31-35 years**, comprising **12.6% (179 individuals)**, followed closely by **26-30 years (11.1%) and 36-40 years (11.0%)**, indicating that a significant portion of the sample falls within the **26-40 age range**. The age group with the lowest representation is **66-70 years (3.2%)**, while individuals **above 71 years** make up **5.0%** of the total.
The distribution shows a gradual decrease in frequency as age increases, suggesting that younger and middle-aged individuals are more prevalent in the sample. Notably, the age group **10-15 years** has the second-lowest representation (3.4%), which might indicate that younger individuals were less targeted or available in the study. The sample size remains relatively balanced across younger and middle-aged categories, ensuring diverse age representation. However, the underrepresentation of elderly individuals may influence study outcomes, particularly if age-related factors play a role in the research focus. If the study involves health-related parameters, it may be beneficial to explore whether age impacts the variables under investigation.
Table 2 percentage and frequency of gender

Gender	N	%
Male	708	50.0
Female	708	50.0
Total	1416	100.0

The table presents the percentage and frequency of Vitamin D levels across various age groups, highlighting a range of categories: Normal, Low, Severe Low, High, and Moderate Low. Here are some observations: **Age Distribution**: The table covers a wide age range, from 10 to over 71 years, which allows for a comprehensive understanding of Vitamin D levels in different life stages. **Vitamin D Levels**:
The highest frequency of individuals with **Normal** Vitamin D levels is found in the 31-35 age group (58), while the lowest is in the 66-70 age group (15).
Low Vitamin D levels are most prevalent in the 16-20 age group (18), whereas the 36-40 age group shows a moderate frequency (35).
Notably, the **Severe Low** category peaks in the 21-25 age group (54), indicating a potential concern for this demographic.
Trends by Age:
Younger individuals (10-15 years) and older adults (over 71 years) show varying frequencies across categories, suggesting that age may influence Vitamin D levels significantly.

The **More than 71** age group has a notable frequency of individuals with **Normal** levels (34), but also a concerning number of those with **Severe Low** levels (17).
Total Counts: The total counts across all age groups sum to 1416, providing a robust dataset that enhances the reliability of the findings.
Implications: The data suggests the need for targeted interventions, especially for age groups with high instances of Low and Severe Low Vitamin D levels, to improve overall health outcomes.

Table 3 percentage and frequency of age group

Age / Vitamin D		Vitamin D					Total
		Normal	Low	Sever Low	High	Moderate Low	
Age	10 - 15 years	16	7	19	1	5	48
	16 - 20 years	28	18	**57**	0	14	117
	21 - 25 years	28	25	**54**	5	**22**	134
	26 - 30 years	45	**31**	**50**	0	**31**	157
	31 - 35 years	58	**38**	**55**	2	**26**	179
	36 - 40 years	44	**35**	**55**	0	**22**	156
	41 - 45 years	32	**35**	46	1	**23**	137
	46 - 50 years	34	**32**	44	0	**24**	134
	51 - 55 years	28	27	30	1	14	100
	56 - 60 years	22	24	25	0	9	80
	61 - 65 years	18	13	16	1	9	57
	66 - 70 years	15	5	14	0	12	46
	More than 71	34	3	17	1	16	71
Total		**402**	**293**	**482**	**12**	**227**	**1416**

The figure presents the distribution of Vitamin D levels by gender, offering insights into how Vitamin D status varies between males and females. Here are some key observations:
Overall Distribution: The total number of individuals assessed is 1416, with an equal distribution of males and females (708 each), which enhances the reliability of gender comparisons.
Vitamin D Levels:
Normal Levels: Females show a higher frequency of Normal Vitamin D levels (223) compared to males (179), indicating that females may have better Vitamin D status overall.
Low Levels: The distribution is relatively close, with males at 152 and females at 141, suggesting a similar prevalence of Low Vitamin D status between genders.
Severe Low Levels: Both genders exhibit high frequencies, with males at 238 and females at 244. This indicates a significant concern for Severe Low Vitamin D levels across both groups.
High Levels: The counts for High Vitamin D levels are quite low overall, with males at 7 and females at 5, indicating that high levels are rare in the sample.
Moderate Low Levels: Males show a higher frequency (132) compared to females (95), suggesting that while both genders experience Moderate Low levels, males are more affected.
Implications: The data highlight critical areas for public health focus, particularly the high prevalence of Severe Low Vitamin D levels in both genders. This may necessitate targeted interventions to improve Vitamin D levels, especially for those at risk.
Gender Differences: The differences in Vitamin D levels between males and females suggest potential biological or lifestyle factors that may influence Vitamin D status, warranting further investigation.

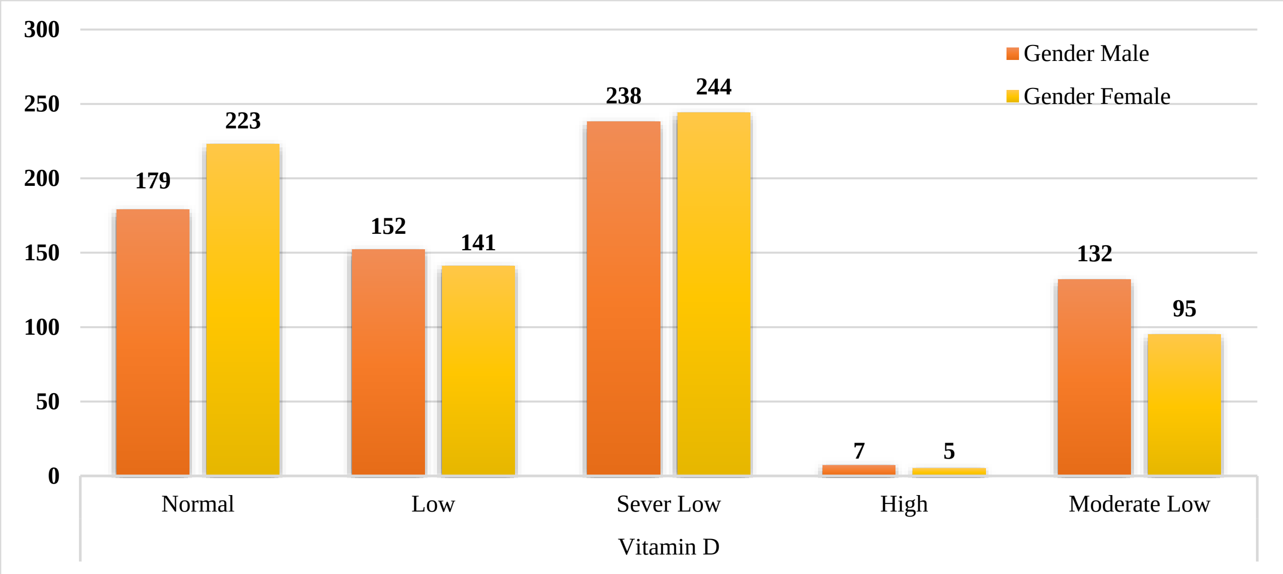

Figure 1 Distribution of vitamin D levels by gender

The table presents the correlations between Vitamin D levels and the variables of age and gender, providing statistical insights into their relationships. Here are some key observations: **Correlation with Gender**: The correlation coefficient (R) for gender is **-0.081**, indicating a weak negative correlation with Vitamin D levels. The **P-Value** of **0.002** suggests that this correlation is statistically significant at the 0.01 level, implying that there may be a meaningful relationship between gender and Vitamin D levels, although the strength of the correlation is weak. **Correlation with Age**: The correlation coefficient for age is **-0.025**, which indicates an almost negligible negative correlation with Vitamin D levels. The **P-Value** of **0.356** shows that this correlation is not statistically significant, suggesting that age does not have a meaningful impact on Vitamin D levels in this dataset. **Sample Size**: The total sample size (N) is 1416, which provides a robust foundation for the analysis, enhancing the reliability of the correlation results. **Implications**: The significant correlation with gender may warrant further investigation to explore the underlying factors influencing Vitamin D levels among males and females. The lack of a significant correlation with age suggests that Vitamin D levels do not vary substantially across different age groups in this sample, indicating that other factors may play a more crucial role.
In summary, while there is a statistically significant correlation between Vitamin D levels and gender, the relationship with age appears to be negligible. Further research could help clarify these dynamics and inform public health strategies.

Table 5 Correlations between Vitamin D and age, gender

Correlations		Vitamin D
Gender	R	-0.081-**
	P-Value	0.002
Age	R	-0.025-
	P-Value	0.356
	N	1416
**. Correlation is significant at the 0.01 level (P-Value).		

5. DISCUSSION

Summary and Conclusion: The analysis of Vitamin D levels across a sample of 1,416 individuals (708 males and 708 females) reveals significant findings regarding deficiency prevalence and demographic distributions.
Key Findings:
1. **Vitamin D Deficiency**: The most prevalent category for both genders is "Severe Low" Vitamin D levels, affecting 238 males and 244 females, indicating a widespread deficiency (482 individuals in total).

The second most common category is "Normal" levels, with 402 individuals (179 males and 223 females), suggesting that a notable portion of the population maintains adequate Vitamin D.

2. **Gender Differences**:

Males show higher frequencies in "Moderate Low" Vitamin D levels (132) compared to females (95).
The "High" Vitamin D category is rare, with only 12 individuals (7 males and 5 females).

3. **Age Distribution**:

The largest age group represented is 31-35 years (12.6%), with a gradual decrease in frequency as age increases.
Notably, the age group 10-15 years has low representation (3.4%), which may indicate underrepresentation in this study.

4. **Correlations**:

A weak negative correlation exists between gender and Vitamin D levels (R = -0.081, P = 0.002), suggesting that gender may influence Vitamin D status.
No significant correlation was found between age and Vitamin D levels (R = -0.025, P = 0.356).

The study's findings highlight a significant prevalence of vitamin D deficiency among both genders, with a weak negative correlation between vitamin D levels and gender and no significant correlation with age. This aligns with prior research, which has consistently shown that vitamin D deficiency is a widespread issue, particularly among younger adults and individuals with central obesity (AlQuaiz et al., 2018). The study found that severe deficiency was most common in both males and females, corroborating results from a large-scale study in Lebanon, which reported an 83.5% overall prevalence of vitamin D inadequacy with no significant association with gender (Salman et al., 2021).
Contrary to the current study's finding of no significant correlation with age, other research has observed age-related trends. A study in Iran found a positive correlation between vitamin D levels and age, suggesting that older individuals had slightly higher vitamin D levels, potentially due to increased supplementation (Khazaei et al., 2017). However, among elderly populations, deficiency remains highly prevalent due to factors like reduced sun exposure, inadequate diet, and physiological changes affecting vitamin D metabolism (Lopez-Leret & Schlatter, 2024).
Gender differences in vitamin D deficiency may stem from biological and lifestyle factors. Studies indicate that men often have lower vitamin D levels than women, possibly due to differences in supplement use and dietary intake (AlQuaiz et al., 2018). Additionally, veiling and cultural practices contribute to lower vitamin D levels in some female populations (Salman et al., 2021). These findings emphasize the need for targeted interventions, including vitamin D supplementation and lifestyle modifications, particularly for high-risk groups such as younger adults and those with central obesity.

6. CONCLUSION

The data highlights a concerning prevalence of Vitamin D deficiency, particularly severe deficiency, in both males and females. The similarities in trends across genders suggest that interventions targeting Vitamin D levels should be implemented broadly. The underrepresentation of younger and elderly individuals in the sample indicates a potential gap in understanding Vitamin D status across all age groups, warranting further research.
Given the significant correlation between gender and Vitamin D levels, future studies should explore underlying factors contributing to these differences. Overall, the findings underscore the need for public health initiatives aimed at improving Vitamin D levels, focusing on dietary habits, sun exposure, and possible supplementation, especially for high-risk age groups.

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