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ASSESSMENT OF VITAMIN D DEFICIENCY AMONG DIFFERENT AGE GROUPS IN TERTIARY CARE HOSPITAL

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Abstract
Vitamin D deficiency is a widespread public health concern affecting all age groups due to its essential role in bone metabolism, immune regulation, and overall physiological function. Despite adequate sunlight availability in many regions, deficiency remains highly prevalent, particularly in developing countries like Pakistan, due to limited sun exposure, lifestyle changes, and poor dietary intake. This cross-sectional study aimed to assess serum vitamin D levels and determine the prevalence of deficiency among different age groups in a tertiary care hospital in Lahore, Pakistan. A total of 100 participants were selected using convenience sampling and categorized into adolescents (10–17 years), young adults (18–25 years), and adults (26–36 years). Serum 25-hydroxyvitamin D [25(OH)D] levels were measured using standard laboratory techniques and classified as deficient, insufficient, or sufficient according to clinical guidelines. Data were analyzed using SPSS. Results showed a high overall prevalence of vitamin D deficiency (57%), with only 17% of participants having sufficient levels. Adolescents demonstrated the highest deficiency rate compared to other age groups. Although no statistically significant differences were observed between age groups or gender, a significant linear trend indicated decreasing deficiency with increasing age. The study concludes that vitamin D deficiency is highly prevalent across all age groups in hospitalized patients, with adolescents being the most vulnerable group. Early screening, public awareness, dietary improvement, and targeted supplementation strategies are strongly recommended to reduce the burden of deficiency.

INTRODUCTION

Vitamin D is a fat-soluble prohormone synthesized in the skin through sunlight (UVB) exposure and obtained in small amounts from diet and supplements. It exists mainly as vitamin D_2 (ergocalciferol) and vitamin D_3 (cholecalciferol), both of which are metabolized in the liver and kidneys into the active form, calcitriol. Unlike traditional vitamins, vitamin D functions as a hormone regulating calcium-phosphorus balance, bone mineralization, immune response, and multiple cellular processes (Holick, 2023).

Vitamin D deficiency is now recognized as a global public health problem affecting nearly one billion people. It is associated with rickets in children, osteomalacia in adults, osteoporosis in the elderly, and increased risk of chronic diseases including infections, cardiovascular disease, and metabolic disorders. Despite abundant sunlight in many regions, deficiency remains highly prevalent due to limited sun exposure, lifestyle changes, skin pigmentation, aging, and dietary inadequacy (Grieco et al., 2025).

Hospitalized patients and specific age groups—particularly adolescents, adults, and the elderly—are at higher risk due to reduced outdoor activity and underlying health conditions.

Problem Statement

Vitamin D deficiency is widespread across all age groups; however, data comparing its prevalence among adolescents, young adults, and adults in hospitalized populations is limited in tertiary care settings. This study aims to fill this gap by assessing serum vitamin D levels and identifying age-related differences.

Research Objectives

- To measure serum 25-hydroxyvitamin D [25(OH)D] levels in patients admitted to a tertiary care hospital.
- To determine the prevalence of vitamin D deficiency among adolescents (10–17 years), young adults (18–25 years), and adults (26–36 years).
- To compare vitamin D status across different age groups and gender.

Research Questions

- What are the serum levels of vitamin D among hospitalized patients in a tertiary care hospital?
- How does vitamin D deficiency vary among adolescents, young adults, and adults?
- Is there a significant difference in vitamin D deficiency between males and females?

Significance of the Study

This study provides:

- Baseline data on vitamin D status in hospitalized patients
- Age-specific prevalence patterns of deficiency
- Evidence for targeted screening and supplementation strategies in clinical practice
- Support for public health interventions in high-risk groups

Vitamin D deficiency (serum 25(OH)D <20 ng/mL) is widely reported across the globe and is linked with skeletal and non-skeletal disorders. Widespread deficiency has been observed in South Asia, the Middle East, Europe, and North America, affecting both healthy individuals and hospitalized patients.

Studies show that adolescents and young adults often have low vitamin D levels due to indoor lifestyles, limited sun exposure, and poor dietary intake. In hospital settings, deficiency rates are even higher due to illness, immobility, and reduced sunlight exposure.

Research also indicates gender and age variations, with females and younger populations in some regions showing higher deficiency rates, while elderly patients often present with severe deficiency due to reduced skin synthesis and comorbidities.

Measurement of serum 25(OH)D using LC-MS/MS and immunoassays has confirmed that deficiency is a consistent global health issue regardless of geographic location, highlighting the role of lifestyle and biological factors over sunlight availability alone.

Overall, literature supports that vitamin D deficiency is a multifactorial, age-dependent, and globally prevalent condition, yet limited studies compare hospitalized age groups within tertiary care settings justifying the present study.

MATERIALS AND METHODOLOGY

Study Design

A hospital-based **cross-sectional observational study** was conducted to determine the prevalence and severity of vitamin D deficiency and its variation across different age groups in a clinical population. This design was selected to provide a snapshot of biochemical and demographic variations within a defined time frame.

Study Setting
The study was carried out in a **tertiary care hospital in Lahore, Pakistan**, equipped with standardized clinical laboratory facilities for biochemical analysis, including serum vitamin D, calcium, and parathyroid hormone (PTH) assessment.

Study Duration
The study was conducted over a period of **six months (January to June 2026)**.

Study Population
The study included patients attending outpatient departments (OPD) or admitted in the hospital during the study period. Participants were stratified into three age groups:

- Adolescents: 10–17 years
- Young Adults: 18–25 years
- Adults: 26–36 years

This stratification allowed comparative analysis across biologically and behaviorally distinct age categories.

Sample Size Determination
A total sample of **100 participants** was determined using a standard single population proportion formula, considering a **95% confidence level** and **10% margin of error**, ensuring adequate statistical power for group comparisons.

Sampling Technique
A **non-probability convenience sampling technique** was employed due to time constraints and accessibility of hospital patients meeting inclusion criteria.

Eligibility Criteria
Inclusion Criteria

- Patients aged 10–36 years
- OPD visitors or hospitalized patients undergoing routine laboratory investigations
- Individuals providing written informed consent

Exclusion Criteria

- Use of vitamin D supplementation within the last 3 months
- Known chronic liver or renal disease
- Malabsorption syndromes
- Pregnancy or lactation
- Incomplete laboratory or demographic data

Data Collection Procedure
Data were collected using a **structured, researcher-administered questionnaire** covering:

- Demographic profile (age, gender)
- Sunlight exposure patterns
- Dietary intake related to vitamin D
- Physical activity level
- Relevant medical history

This ensured integration of both biochemical and lifestyle-related determinants.

Sample Collection and Handling
Approximately **3–5 mL of venous blood** was collected under aseptic conditions from each participant. Samples were centrifuged, and serum was separated and stored at **−20°C** until biochemical analysis was performed.

Laboratory Analysis
Serum **25-hydroxyvitamin D [25(OH)D]** levels were measured using **Chemiluminescent Immunoassay (CLIA)**, a standardized and widely validated method.
Additionally, serum **calcium** and **parathyroid hormone (PTH)** levels were recorded to assess metabolic and endocrine correlation with vitamin D status.

Classification of Vitamin D Status
Vitamin D status was categorized based on internationally accepted clinical thresholds:

- **Deficient:** < 20 ng/mL
- **Insufficient:** 20–30 ng/mL
- **Sufficient (Normal):** > 30 ng/mL

Statistical Analysis
Data were analyzed using **IBM SPSS Statistics version 25**. The following statistical techniques were applied:

- Descriptive statistics (mean, standard deviation, frequency, percentage)
- One-way ANOVA (to compare vitamin D levels across age groups)

- Post hoc Tukey's HSD test (for pairwise group comparisons)
- Independent samples t-test (for gender-based differences)
- Chi-square test (for association between categorical variables)

A **p-value < 0.05** was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the relevant institutional review board prior to data collection. Written informed consent was obtained from all participants. Confidentiality, anonymity, and voluntary participation were strictly maintained throughout the study in accordance with ethical research guidelines.

Limitations of the Study

- The single-center design limits generalizability of findings
- Cross-sectional nature restricts causal inference
- Convenience sampling may introduce selection bias
- Seasonal variation in vitamin D levels was not controlled

This methodological framework ensured a systematic evaluation of vitamin D status across different age groups while incorporating biochemical, demographic, and lifestyle factors, thereby strengthening the clinical relevance of the findings.

RESULTS

4.1 Descriptive Statistics

Descriptive statistics for the study variables, including serum vitamin D, calcium, and parathyroid hormone (PTH), are presented in Table 1. All variables were assessed for 100 participants with no missing data.

Table 1: *Descriptive Statistics of Continuous Variables (N = 100)*

Variable	N	Min	Max	M	SD
Vitamin D (ng/mL)	100	4.30	58.40	21.42	13.98
Calcium (mg/dL)	100	8.00	10.50	9.22	0.75
Parathyroid Hormone (pg/mL)	100	15.40	87.60	50.55	20.29

Note. M = mean; SD = standard deviation. No missing data were observed.

The mean vitamin D level (M = 21.42, SD = 13.98) indicates overall insufficiency in the sample.

4.2 Sample Characteristics

4.2.1 Gender Distribution

The sample consisted of 51 males (51%) and 49 females (49%), reflecting a balanced gender distribution (Table 2).

Table 2: *Gender Distribution of Participants (N = 100)*

Gender	n	%
Male	51	51.0
Female	49	49.0

Note. Percentages are based on total sample size.

4.2.2 Age Group Distribution

Participants were categorized into three age groups (Table 3).

Table 3: *Age Group Distribution (N = 100)*

Age Group	n	%
Adolescent (10–17)	27	27.0
Young Adult (18–25)	35	35.0
Adult (26–36)	38	38.0

The distribution was relatively balanced, enabling valid comparative analyses.

4.3 Vitamin D Status Distribution

Participants were classified into three clinical categories of vitamin D status (Table 4).

Table 4: *Vitamin D Status Distribution (N = 100)*

Status	n	%
Normal	17	17.0
Insufficient	26	26.0
Deficient	57	57.0

The findings indicate a high prevalence of vitamin D deficiency, affecting more than half of the participants.

4.4 Vitamin D Levels by Age Group

A one-way analysis of variance (ANOVA) was conducted to examine differences in vitamin D levels across age groups (Table 5).

Table 5: *One-Way ANOVA for Vitamin D Levels by Age Group*

Source	SS	df	MS	F	p
Between Groups	488.46	2	244.23	1.26	.289
Within Groups	18855.29	97	194.38		
Total	19343.75	99			

***Note*.** SS = sum of squares; MS = mean square.

The ANOVA results showed no statistically significant differences in vitamin D levels among age groups, $F(2, 97) = 1.26$, $p = .289$.
Post hoc comparisons using Tukey's HSD test also revealed no significant pairwise differences (all $p > .05$), confirming homogeneity across age categories.

4.5 Association Between Age Group and Vitamin D Status

A chi-square test of independence was performed to assess the association between age group and vitamin D status (Table 6).

Table 6: *Association between Age Group and Vitamin D Status*

Age Group	Normal	Insufficient	Deficient	Total
Adolescent	3	4	20	27
Young Adult	6	9	20	35
Adult	8	13	17	38
Total	17	26	57	100

Chi-Square Test Results

Test	χ^2	df	p
Pearson Chi-Square	5.59	4	.232
Likelihood Ratio	5.75	4	.219
Linear-by-Linear Association	4.11	1	.043*

Note. *p < .05.

The Pearson chi-square test indicated no significant association between age group and vitamin D status, $\chi^2(4) = 5.59$, $p = .232$. However, the significant linear-by-linear association suggests a decreasing trend in deficiency with increasing age.

4.6 Gender Differences in Vitamin D Levels

An independent samples t-test was conducted to compare vitamin D levels between males and females (Table 7).

Table 7: ***Independent Samples t-Test for Vitamin D Levels by Gender***

Gender	n	M	SD			
Male	51	21.19	13.62			
Female	49	21.66	14.48			
Test				**t**	**df**	**p**
Equal variances assumed				-0.17	98	.867

Note. Levene's test for equality of variances: F = 0.10, p = .749.

The results indicated no significant gender differences in vitamin D levels, $t(98) = -0.17$, $p = .867$, suggesting a similar risk of deficiency among males and females.

4.7 Summary of Findings

Overall, the results demonstrate a high prevalence of vitamin D deficiency across all demographic groups. No statistically significant differences were observed across age groups or gender. However, a significant linear trend suggests that vitamin D deficiency decreases with increasing age.

Discussion

This study demonstrated a **high burden of vitamin D deficiency (57%)** among patients in a tertiary care hospital, with an overall mean serum level of **21.42 ng/mL**, indicating widespread insufficiency across all age groups. Although **One-Way ANOVA showed no statistically significant differences between age groups (p = 0.289)**, a **significant linear trend (p = 0.043)** revealed a gradual reduction in deficiency from adolescents (74%) to adults (45%), suggesting age-related improvement in vitamin D status.

The findings highlight adolescents as the most vulnerable group. This aligns with evidence from population-based studies reporting high deficiency rates among teenagers due to **rapid skeletal growth, limited outdoor exposure, poor dietary intake, and low awareness of supplementation** (Cho et al., 2026). Similar patterns have been reported in pediatric cohorts where vitamin D insufficiency exceeds 60%, reinforcing adolescence as a critical risk period for hypovitaminosis D.

Biochemically, the study also revealed an elevated mean **PTH level (50.55 pg/mL)** alongside low vitamin D status, suggesting early **secondary hyperparathyroidism**. This inverse relationship is well documented, where declining 25(OH)D levels trigger compensatory PTH elevation to maintain calcium homeostasis. Evidence from clinical studies confirms that even mild vitamin D insufficiency can elevate PTH levels in a substantial proportion of patients, contributing to increased bone turnover and long-term skeletal fragility (Rajab, 2022). This highlights the clinical importance of assessing both vitamin D and PTH simultaneously in hospitalized patients.

From a public health perspective, the persistently high prevalence across all age groups reflects broader systemic issues including **limited sun exposure, indoor lifestyles, poor dietary vitamin D intake, and lack of routine supplementation**. International guidelines recommend targeted screening and supplementation (400–1000 IU/day) for at-risk populations and maintaining serum 25(OH)D above 50 nmol/L to ensure physiological adequacy (Zemp et al., 2025). These recommendations strongly support routine vitamin D screening in tertiary care settings, particularly in South Asian populations where deficiency is endemic.

Overall, despite the absence of statistically significant differences between groups, the observed trends confirm that vitamin D deficiency remains a **pervasive, age-independent but adolescent-predominant public health concern**, warranting early detection and preventive intervention.

Conclusion

The study concludes that vitamin D deficiency is highly prevalent among hospitalized patients in a tertiary care setting, with the majority showing suboptimal serum levels. Although no significant differences were found across age groups or gender, a consistent trend indicates slightly better vitamin D status with increasing age.

These findings emphasize the need for:

- Routine screening of vitamin D in hospital settings
- Preventive supplementation strategies
- Awareness regarding sun exposure and dietary intake

Early identification and correction of deficiency may reduce long-term skeletal and metabolic complications across all age groups.

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