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ORIGINAL ARTICLE

Serum vitamin D status in adults from Peshawar, Pakistan: local burden and public health implications from a hospital-based study

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ABSTRACT

Objectives: To evaluate serum vitamin D levels among adults attending the outpatient clinic at Hayatabad Medical Complex, Peshawar, and to assess the prevalence of deficiency and insufficiency.

Methods: This cross-sectional study was conducted from January to June 2024 at Hayatabad Medical Complex, Peshawar, Pakistan. Using convenience sampling, 101 adults aged 18-70 years attending routine health checks were enrolled. Individuals with chronic kidney or liver disease, malabsorption syndromes, pregnancy/lactation, or current use of vitamin D supplements were excluded. Demographic data and daily sun exposure were recorded through structured questionnaires. Serum 25-hydroxyvitamin D [25(OH)D] levels were measured using high-performance liquid chromatography. Deficiency was defined as <20 ηg/mL, insufficiency as 20–29 ηg/mL, and sufficiency as ≥30 ηg/mL.

Results: Of the 101 participants (49 males, 52 females; mean age 44.9±16.6 years), the mean serum vitamin D level was 30.5±19.4 ηg/mL (range: 4.46-102.12). Vitamin D deficiency was found in 32 (31.7%) participants, insufficiency in 29 (28.7%), and sufficiency in 40 (39.6%). No significant gender-based differences were observed in vitamin D levels or status (p>0.05). A weak positive correlation with sun exposure did not reach statistical significance (p=0.058).

Conclusion: Vitamin D deficiency and insufficiency affected 60% of adults in this hospital-based study from Peshawar-Pakistan, indicating a substantial local burden. These findings have important public health implications and call for targeted public health strategies, including dietary fortification, supplementation, and awareness programs, to reduce the prevalence of hypovitaminosis D.

Keywords: Vitamin D (MeSH); Deficiency (MeSH); Insufficiency (MeSH); Pakistan (MeSH); Serum Levels (MeSH); Public health interventions (Non-MeSH); Hypoalphalipoproteinemias (MeSH).

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INTRODUCTION

Vitamin D, a fat-soluble vitamin crucial for calcium homeostasis and bone health, is increasingly recognized for its broader physiological roles, including immune modulation and cardiovascular protection.[1] Despite abundant sunlight in South Asia, vitamin D deficiency persists as a major public health issue, with prevalence rates varying widely across countries and populations.[2]

Recent studies from Pakistan have reported wide variations in the prevalence of vitamin D deficiency. Gul A, et al., observed a significant association with type 2 diabetes, noting deficiency in 30% of diabetic patients compared to none in controls.[2] A meta-analysis by Mahar B, et al,. estimated an overall pooled prevalence of 78%, with rates reaching 84% among children and adolescents.[3] Similarly, Riaz H, et al., found that among 4,830 randomly selected citizens, 53.5% were vitamin D deficient and 31.2% insufficient, leaving only 15.3% with adequate levels.[4] These variations suggest regional differences across Pakistan, influenced by factors such as urbanization, dietary practices, clothing habits, and predominantly indoor lifestyles.

Internationally, Asian populations consistently demonstrate a high prevalence of vitamin D deficiency. In India, studies report deficiency rates exceeding 70%,[6] while research from China shows comparable trends, particularly in urban populations with limited outdoor activity.[7] Contributing factors include cultural practices such as clothing that restricts sun exposure, diets low in vitamin D-rich foods, and higher skin melanin levels that reduce cutaneous vitamin D synthesis.[1,7-10]

Despite available data from major Pakistani cities, evidence on vitamin D status in Khyber Pakhtunkhwa, particularly Peshawar, remains limited. Assessing regional variations is essential for designing targeted public health interventions and formulating region-specific supplementation strategies. This study was planned to assess serum vitamin D levels among adults in Peshawar, determine the prevalence of deficiency and insufficiency, and compare the findings with national and international data to better define the local burden of this nutritional disorder.

METHODS

This cross-sectional study was conducted at the outpatient department of Medicine, Hayatabad Medical Complex, Peshawar, from January 2024 to June 2024.

The minimum required sample size was calculated as 94, based on an expected prevalence of vitamin D deficiency of 73%,[9] a 95% confidence level, and a 9% margin of error. To account for potential exclusions, a total of 101 participants were recruited. The study was approved by the Institutional Review Board of Hayatabad Medical Complex, Peshawar (IRB app-roval

number: HMC/IRB/2024/001).

The study enrolled adults aged 18–70 years attending the outpatient clinic for routine health checks or non-acute consultations who provided written informed consent. Exclusion criteria included known chronic kidney disease, liver disease, malabsorption syndromes, pregnancy, lactation, current use of vitamin D supplements or medications affecting its metabolism, and acute illness requiring hospitalization.

Demographic data including age, gender, weight, height, and daily sun exposure were collected using structured questionnaires. Sun exposure was recorded as the self-reported average daily outdoor time during daylight hours over the past month, while Body Mass Index (BMI) was calculated as weight (kg)/height (m^2).

Fasting blood samples (5 mL) were collected in plain tubes and centrifuged within 2 hours. Serum 25-hydroxyvitamin D [25(OH)D] levels were measured using a high-performance liquid chromatography (HPLC) system (Agilent 1260 Infinity, USA) with commercial kits (Chromsystems, Germany). The assay showed an inter-assay coefficient of variation <8% and intra-assay variation <5%. Results were expressed in ηg/mL.

Data were analyzed using SPSS version 26.0. Descriptive statistics were presented as means±standard deviations for continuous variables and frequencies/percentages for categorical variables. The Chi-square test was applied for categorical comparisons and the independent t-test for continuous variables. Pearson correlation was used to assess associations between vitamin D levels and continuous variables. A p-value <0.05 was considered statistically significant.

RESULTS

The study included 101 participants with mean age 44.92±16.6 years (range: 23-70 years). The sample comprised 49 (48.5%) males and 52 (51.5%) females. Mean BMI was 25.4±4.2 kg/m^2 and average daily sun exposure was 5.52±2.4 hours. Demographic characteristics are summarized in Table I.

Serum vitamin D levels ranged from 4.46 to 102.12 ηg/mL, with a mean of 30.5±19.4 ηg/mL. Overall, 32 participants (31.7%) were vitamin D deficient and 29 (28.7%) had insufficiency (Table II).

No statistically significant difference was observed in vitamin D levels between males (31.2±18.8 ηg/mL) and females (29.9±19.9 ηg/mL), p=0.742. Similarly, vitamin D status distribution did not differ significantly by gender (χ^2=1.23, p=0.542).

The mean serum vitamin D level was 30.53±19.39 ηg/mL. The mean age of participants was 44.92±16.57 years, with a mean BMI of 25.4±4.2 kg/m^2 and mean daily sun exposure of 5.52±2.39 hours (Table III).

Weak positive correlation was observed between vitamin D levels and daily sun exposure (r=0.189, p=0.058), though this did not reach statistical significance. No significant correlation was found between vitamin D levels and age (r=-0.076, p=0.449) or BMI (r=0.034, p=0.736).

DISCUSSION

This study found that 60% of adults visiting a teaching hospital in Peshawar had suboptimal vitamin D status, with 31% showing deficiency and 29% insufficiency. Only 40% achieved sufficient vitamin D levels (≥30 ηg/mL). The mean serum vitamin D level of 30.5±19.4 ηg/mL indicates borderline adequacy for the overall population.

Our deficiency rate of 31% is notably lower than previous Pakistani studies. Gul A, et al., found that 30% of diabetic patients had vitamin D deficiency in their hospital-based study from Peshawar,[2] while a comprehensive meta-analysis by Mahar B, et al., reported an overall pooled prevalence of 78% across Pakistan, with some subgroups showing rates as high as 84%.3 Riaz H, et al., documented that 53.5% of Pakistani citizens had vitamin D deficiency in their large national survey.[4] This difference may be attributed to our hospital-based sampling from an urban tertiary care

Table I: Demographic Characteristics of study population (n=101)

Characteristic		Value
Age (years), mean±SD		44.92±16.6
Gender, n (%)	Male	49 (48.5)
	Female	52 (51.5)
Body Mass Index (kg/m^2), mean±SD		25.4±4.2
Sun Exposure (hours/day), mean±SD		5.52±2.4

SD: Standard deviation; n: Frequency

Table II: Distribution of serum vitamin D levels (n=101)

Category	Serum Vitamin D Level (ηg/mL)	Number (%)
Deficiency (<20 ηg/mL)	<20	32 (31.7)
Insufficiency (20-29 ηg/mL)	20-29	29 (28.7)
Sufficiency (≥30 ηg/mL)	≥30	40 (39.6)

Table III: Descriptive statistics of study variables (n=101)

Variable	Minimum	Maximum	Mean	Std. Deviation
Vitamin D levels (ηg/mL)	4.46	102.12	30.53	19.39
Age (years)	23	70	44.92	16.57
Body Mass Index (kg/m^2)	17	42	25.4	4.2
Sun exposure (hours/day)	0	8	5.52	2.39

center, potentially selecting a more health-conscious population with better nutritional awareness. Additionally, seasonal variation may contribute to differences, as our study was conducted during winter-spring months when sun exposure patterns differ from other regions. The variation in study populations, methodologies, and geographic locations across these studies may also explain the differing prevalence rates observed.

Compared to other Asian countries, our findings show relatively lower deficiency rates. Studies from India consistently report 70-80% deficiency rates,[6] while research from China demonstrates similar high prevalence patterns.[7] The difference may reflect geographic location, with Peshawar's latitude (34°N) providing more favorable conditions for vitamin D synthesis compared to tropical regions where intense sunlight paradoxically limits exposure due to behavioral adaptations.[11,12]

Despite lower deficiency rates compared to other regional studies, the finding that 60% of participants had suboptimal vitamin D status represents a significant public health concern. Vitamin D insufficiency has been associated with increased risk of osteoporosis,[12,13] cardiovascular disease,[14,15] autoimmune disorders,[16] and infectious diseases.[17] Given Pakistan's high burden of tuberculosis, cardiovascular disease, and osteoporotic fractures, addressing vitamin D deficiency could contribute to reducing these health problems.

Our findings support implementing targeted interventions including:

• Fortification of commonly consumed foods like wheat flour and cooking oil with vitamin D[18]

• Public awareness campaigns about safe sun exposure practices[19]

• Supplementation programs for high-risk groups including elderly, pregnant women, and those with limited sun exposure[10,12]

• Regular screening for vitamin D status in clinical practice.[20,21]

Limitations of the study

Several limitations must be acknowledged. The small sample size and single-center, hospital-based design limit generalizability to the broader Peshawar population. Convenience sampling may have introduced selection bias toward more health-conscious individuals. The study was conducted during winter-spring months, potentially affecting vitamin D levels due to seasonal variation.[22] Self-reported sun exposure assessment may be subject to recall bias. Additionally, we did not collect data on dietary vitamin D intake, use of sunscreen, or indoor/outdoor occupation, which could influence vitamin D status.[23] The influence of obesity on vitamin D bioavailability was not specifically analyzed in our study.[24]

RECOMMENDATIONS

Larger, community-based studies across different seasons are needed to better characterize vitamin D status in Khyber Pakhtunkhwa. Investigation of specific risk factors including dietary patterns, occupational sun exposure, and cultural practices would provide insights for targeted interventions. Cost-effectiveness analyses of different intervention strategies would inform policy decisions. Studies examining the relationship between vitamin D status and specific health outcomes in Pakistani populations would strengthen the evidence base for intervention programs.[25]

CONCLUSION

Vitamin D deficiency and insufficiency were observed in 60% of adults in this hospital-based study from Peshawar, highlighting a significant public health concern, though the rates were lower compared to other Pakistani cities. These findings highlight the need for comprehensive public health strategies including food fortification, targeted supplementation programs, and community awareness initiatives. Regular monitoring of vitamin D status should be integrated into routine healthcare delivery to identify and address this preventable nutritional deficiency.

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AUTHORS' CONTRIBUTION

The Following authors have made substantial contributions to the manuscript as under:

MI & IK: Acquisition of data, drafting the manuscript, approval of the final version to be published

AJ, MMS & MBK: Analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

NS, SJK: Conception and study design, drafting the manuscript, critical review, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request

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