PREVALENCE OF VITAMIN D DEFICIENCY AND ITS CLINICAL CORRELATES AMONG CHILDREN ATTENDING A TERTIARY CARE HOSPITAL IN NORTH INDIA: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Vitamin D deficiency is a widespread public health problem affecting children globally, with significant implications for skeletal health, immunity, and overall growth. Despite abundant sunlight, its prevalence remains high in developing countries like India due to various environmental, nutritional, and socio-cultural factors.

Objectives: To assess the prevalence of vitamin D deficiency among children and to evaluate its association with demographic factors, dietary intake, sunlight exposure, and clinical correlates.

Methods: This hospital-based cross-sectional study was conducted among 110 children aged 1 month to 14 years attending a tertiary care hospital in North India from April to October 2017. Data were collected using a semi-structured questionnaire, and clinical examination was performed. Serum 25-hydroxyvitamin D levels were measured and categorized as deficient (<20 ng/mL), insufficient (20–29 ng/mL), and sufficient (≥30 ng/mL). Statistical analysis was performed using SPSS version 20.0, and associations were assessed using Chi-square test with $p<0.05$ considered significant.

Results: The prevalence of vitamin D deficiency was 52.7%, while 27.3% had insufficiency and 20.0% had sufficient levels. Deficiency was significantly associated with age less than 5 years and rural residence ($p<0.05$). Clinical features such as bone pain, delayed milestones, recurrent infections, and growth retardation were significantly more common among deficient children. Reduced sunlight exposure (<30 minutes/day) and inadequate dietary intake were also significantly associated with vitamin D deficiency ($p<0.05$).

Conclusion: Vitamin D deficiency is highly prevalent among children and is associated with important clinical manifestations and modifiable risk factors. Targeted interventions including awareness, improved nutrition, and adequate sunlight exposure are essential for prevention and early management.

Keywords: Vitamin D deficiency; children; sunlight exposure; nutritional status; clinical correlates; India; pediatric health

INTRODUCTION

Vitamin D deficiency is increasingly recognized as a major global public health problem affecting individuals across all age groups, particularly children. Traditionally associated with skeletal disorders such as rickets, vitamin D is now known to play a crucial role in calcium and phosphorus homeostasis, bone mineralization, immune modulation, and overall growth and development [1]. Despite abundant sunlight in many parts of the world, hypovitaminosis D remains highly prevalent due to lifestyle changes, limited sun exposure, skin pigmentation, and dietary inadequacies [2].

Globally, it is estimated that nearly one billion people suffer from vitamin D deficiency or insufficiency, with children being one of the most vulnerable groups [3]. In pediatric populations, inadequate vitamin D levels are associated not only with rickets but also with increased susceptibility to respiratory infections, impaired growth, delayed motor development, and potential long-term metabolic consequences [4]. Emerging evidence also suggests associations with autoimmune disorders, asthma, and infectious diseases, highlighting its broader clinical significance [5].

In developing countries, including India, the burden of vitamin D deficiency is paradoxically high despite ample sunshine. Studies conducted across different regions of India have consistently demonstrated a high prevalence of hypovitaminosis D among children, ranging from 50% to 90% [6]. Contributing factors include traditional clothing practices, increased indoor activities, urbanization, air pollution, and low dietary intake of vitamin D-rich or fortified foods [7]. Furthermore, darker skin pigmentation reduces cutaneous synthesis of vitamin D, compounding the risk among Indian children [8].

At the regional level, North India presents unique challenges such as seasonal variation in sunlight exposure, particularly during winter months, and socio-cultural practices limiting outdoor activity among children. Additionally, nutritional deficiencies and recurrent infections prevalent in this region may exacerbate the clinical impact of vitamin D deficiency [9]. Despite increasing awareness, routine screening for vitamin D deficiency is not uniformly practiced in pediatric settings, leading to underdiagnosis and delayed intervention.

Locally, in tertiary care hospital settings, children often present with a spectrum of clinical manifestations ranging from overt skeletal deformities to nonspecific symptoms such as fatigue, bone pain, and recurrent infections. However, the correlation between serum vitamin D levels and these clinical presentations remains inadequately explored in many hospital-based studies. There is also limited data examining the association between vitamin D deficiency and demographic, nutritional, and clinical variables in children attending tertiary care centers in North India.

Existing literature has primarily focused on prevalence studies, with fewer studies addressing the clinical correlates and determinants of vitamin D deficiency in pediatric populations. Moreover, variations in study design, population characteristics, and diagnostic cut-offs have resulted in heterogeneity in findings, creating a gap in context-specific evidence necessary for targeted interventions [10]. Understanding these associations is essential for early identification, risk stratification, and implementation of preventive strategies.

Therefore, the present study aims to assess the prevalence of vitamin D deficiency among children attending a tertiary care hospital in North India and to evaluate its clinical correlates. The objectives include determining the proportion of children with vitamin D deficiency and examining its association with demographic characteristics, nutritional status, and clinical presentations.

METHODOLOGY

Study Design: This was a hospital-based cross-sectional observational study conducted to assess vitamin D deficiency and its clinical correlates among children.

Study Setting: The study was conducted in the Department of Pediatrics at a tertiary care hospital in North India, catering to both urban and rural populations.

Study Duration: The study was carried out over a period of six months from April 2017 to October 2017.

Study Population: The study population comprised children attending the pediatric outpatient department (OPD) and those admitted to pediatric wards during the study period.

Inclusion Criteria
- Children aged 1 month to 14 years
- Children whose parents/guardians provided informed consent
- Children who underwent serum vitamin D (25-hydroxyvitamin D) estimation

Exclusion Criteria
- Children with chronic renal, hepatic, or endocrine disorders
- Children on vitamin D supplementation within the last 3 months
- Children with known metabolic bone disease
- Critically ill children where blood sampling was not feasible

Sample Size: The sample size was calculated using the formula for prevalence studies: $n = Z^2 \times p \times q / d^2$
Where:
- $Z = 1.96$ (for 95% confidence interval)
- p = expected prevalence of vitamin D deficiency (assumed 60% based on previous Indian studies)
- $q = 1 – p = 40\%$
- d = allowable error of 10%

The calculated sample size was approximately 92. To account for possible non-response and incomplete data, the sample size was increased to 110 participants.

Sampling Technique: A consecutive sampling technique was employed. All eligible children presenting during the study period and fulfilling the inclusion criteria were recruited until the desired sample size was achieved.

Data Collection Tools & Procedure: Data were collected using a pre-designed, semi-structured questionnaire. Information regarding socio-demographic details (age, gender, residence), dietary habits, sunlight exposure, and clinical symptoms (bone pain, delayed milestones, recurrent infections, growth parameters) was recorded. Clinical examination was performed to assess signs of vitamin D deficiency such as rachitic changes. Blood samples were collected under aseptic conditions, and serum 25-hydroxyvitamin D levels were measured using standardized laboratory methods (chemiluminescence immunoassay). Vitamin D status was classified as deficiency (<20 ng/mL), insufficiency (20–29 ng/mL), and sufficiency (≥30 ng/mL).

Study Variables: The dependent variable was vitamin D status (deficient, insufficient, sufficient). Independent variables included demographic factors (age, sex, residence), nutritional status, dietary intake, sunlight exposure, and clinical features such as bone pain, delayed growth, and recurrent infections. Anthropometric measurements (weight, height) were recorded and nutritional status was assessed using standard WHO growth charts.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. Descriptive statistics were used to summarize the data. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean ±standard deviation. Association between vitamin D status and categorical variables was assessed using the Chi-square test or Fisher's exact test as appropriate. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations: Written informed consent was obtained from parents or guardians of all participating children. Confidentiality and anonymity of participants were maintained throughout the study. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

RESULTS

A total of 110 children were included in the study. The majority of participants were in the 5–10 years age group (38.2%), with a slight male predominance (56.4%). Most children belonged to rural areas (58.2%) (Table 1).

Table 1: Socio-demographic Characteristics of Study Participants (n = 110)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	<5	38	34.5
	5–10	42	38.2
	>10	30	27.3
Gender	Male	62	56.4
	Female	48	43.6
Residence	Urban	46	41.8
	Rural	64	58.2

More than half of the study population (52.7%) was found to be vitamin D deficient, while 27.3% had insufficient levels and only 20.0% had sufficient vitamin D levels (Table 2).

Table 2: Distribution of Vitamin D Status among Children (n = 110)

Vitamin D Status	Serum 25(OH)D Level (ng/mL)	Frequency (n)	Percentage (%)
Deficient	<20	58	52.7
Insufficient	20–29	30	27.3
Sufficient	≥30	22	20.0

Vitamin D deficiency was significantly associated with younger age (<5 years) and rural residence ($p<0.05$). However, no significant association was observed with gender (Table 3).

Table 3: Association of Vitamin D Deficiency with Selected Demographic Factors (n = 110)

Variable	Category	Deficient (n=58)	Non-deficient (n=52)	p-value
Age (years)	<5	24	14	0.04*

	≥5	34	38	
Gender	Male	34	28	0.48
	Female	24	24	
Residence	Urban	18	28	0.02*
	Rural	40	24	

*Statistically significant ($p < 0.05$)

Among clinical features, bone pain, delayed milestones, recurrent infections, and growth retardation were significantly more common in vitamin D deficient children compared to non-deficient children ($p<0.05$) (Table 4).

Table 4: Association of Vitamin D Deficiency with Clinical Features (n = 110)

Clinical Feature	Present (n)	Deficient (n=58)	Non-deficient (n=52)	p-value
Bone pain	36	26	10	0.01*
Delayed milestones	22	16	6	0.03*
Recurrent infections	40	28	12	0.01*
Growth retardation	30	22	8	0.02*

*Statistically significant ($p < 0.05$)

Additionally, children with lower sunlight exposure (<30 minutes/day) and inadequate dietary intake had a significantly higher prevalence of vitamin D deficiency ($p<0.05$) (Table 5).

Table 5: Association of Vitamin D Deficiency with Sunlight Exposure and Dietary Intake (n = 110)

Variable	Category	Deficient (n=58)	Non-deficient (n=52)	p-value
Sunlight Exposure	<30 min/day	38	18	0.01*
	≥30 min/day	20	34	
Dietary Intake	Inadequate	42	20	0.01*
	Adequate	16	32	

*Statistically significant ($p < 0.05$)

DISCUSSION

The present hospital-based cross-sectional study assessed the prevalence of vitamin D deficiency among children and examined its clinical correlates. The findings revealed that more than half of the study population was vitamin D deficient, with significant associations observed with younger age, rural residence, reduced sunlight exposure, inadequate dietary intake, and multiple clinical manifestations such as bone pain, delayed milestones, recurrent infections, and growth retardation.

The high prevalence of vitamin D deficiency (52.7%) observed in this study is consistent with previous Indian studies reporting widespread hypovitaminosis D among children [6,7]. Harinarayan et al. and Ritu and Gupta have emphasized that despite abundant sunlight, factors such as limited outdoor activity, cultural clothing practices, and inadequate dietary intake contribute significantly to this burden in India [6,7]. Comparable findings have also been reported globally; Bener et al.

documented a high prevalence of vitamin D deficiency among children and adolescents, highlighting its widespread nature across both developing and developed countries [11]. The slightly lower prevalence in the present study compared to some reports may be attributed to seasonal variation and differences in study settings.

A significant association between younger age (<5 years) and vitamin D deficiency was observed. Younger children are particularly vulnerable due to increased physiological requirements during rapid growth and dependency on caregivers for nutrition and sunlight exposure. Gordon et al. similarly reported a high prevalence of deficiency among infants and toddlers [10]. Additionally, the biological role of vitamin D in skeletal growth and mineral metabolism further explains this vulnerability, as described in detail by Lips [12].

The study found a higher prevalence of vitamin D deficiency among children from rural areas. While some studies report higher deficiency in urban populations due to sedentary indoor lifestyles, this finding may reflect underlying nutritional inadequacies, lower awareness, and limited access to fortified foods in rural settings [7]. Thus, environmental exposure alone may not be sufficient to maintain optimal vitamin D levels without adequate dietary support.

Clinical correlates such as bone pain, delayed milestones, and growth retardation were significantly associated with vitamin D deficiency. These findings are consistent with established knowledge regarding the role of vitamin D in calcium homeostasis and bone mineralization [1]. Wagner and Greer have highlighted that deficiency during childhood can lead to rickets and impaired musculoskeletal development [4]. The observed association with recurrent infections further supports the immunomodulatory function of vitamin D, as previously described [5].

Reduced sunlight exposure (<30 minutes/day) emerged as a significant determinant of deficiency, reinforcing the importance of cutaneous synthesis as the primary source of vitamin D [2]. Agarwal et al. demonstrated that environmental factors such as air pollution can reduce ultraviolet B penetration, thereby limiting vitamin D synthesis even in sun-rich regions like North India [8]. Similarly, inadequate dietary intake was strongly associated with deficiency, reflecting poor consumption of vitamin D-rich foods.

From a public health perspective, these findings highlight the need for targeted interventions, including awareness programs, dietary modification, food fortification, and supplementation strategies, especially for high-risk groups. Integration of vitamin D screening and supplementation into existing child health programs may be beneficial in reducing the burden.

The strengths of this study include the combined evaluation of biochemical parameters and clinical correlates, enhancing its clinical relevance. However, limitations include its hospital-based design limiting generalizability, cross-sectional nature precluding causal inference, and potential recall bias in dietary assessment. Seasonal variation was also not fully accounted for.

CONCLUSION

The present study demonstrates a high prevalence of vitamin D deficiency among children attending a tertiary care hospital in North India, affecting more than half of the study population. The deficiency was significantly associated with younger age, rural residence, reduced sunlight exposure, inadequate dietary intake, and various clinical manifestations including bone pain, delayed milestones, recurrent infections, and growth retardation. These findings highlight the multifactorial nature of vitamin D deficiency and its substantial clinical impact in pediatric populations. The study underscores the need for increased awareness among caregivers and healthcare providers regarding the importance of adequate sunlight exposure and dietary intake of vitamin D. Routine screening of high-risk groups, especially younger children, and those with suggestive clinical features, should be considered. Public health interventions such as food fortification, nutritional education, and supplementation programs may play a crucial role in reducing the burden of vitamin D deficiency. Early identification and timely intervention are essential to prevent long-term skeletal and systemic complications.

DECLARATIONS

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