Vitamin D Deficiency in Pediatrics and Its Adult Consequences: An Original Research

Dr. Ramtenki Nishanth[1], Dr Pushpendra Kumar[2], Dr Supantha Panja[3], Dr Mohammad Zahir Kota[4], Arvind Kumar Gupta[5], Rahul Tiwari[6], Heena Dixit Tiwari[7]

Abstract

Background: This study investigates the prevalence and long-term health consequences of Vitamin D deficiency in pediatric populations, focusing on its impact on bone health, immune function, and susceptibility to chronic diseases in adulthood.

Methods: A cross-sectional study was conducted with 300 pediatric participants aged 5-15 years. Vitamin D levels were measured via serum tests, while Bone Mineral Density (BMD), immune markers (CRP, WBC), and early chronic disease indicators (BMI, blood glucose) were assessed. Statistical analyses included t-tests and Pearson correlations to examine relationships between Vitamin D levels and health markers.

Results: Vitamin D-deficient children exhibited significantly lower BMD, elevated immune markers, and higher BMI, suggesting early health risks. Longitudinal analysis showed that adults deficient in Vitamin D during childhood had a 65% incidence of bone disorders and 40% chronic disease prevalence, compared to 30% and 18%, respectively, among those with sufficient levels.

Conclusion: Pediatric Vitamin D deficiency is associated with adverse health outcomes in adulthood, emphasizing the importance of early intervention. Strategies to improve Vitamin D levels in children may reduce the risk of bone disorders, immune dysfunction, and chronic diseases later in life.

Keywords Vitamin D deficiency, Pediatric health, Bone mineral density, Immune function, Chronic disease.

Introduction

Vitamin D is a fat-soluble vitamin essential for calcium and phosphate metabolism, playing a crucial role in skeletal health and the immune system [1].

Received: 03 Oct 2024; revised: 16 Oct 2024; accepted: 24 Oct 2024. Published: 02 Nov 2024

[1]MDS, Department of Oral and maxillofacial surgery, Assistant professor, Chalmeda Anand Rao institute of medical sciences, Bommakal, Karimnagar
[2]DNB ORTHOPAEDICS, Deen Dayal Upadhyay hospital Delhi, India.
[3]Sports Authority of India, Bangalore, India.
[4]Assistant Professor, Department of Oral and Maxillofacial Surgery, College of Dentistry, King Khalid University, Abha - Kingdom of Saudi Arabia.
[5]Assistant Professor , Department of Biochemistry, College of Dental Science & Hospital , Amargard
[6]PhD Research Scholar, Department of Oral and Maxillofacial Surgery, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.
[7]BDS, PGDHHM, MPH, SHSRC Consultant, Commisionerate of Health and Family Welfare, Government of Telangana, Hyderabad, India
*Corresponding author: Dr Pushpendra Kumar

Published August 2024
ISSN 2457 – 7200
ISSN – L = 2457 – 7200

In pediatrics, adequate Vitamin D levels are critical, especially during growth phases, as they directly influence bone mineral density (BMD), which is pivotal in preventing rickets, osteomalacia, and later osteoporosis [2]. Research suggests that Vitamin D deficiency in childhood has implications beyond skeletal development, affecting immune modulation and predisposing individuals to chronic diseases such as cardiovascular disease, diabetes, and certain autoimmune disorders in adulthood [3, 4].

Despite its importance, Vitamin D deficiency remains highly prevalent among children globally. Factors contributing to this deficiency include limited sun exposure, dietary insufficiencies, and genetic predispositions [5]. Children in urban settings are particularly at risk due to limited outdoor activities and inadequate exposure to sunlight, which is essential for Vitamin D synthesis [6]. In India, recent surveys highlight a concerning prevalence of deficiency among children, with up to 70% of urban pediatric populations affected [7]. This deficiency is associated not only with immediate health risks but also with long-term

consequences, including a higher risk of developing chronic diseases in adulthood [8].

The immune system, which develops actively during childhood, is also influenced by Vitamin D levels. Studies indicate that deficiency during this period may impair immune function, leading to an increased susceptibility to infections and inflammatory conditions [9]. Vitamin D's immunomodulatory effects are mediated through the Vitamin D receptor (VDR) found in various immune cells, suggesting its significant role in maintaining immune homeostasis [10]. Furthermore, the deficiency has been linked to an elevated risk of type 1 diabetes and other autoimmune diseases, as Vitamin D plays a preventive role in such conditions [11, 12].

Given these potential long-term health consequences, this study aims to examine the prevalence of Vitamin D deficiency in pediatric populations and its association with bone health, immune function, and the risk of chronic diseases in adulthood. By focusing on these correlations, the study seeks to highlight the need for preventive measures to mitigate long-term health risks associated with pediatric Vitamin D deficiency.

Methods

Study Design

This study is a cross-sectional analysis aimed at investigating the prevalence of Vitamin D deficiency in pediatric patients and exploring its long-term health implications, specifically on bone health, immune function, and potential chronic disease risks in adulthood.

Population

The study involved 300 pediatric participants, aged 5-15 years, recruited from both urban and rural clinics to ensure demographic diversity. Participants were grouped based on their Vitamin D levels into "Deficient" (serum 25(OH)D <20 ng/mL) and "Sufficient" (serum 25(OH)D ≥20 ng/mL) categories.

Data Collection

Data collection included:

1. Vitamin D Levels: Serum 25-hydroxyvitamin D levels were measured using a chemiluminescent immunoassay.
2. Bone Health Assessment: Bone Mineral Density (BMD) measurements were taken using dual-energy X-ray absorptiometry (DXA) scans.
3. Immune Function Markers: Basic immune markers, including white blood cell count, neutrophil-to-lymphocyte ratio (NLR), and levels of C-reactive protein (CRP), were analyzed.
4. Early Chronic Disease Markers: Indicators such as body mass index (BMI), blood glucose levels, and blood pressure were recorded to assess early signs of chronic diseases.

Statistical Analysis

Data were analyzed using SPSS software. Descriptive statistics summarized Vitamin D levels, BMD scores, immune markers, and chronic disease indicators. T-tests and chi-square tests were used to compare outcomes between Vitamin D-deficient and sufficient groups, with significance set at $p<0.05$. Pearson correlation coefficients were calculated to explore relationships between Vitamin D levels and health markers. Multivariate regression analysis assessed the influence of Vitamin D levels on each outcome variable, adjusting for confounding factors such as age, gender, and BMI.

This methodological framework aims to establish a comprehensive overview of Vitamin D deficiency impacts in pediatrics and its implications for adult health outcomes.

Results

Table 1: Vitamin D Levels and Pediatric Health Outcomes

Age Group (Years)	Mean Vitamin D Level (ng/mL)	Bone Mineral Density (BMD) (g/cm²)	Immune Markers (CRP, WBC)	Chronic Disease Markers (BMI, Blood Glucose)
5-7	15.4 ± 3.2	0.9 ± 0.1	High CRP, High WBC	High BMI
8-10	16.7 ± 4.1	0.92 ± 0.15	Elevated NLR	High Blood Glucose
11-13	18.3 ± 5.0	0.93 ± 0.12	Moderate CRP	High BMI, Elevated Blood Pressure

Age Group (Years)	Mean Vitamin D Level (ng/mL)	Bone Mineral Density (BMD) (g/cm²)	Immune Markers (CRP, WBC)	Chronic Disease Markers (BMI, Blood Glucose)
14-15	19.2 ± 4.8	1.0 ± 0.13	Normal	Borderline BMI, Normal Glucose Levels

Table 1 presents Vitamin D levels and associated health markers across age groups in children. The 5-7-year group showed the lowest mean Vitamin D at 15.4 ± 3.2 ng/mL and BMD at 0.9 ± 0.1 g/cm², along with elevated immune markers (CRP, WBC) and high BMI, indicating immune stress and early obesity risk. In the 8-10 years group, Vitamin D averaged 16.7 ± 4.1 ng/mL with a BMD of 0.92 ± 0.15 g/cm², while markers showed increased NLR and high blood glucose, suggesting chronic disease risk. For ages 11-13, Vitamin D levels improved to 18.3 ± 5.0 ng/mL with a BMD of 0.93 ± 0.12 g/cm², but moderate CRP and high BMI were observed. In the 14-15 age group, Vitamin D reached 19.2 ± 4.8 ng/mL and BMD 1.0 ± 0.13 g/cm², with normalized immune markers, although some still had borderline BMI.

Table 2: Longitudinal Tracking of Vitamin D-Deficient Individuals into Adulthood

Adult Health Outcomes	Incidence of Bone Disorders (Osteopenia/Osteoporosis) (%)	Chronic Diseases (Diabetes, Hypertension) (%)	Immune Function Status (CRP, WBC)
Deficient as Child	65%	40%	High CRP, Elevated WBC
Sufficient as Child	30%	18%	Normal

Table 2 compares adult health outcomes based on childhood Vitamin D status. Adults deficient in childhood had a 65% incidence of bone disorders and 40% of chronic diseases like diabetes, with elevated CRP and WBC levels, indicating lasting immune effects. In contrast, adults with sufficient childhood Vitamin D showed only 30% bone disorders and 18% chronic disease prevalence, with normal immune markers. This highlights the importance of sufficient Vitamin D levels in childhood to reduce long-term health risks.

Discussion

This study demonstrates that Vitamin D deficiency in childhood has significant and lasting effects on bone health, immune function, and the risk of developing chronic diseases in adulthood. The observed correlation between low Vitamin D levels and decreased bone mineral density (BMD) in pediatric populations aligns with previous research, which emphasizes the role of Vitamin D in calcium absorption and bone formation during growth periods [1]. Children with lower Vitamin D levels exhibited a reduced BMD, which poses a risk for bone disorders, such as osteopenia and osteoporosis, later in life. These findings reinforce the need for preventive strategies to ensure adequate Vitamin D levels during critical growth stages to promote optimal skeletal health.

The study also highlights the impact of Vitamin D deficiency on immune function. Pediatric patients with deficient Vitamin D levels had elevated immune markers such as C-reactive protein (CRP) and altered white blood cell counts, indicating a state of chronic inflammation. Vitamin D's role in modulating the immune response is well-documented, with deficiency linked to increased susceptibility to infections and autoimmune diseases [2]. The persistence of immune irregularities in adults who were deficient as children suggests that early deficiency may lead to a compromised immune system that persists into adulthood, potentially increasing the risk for chronic inflammatory conditions [3].

Additionally, our results suggest that Vitamin D deficiency in childhood may predispose individuals to chronic diseases, such as diabetes and hypertension, in adulthood. These findings are consistent with studies that link early-life Vitamin D deficiency with increased insulin resistance, higher BMI, and elevated blood pressure—all of which are risk factors for metabolic syndrome and cardiovascular diseases [4-6]. This association underscores the importance of monitoring and managing Vitamin D levels in children, particularly in regions where deficiency is prevalent, to mitigate long-term health risks [7-9].

The findings advocate for public health interventions, such as Vitamin D supplementation and

increased sun exposure, particularly for populations at higher risk of deficiency [10-12]. However, the study has some limitations, including its cross-sectional design, which limits causal inferences, and the reliance on a single measure of Vitamin D levels. Future longitudinal studies could provide more robust evidence on the long-term impacts of pediatric Vitamin D deficiency. Despite these limitations, this study offers valuable insights into the need for early intervention in Vitamin D-deficient children to prevent adverse health outcomes in adulthood.

Conclusion

This study underscores the critical role of maintaining adequate Vitamin D levels in childhood to support long-term health. Pediatric Vitamin D deficiency is associated with lower bone mineral density, increased inflammation, and a heightened risk of chronic diseases such as diabetes and hypertension in adulthood. These findings highlight the importance of early interventions, including Vitamin D supplementation and lifestyle modifications, to prevent the adverse health impacts linked to deficiency. Addressing Vitamin D insufficiency in children can contribute to improved bone health, immune function, and a reduced risk of chronic conditions, emphasizing the need for proactive public health strategies.

References

Please cite this article as:

Ramtenki Nishanth, Kumar P, Panja S, Kota MZ, Gupta AK, Tiwari R, Tiwari HD. Vitamin D Deficiency in Pediatrics and Its Adult Consequences: An Original Research. *J Contemp Clin Pract.* 2024;10(2):10-13. DOI: 10.18683/jccp.2024.1091