East African Scholars Journal of Medical Sciences
Abbreviated Key Title: East African Scholars J Med Sci
ISSN: 2617-4421 (Print) & ISSN: 2617-7188 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-7 | Issue-10 | Oct-2024 | DOI: https://doi.org./10.36349/easms.2024.v07i10.007

Original Research Article

Prevalence of Vitamin D Deficiency in Children Aged Between 1 to 16 Years: An Observational Study

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Article History
Received: 17.09.2024
Accepted: 23.10.2024
Published: 28.10.2024

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: ***Introduction:*** Vitamin D is crucial for bone growth, mineralization, and various metabolic processes in the body. Consequently, a deficiency or insufficiency of this vitamin can lead to long-term consequences, especially in children. Therefore, this study aimed to assess the prevalence of vitamin D deficiency vitamin D deficiency in children aged between 1 to 16 years. ***Methods:*** This was an observational study conducted in the Department of Paediatrics, Dr. Sirajul Islam Medical College & Hospital, Dhaka & Ad-Din Akij Medical College Hospital, Khulna, Bangladesh during the period from July 2023 to July 2024. The study enrolled children aged 1 to 16 years from the pediatric department, excluding those with specific health issues. Data analysis was conducted with SPSS 23, and ethical approval was obtained from Dr. Sirajul Islam Medical College & Hospital and Ad-Din Akij Medical College Hospital. ***Results:*** In our study, we included 100 children with vitamin D deficiency symptoms who attended the paediatrics department of our study institutions. Participants were categorized into four age groups: 1-3 years (30%), 4-6 years (15%), 7-10 years (21%), and 11-16 years (34%). The sample comprised 59% females and 41% males, with an average age of 12.84 years. Most were from middle-class families (39%), and 48% were in primary school. Common health issues included leg pain (58%), growth retardation (47%) and muscle pain/bone pain (39%). Vitamin D deficiency was prevalent, with rates of 50.00% in 1-3 years, 53.33% in 4-6 years, 47.62% in 7-10 years, and 61.76% in 11-16 years, indicating increased insufficiency with age. ***Conclusion:*** This study shows that vitamin D deficiency is high among our study children. A comprehensive action plan, including supplementation and food fortification, is crucial to prevent this deficiency in Bangladesh.

Keywords: Prevalence, Vitamin D, Deficiency, Children.

INTRODUCTION

Vitamin D is referred to as "the Sunshine Vitamin". For the majority of people, sunlight exposure is the main source of vitamin D. When exposed to ultraviolet (UV) radiation, vitamin D3 is generated in human skin through photoisomerization of 7-dehydrocholesterol (7DHC), which eventually creates pre-vitamin D3 [1]. Exposure to the amount of sunshine that generates a mild pinkness of the skin after 24 hours (1MED) is similar to taking around 20,000 IU of vitamin D [2]. Some foods naturally contain vitamin D, including egg yolk, liver, cod liver oil, mushrooms, milk, and dairy products. However, these foods are insufficient to meet the requirement of vitamin D in children [3].

Vitamin D deficiency (VDD) is one of the most frequent micronutrient deficits among children and adults worldwide [4]. It has re-emerged as a public health concern in both developing and developed nations, even though it was supposed to be eliminated [5-7]. Vitamin D deficiency affects 30% to 50% of children worldwide, whereas incidence in tropical areas such as India varies from 70% to 100% across all age categories [8,9]. Rickets is just the tip of the iceberg in terms of vitamin D insufficiency in children. [10] Even seemingly healthy children can suffer from a vitamin D deficiency, which can have serious health consequences. It may present with linear growth retardation (or growth failure), limb pain, muscular weakness, lethargy, irritability, hypocalcemic convulsions, and recurring respiratory tract infections during infancy [11, 12].

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Additionally, it was reported that Subclinical VDD has been associated with an increased risk of developing several chronic noncommunicable diseases in adulthood, including diabetes, autoimmune disease, ischemic heart disease, hypertension, cancer, and multiple sclerosis [13-15].

The prevalence of vitamin D deficiency in Bangladesh is commonly underestimated since it was thought to be low risk due to cutaneous vitamin D production in response to excessive solar exposure. According to a recent study, vitamin D deficiency is rather common in Bangladesh, with a high prevalence rate of 80.0% [16]. Vitamin D insufficiency has been reported to be caused by several significant factors, including an indoor lifestyle, inadequate exposure to sunlight, air pollution, skin color, the mother's and child's clothing coverings, and the mother's educational background [17-19].

Nevertheless, there is no clear threshold for the ideal blood levels of 25-hydroxyvitamin D. The majority of experts agree that a 25-hydroxyvitamin D level of less than 50 nmol per liter, or 20 ng/ml, is indicative of vitamin D deficiency. [20] The ideal serum 25(OH)D level for overall health in children is still unknown because there are fewer outcome data available. A relative deficiency of vitamin D in children can be defined as a level of 25-hydroxyvitamin D between 50 and 75 nmol/L [21].

The prevalence of vitamin D insufficiency was higher among American children aged 6–11 years (73%) than those aged 1–5 years (63%); among girls (71%) than boys (67%); and among non-Hispanic black (92%) and Hispanic (80%) children than non-Hispanic white children (59%). [16] According to several additional research, between 30% and 50% of children in Australia, Turkey, India, and Lebanon may have vitamin D insufficiency [16,21,22].

Bangladesh is thought to be in danger of rickets and other health issues linked to vitamin D deficiency, based on reports from other Asian nations. Therefore, our study aimed to determine the prevalence of vitamin D deficiency in children aged 1 to 16 years.

METHODOLOGY & MATERIALS

This was an observational study conducted in the Department of Paediatrics, Dr. Sirajul Islam Medical College & Hospital, Dhaka & Ad-Din Akij Medical College Hospital, Khulna, Bangladesh during the period from July 2023 to July 2024. In our study, we included 100 children with vitamin D deficiency symptoms who attended the paediatrics department of our institutions.

These are the following criteria to be eligible for enrollment as our study participants:

Inclusion Criteria:

a) Children ages ranged from 1 to 16 years
b) Children with leg pain
c) Children with growth retardation
d) Children with muscle and bone pain.

Exclusion Criteria:

a) Children with any history of acute illness (e.g., bronchiolitis, acute asthma, gastroenteritis, dengue fever, etc.)
b) Children with other chronic illnesses such as typhoid fever, tuberculosis, any congenital disease, and genetic disease
c) Children having any endocrine disorder
d) Parents who were unwilling to participate were excluded from our study.

Data Collection: Digital scales were used to assess weights and a wall-mounted stadiometer was used to measure each participant's height. Measurements of anthropometry were taken in accordance with standard operating procedure (SOP). A questionnaire was used to gather data on socioeconomic status.

25-hydroxyvitamin D measurement: The most accurate indicator of total vitamin D status is the measurement of circulating levels of 25-hydroxyvitamin D [25(OH)D]. Serum 25 (OH)D can be measured using several accepted techniques. The most widely used method in Bangladesh for measuring serum 25 (OH)D levels is the direct enzyme-linked immunosorbent assay technique, which is what we employed in our investigation. We defined sufficient as 30-100 ng/ml, insufficient as 10-29 ng/ml, and deficient as less than 10 ng/ml in our investigation.

Statistical Analysis: All data were recorded systematically in preformed data collection form. Quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage. Statistical analysis was performed by using SPSS 23 (Statistical Package for Social Sciences) for Windows version 10. The study was approved by the Ethical Review Committee of Dr. Sirajul Islam Medical College & Hospital and Ad-Din Akij Medical College Hospital.

RESULTS

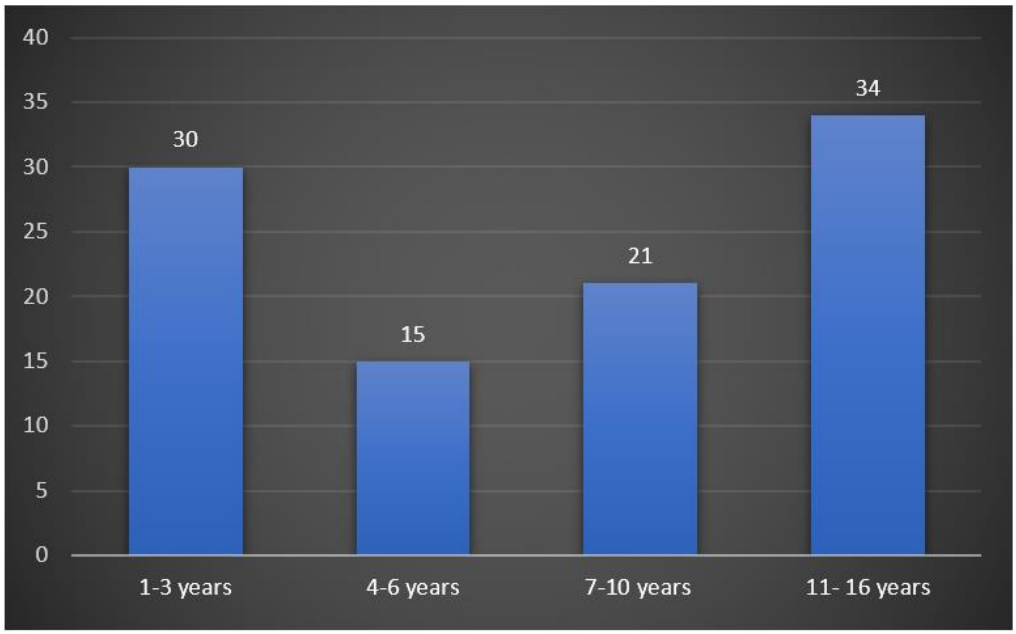

Figure 1: Distribution of study participants by their age

Figure 1 shows that the participants were divided into four groups according to their ages: 1-4 years, 5-8 years, 9-12 years, and 13 - 16 years. Most of the participants (34%) were in the 13-16 age group, followed by 30% in the 1-3 age group, 21%, and 15% were in the 7-10 and 4-6 years age groups respectively.

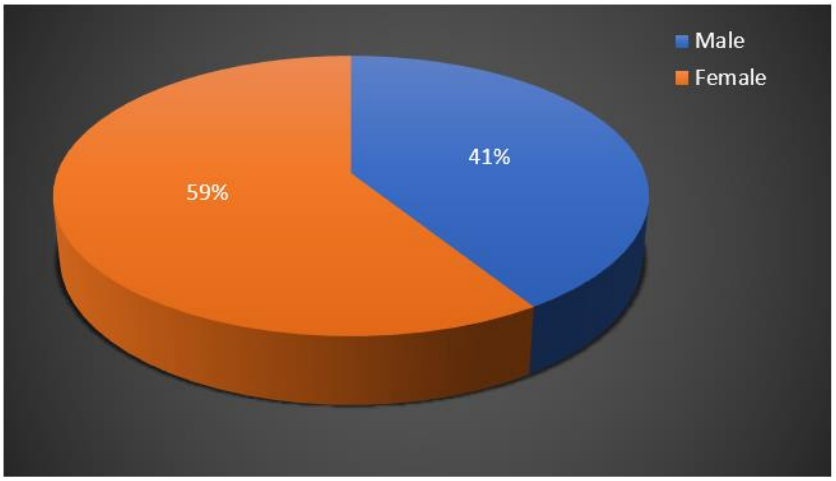

Figure 2: Distribution of our study participants by gender

The pie chart shows that the majority (59%) of the children were female compared to male (41%). The male and female ratio was 1:1.4 in the study.

Table 1: Characteristics of the study participants

Characteristics	**n**	**%**
Mean age (years)	12.84 ± 3.98	
Height (cm)	110.85 ± 52.86	
Weight (kg)	28.14 ± 19.31	
BMI (kg/m^2)	21.9 ± 7.27	
Socioeconomic status (monthly income)		
Lower class (≤12500 tk)	29	29.00
Middle class (12500-21500 tk)	39	39.00
Upper class (≥21500 tk)	32	32.00

Children education level		
Preschool	24	24.00
Primary	48	48.00
Secondary	28	28.00
Mothers' education		
Illiterate	22	22.00
SSC	26	26.00
HSC	34	34.00
Graduate or above	18	18.00
Symptoms		
Muscle pain/bone pain	39	39.00
Tingly sensation in hands or feet	11	11.00
Leg pain	58	58.00
Growth retardation	47	47.00

Table 1 shows that the mean age of our participants was 12.84 ± 3.98 years. The mean height was 110.85 ± 52.86 cm, and weight was 28.14 ± 19.31 kg. The majority (39%) of children belonged to middle-class families. Most children were in the primary (48%) level, followed by 28% in the secondary level. Maximum (34%) mothers of the children completed HSC. Most of the participants (58%) had leg pain, followed by growth retardation (47%) and muscle pain/bone pain (39%).

Table 2: Serum 25-hydroxyvitamin D levels by age group

Age	<10 ng/ml		10 - 29 ng/ml		30 - 100 ng/ml	
	N	P (%)	N	P (%)	N	P (%)
1-3 years (n=30)	15	50.00	9	30.00	6	20.00
4-6 years(n=15)	8	53.33	4	26.67	3	20.00
7-10 years (n=21)	10	47.62	8	38.10	3	14.29
11- 16 years (n=34)	21	61.76	8	23.53	5	14.71

Table 2 shows the distribution of serum 25-hydroxyvitamin D levels according to different age groups. Among the 1-3 years group, the majority (50%) were deficient, 30% were insufficient and 20% were sufficient. Among 4-6 years, 53.33% were deficient, 26.67% were insufficient and only 20% were sufficient. Among the 7-10 years group, 47.62% were deficient, 38.10% were insufficient and only 14.29% were sufficient. Among the 11 - 16 years group, 61.76% were deficient, 23.53% were insufficient and 14.71 % were sufficient. Serum 25-hydroxyvitamin D deficiency rate is very high among our study children and insufficiency is increased as age progresses.

Table 3: Anthropometry measurements of study participants by Serum 25-hydroxyvitamin D levels

Anthropometry	<10 ng/ml	10 - 29 ng/ml	30 - 100 ng/ml
Height (cm)	102.62 ± 50.26	114.81 ± 52.62	119.85 ± 51.84
Weight (kg)	24.57 ± 19.34	28.14 ± 18.29	29.74 ± 20.36

Table 2 shows that the mean height and weight were lower in the deficient group (<10 ng/ml), compared to the insufficient group (10 - 29 ng/ml) & sufficient group (30 - 100 ng/ml). Children in the sufficient group had a normal growth of height and weight, unlike the children from the other two groups.

DISCUSSION

In this study, we discovered that approximately 55% of the children evaluated are vitamin D deficient, as defined by serum 25-hydroxyvitamin D levels below 10 ng/ml. This study indicates that the vitamin D status among the children is inadequate, placing Bangladeshi children at risk for vitamin D deficiency and its associated health consequences.

Our results show that serum 25-hydroxyvitamin D levels in the pediatric population decline with age, leading to an increased prevalence of vitamin D deficiency as children grow older. Antenatal vitamin D supplementation has been shown to enhance both maternal and cord blood 25(OH)D levels. [23] Another study highlights that Bangladeshi infants are born with insufficient vitamin D levels, linked to low maternal antenatal 25(OH)D levels observed in both urban and rural women of reproductive age. [24] In India, a study found that 51% of three-month-old breastfed infants had 25(OH)D levels below 37.5 nmol/L, with a mean level of 49 nmol/L. [25] Similarly, in Pakistan, a group of six-month-old breastfed infants had a mean 25(OH)D level of 25 nmol/L (SD 18), with 71% of infants under three months showing levels below 40 nmol/L. [26] Additionally, a Middle Eastern study reported that

among 78 breastfed infants aged 1 to 4 months born to women with low milk intake and who covered their skin when outdoors, 82% had 25(OH)D levels below 25 nmol/L, with a median level of 11.5 nmol/L [27]. Compared to American children, our data indicates a significantly higher prevalence of vitamin D deficiency. The American Academy of Pediatrics updated its recommendations in November 2008, suggesting that all children receive 400 IU/day of vitamin D from birth through adolescence [28].

The mean level of 25(OH)D among younger children was notably higher than in any other age group. Parents often provide vitamin D-fortified formula to their children under two years, as per feeding guidelines for infants and toddlers [29]. However, there are no formal recommendations for vitamin D supplementation for children older than two years, leading to a decline in supplementation as children age. This may explain the lower mean serum 25(OH)D levels observed in children aged 6 to 16 years compared to younger children, as well as the higher prevalence of vitamin D deficiency in school-aged children compared to preschoolers. While the prevalence of 25(OH)D < 25 nmol/L was comparable to that of American children, Zhu *et al.*, had a significantly higher prevalence of vitamin D level at < 50 nmol/L in most stages, including 2–5 years (22% vs. 14%), 6–11 years (40% vs. 20%), and adolescents (46% vs. 28.8%) [18,19,29].

Zhu *et al.*, also noted that serum 25(OH)D levels among children aged 0-5 years during winter were comparable to those in summer and autumn, significantly higher than in spring. This may be attributed to the emphasis on vitamin D supplementation for young children during the winter months when sunlight exposure is limited and children are typically dressed in multiple layers outdoors. Furthermore, serum 25(OH)D levels were lower in American adolescent girls compared to boys [30].

In this study, the prevalence of vitamin D deficiency was found 50% in the 1-3 years age group and 61.76% in the 11-16 years group. Most of the cases of insufficiency were present in 1-3 years (23.53%) & 11-16 years (30%) age group.

Since vitamin D deficiency is more severe in Bangladeshi children than in children from the United States and many other ethnic groups, we recommend that vitamin D supplementation should be given to the country's pediatric population.

Limitations of the study

We took a small sample size due to our short study period. Our study did not represent the whole paediatric population in Bangladesh. After evaluating those children, we did not follow up with them for the long term and did not know other possible interference that may happen in the long term with these children.

CONCLUSION AND RECOMMENDATIONS

In our study, we found the prevalence of vitamin D deficiency and insufficiency among children, particularly those aged 8-16 years. Given the importance of vitamin D for growth and development, a comprehensive action plan is essential. We recommend extending vitamin D supplementation to adolescents in Bangladesh and enhancing awareness about its importance. Additionally, fortifying foods such as milk, oil, yogurt, and cereal, along with ensuring quality control of these fortifications, is essential for preventing vitamin D deficiency in the country.

So further study needs to be done to validate the findings of our study in the national representative samples.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite This Article: Shahina Pervin, Farhana Karim, Md. Bellal hossain, Naznin Akhter (2024). Prevalence of Vitamin D Deficiency in Children Aged Between 1 to 16 Years: An Observational Study. *East African Scholars J Med Sci, 7*(10), 427-432.