Original Article

Vitamin D Deficiency among the Children: A Silent Epidemic in a Selected Rural Area of Bangladesh

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Received: 10 October 2018 Accepted: 30 April 2020
doi: https://doi.org/10.3329/jemc.v10i2.53534

Abstract

***Background**: Vitamin D deficiency is widespread among the children worldwide. Most of the third world countries have the high prevalence of vitamin D deficiency, especially among the children. Unfortunately very less research work has been conducted on this subject and Bangladesh is no exception to this. Vitamin D deficiency among the Bangladeshi children has not been investigated at a level that could bring the phenomenon to the fore of the concerned stakeholders and policy makers. **Objective**: To assess the prevalence of vitamin D deficiency among children in Kaliakoir Upazila, Gazipur District, Bangladesh. **Materials and Methods**: A cross-sectional study was conducted in children aged 0 month to <18 years attending Upazila Health (pediatrics) Complex and community clinics with minor illness. After obtaining informed written consent, venous blood was taken and serum 25(OH) D levels were determined by direct enzyme linked immunosorbent assay. Serum 25(OH) D was categorized as deficient (<10 ng/mL), insufficient (10–29 ng/mL) and sufficient (30–100 ng/mL). **Results**: Deficient serum 25(OH) D level was found in 30.15% infants of up to one year age group, 35% in 2–5 years, 35.21% in 6–11 years and 37.21% in 12–16 years age group. Insufficient level was found in 52.38% in infants up to one year, 50% in 2–5 years, 54.93% in 6–11 years and 59.30% in 12–16 years age group. **Conclusion**: The prevalence of vitamin D deficiency and insufficiency among children in rural Bangladesh is high. The study recommends that vitamin D supplementation in rural Bangladeshi children should be formally launched from first day of birth up to minimum adolescence.*

***Key words**: Vitamin D Deficiency; Serum 25(OH)D; Children; Rural Bangladesh*

J Enam Med Col 2020; 10(2): 93−98

Introduction

Once foods were fortified with vitamin D and rickets appeared to have been conquered, many health care professionals thought the major health problems resulting from vitamin D deficiency had been resolved. However, rickets can be considered as the tip of the vitamin D–deficiency iceberg. In fact, vitamin D deficiency remains common in children and adults. In utero and during childhood, vitamin D deficiency can cause growth retardation and skeletal deformities and may increase the risk of hip fracture later in life. Vitamin D deficiency in adults can precipitate or exacerbate osteopenia and osteoporosis, cause osteomalacia and muscle weakness, and increase the risk of fracture.

Vitamin D deficiency prevails in epidemic proportions all over the Indian subcontinent, with a prevalence of 70–100% in the general population.[1] Vitamin D deficiency is epidemic, yet it is the most underdiagnosed and undertreated nutritional deficiency in the world. Vitamin D deficiency is widespread in individuals irrespective of their age, gender, race and geography.

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Vitamin D deficiency is common in worldwide, even in tropical countries like Bangladesh which gets enough sunlight. Now a days, vitamin D deficiency is a silent and neglected global public health issue. Almost one billion people in the world suffer from vitamin D deficiency or insufficiency.[2] Vitamin D is known as 'the sunshine vitamin'. The major source of vitamin D for most human is exposure to sunlight. With exposure to ultraviolet (UV) radiation, vitamin D3 is synthesized in human skin via the photoisomerization of 7-dehydrocholesterol (7DHC) which ultimately produces pre-vitamin D3.[3] There prevails a misconception that vitamin D deficiency is prevalent only in western countries where there is less sunlight, but in reality, the scenario is different. It is generally perceived that hypovitaminosis D is less frequent in tropical countries, as cutaneous vitamin D synthesis is stimulated by exposure to sun. Surprisingly 80% of the apparently healthy population is deficient in vitamin D (<20 ng/mL) and up to 40% of the population is severely deficient (<10 ng/mL) in South Asia.[4]

Vitamin D deficiency is responsible for rickets among children. Rickets is widespread in regions in Northern China where 42% of infants were found to suffer from rickets which occur as a consequence of vitamin D deficiency during winter and spring seasons.[5] Vitamin D deficiency is a silent and neglected global public health issue. Almost one billion people in the world suffer from vitamin D deficiency or insufficiency.[2] In Northern Pakistan, despite abundant sunlight, rickets was a common problem in infants and children due to malnutrition, lack of awareness and antenatal factors.[6] High prevalence of vitamin D deficiency in South Asia can be explained by skin pigmentation and traditional clothing. Moreover, air pollution and limited outdoor activity is also responsible for this in the urban population.[7] In Japan, the status of vitamin D is relatively better than other regions of South Asia due to high sea fish consumption.[8]

The vitamin D receptor is distributed in the osteoblasts, small intestine, colon, activated T and B lymphocytes, islet cells, mononuclear cells and most other organs in the human body including the brain, heart, skin, gonads, prostate, and breast.[9] In the recent times, there has been lots of studies regarding the influence of vitamin D on extra-skeletal health, besides skeletal health.[10-16] Hypovitaminosis D may be associated with diabetes mellitus[11], cancers[12], autoimmune diseases[13], infectious diseases[14], multiple sclerosis[15], and other cardiovascular diseases[16]. Vitamin D is a fat soluble vitamin. It functions like a hormone. This is an essential nutrient and essential for maintaining calcium homeostasis. It has got anti-inflammatory and immune-modulating properties. The major forms of this vitamin are D2 (ergocalciferol) and D3 (cholecalciferol). Fifteen to twenty minutes of daily sun exposure without sunscreen in lower Midwestern and Southern latitudes between 10 am and 3 pm in bare chest and back is usually sufficient to ensure adequate synthesis of vitamin D metabolites (UV wavelength 270–300 nm).[17] The large excesses of vitamin D3 from prolonged sun exposure are destroyed in the skin making no vitamin D toxicity. The other negative effects are sunburn, premature skin aging, skin damage, skin cancer, dehydration, heat stress or heat stroke due to long time exposure of UV light from the sun.[2]

According to most expert opinion, vitamin D deficiency is defined as a 25-hydroxyvitamin D level of less than 50 nmol per liter[18], which is equivalent to 20 ng/mL. In children, due to fewer outcome data, the optimal level of serum 25(OH)D for general health is not known yet. Moreover, it is controversial than in adults.[19] Although there is no definite cut-off point for the optimal levels of 25-hydroxyvitamin D as measured in serum[20], it is evident that biochemical squeale of vitamin D deficiency may appear at cut-off levels of 75 nmol/L.[21] Expert opinion suggested that the minimal optimal circulating vitamin D level should be increased from 50 nmol/L to 75 nmol/L.[2] The level of 25-hydroxyvitamin D between 50 nmol/L and 75 nmol/L can be considered as a relative insufficiency of vitamin D in children.[22] Most tissues and cells in the body have vitamin D receptors and several possess the enzymatic machinery to convert the primary circulating form of vitamin D (25-hydroxyvitamin D) to the active form 1, 25-dihydroxyvitamin D and it has provided new insights into the function of this vitamin. Vitamin D can play an important role in decreasing the risk of many chronic illnesses, including common

cancers, autoimmune diseases, infectious diseases, and cardiovascular disease.

Considering the report from other Asian countries, it is assumed that Bangladesh is at risk of rickets and other vitamin D deficiency-related health consequences.[23] But there are very less studies regarding vitamin D deficiency in infant, boyhood and adolescence stages. Therefore, the study aims to determine the prevalence of vitamin D deficiency among the children in a selected rural area of Bangladesh. The study considers and discusses the nature of vitamin D deficiency, its role in skeletal and non-skeletal health, and suggests strategies for its prevention and treatment.

Materials and Methods

This cross-sectional study was conducted in Upazila Health Complex and community clinics of Kaliakoir Upazila, Gazipur from the period of January to August 2018. Total 300 children aged 1 to 16 years who came to the local clinics for treatment were included for the study. Subjects having rickets or hypocalcaemia or any abnormality in liver or renal function, which might affect hydroxylation of vitamin D, calcium and phosphorus metabolism, were excluded. Informed consent was taken from the respondents and/or their guardians before interview and sample collection. Privacy and anonymity of the participants were strictly maintained. Subjects were divided into four groups according to their ages: up to 1 year (infant), 2–5 years (childhood [pre-school]), 6–11 years (pre-puberty [primary and junior school]) and 12–16 years (adolescence [secondary school]). Descriptive statistics were performed for age, sex, biochemical parameters, and lifestyle factors. Socio-economic status (SES) was estimated using a wealth index, producing a weighted score. Scores were categorized into quintiles, with category 1 representing the poorest and category 5 the richest. Data were analyzed using IBM SPSS version 20.00.

Results

Respondents' characteristics

Among the participants, male were 45% and female were 55%. The numbers of participants were carefully selected to maintain equality and balance. There were 21% subjects in up to 1 year group, 26.66% in 2–5 years group, 23.67% in 6–11 years group and 28.67% in 12–16 years group. Height and weight of the participants were 108.85 ± 55.86 cm and 18.2 ±21.21 kg respectively. According to wealth index, participants were distributed almost equally in different socio-economic categories (Table I).

Table I: Distribution of subjects according to demographic characteristics (N=300)

Characteristics			
	Category	**n**	**%**
Age	Up to 1 year	63	21.00
	2–5 years	80	26.66
	6–11 years	71	23.67
	12–16 years	86	28.67
Sex	Male	135	45.00
	Female	165	55.00
Socio-economic status			
	Power elites	37	12.33
	Below middle class	80	26.67
	Middle class	70	23.34
	Upper middle class	58	19.33
	Wealthy	55	18.33
Height (cm)	108.85 ± 55.86		
Weight (kg)	18.2 ± 21.21		

Serum 25-hydroxyvitamin D levels

The distribution of serum 25-hydroxyvitamin D levels according to different age groups shows that in up to 1 year group 30.15% were deficient, 52.38% insufficient and 17.46% were sufficient. In 2–5 years group 35% were deficient, 50% insufficient and 15% were sufficient. In 6–11 years group 35.21% were deficient, 54.93% insufficient and 8.45% were sufficient. In 12– 16 years group 37.21% were deficient, 59.30% insufficient and only 3.49% were sufficient. Serum 25-hydroxyvitamin D deficiency rate is high among Bangladeshi rural children and insufficiency increases with age (Table II).

Table II: Distributions of subjects according to age and serum 25-hydroxyvitamin D levels

Age	<10 ng/mL N%	10–29 ng/mL N%	30–100 ng/mL N%
Up to 1 year	19 (30.15)	33 (52.38)	11 (17.46)
2–5 years	28 (35.00)	40 (50.00)	12 (15.00)
6–11 years	25 (35.21)	39 (54.93)	6 (8.45)
12–16 years	32 (37.21)	51 (59.30)	3 (3.49)

Discussion

The study found that almost 80% children are vitamin D deficient where the study applied the definition of vitamin deficiency [25(OH)D <10 ng/mL]. From this finding we can say that the vitamin D status of children in Bangladesh is poor. Bangladeshi people are at risk of vitamin D deficiency and vitamin D-related other health consequences. In our study we found that the serum 25-hydroxyvitamin D levels among pediatric population gradually decreases along with increasing age of the children.

According to another study, it is documented that the Bangladeshi infants start their life with poor vitamin D level due to low maternal antenatal 25(OH) D in urban and rural Bangladeshi women of reproductive age.[24] A study in India (18° N) reveals that 51% had values of 25(OH) D < 37.5 nmol/L among 35 three months aged breastfed infants and they had a mean 25(OH) D of 49 nmol/L.[25] In Pakistan (25° N), 38 six months aged breastfed infants had a mean 25(OH)D of 25 nmol/L (18 SD), and 71% of infants (12/17) aged less than three months, had 25(OH)D <40 nmol/L.[26] Another study from Middle East shows that 78 infant, aged 1–4 months breastfed term infants, born to women with low milk intake and a habitual practice of covering the skin entirely when outdoors, 82% had 25(OH)D <25 nmol/L and had a median 25(OH)D of 11.5 nmol/L.[27] In studies in Saudi Arabia, the United Arab Emirates, Australia, Turkey, India, and Lebanon, 30 to 50% of children and adults had 25-hydroxyvitamin D levels under 20 ng per milliliter.[23, 28-30]

Prevalence of vitamin D insufficiency was found higher among American children aged 6–11 years (73%) compared with children aged 1–5 years (63%), girls (71%) compared with boys (67%) and non-Hispanic black (92%) and Hispanic (80%) children compared with non-Hispanic white children (59%).[31] A study in Boston[21] showed that 52% of Hispanic and black adolescents and in a study in Maine[32] 48% of white preadolescent girls had 25-hydroxyvitamin D levels below 20 ng per milliliter. If we compare our data with the data of American study, our children had much higher prevalence of vitamin D deficiency than the American children and adolescents.

American Academy of Pediatrics released a new recommendation in November 2008 stating that all children should receive 400 IU/day of vitamin D from their first day of life through adolescence.[33] So we suggest the recommendation on vitamin D supplementation for Bangladeshi pediatric population should be implemented because vitamin D deficiency is more severe than that of American children and then many other ethnic groups.

The present study had some limitations. The respondents do not represent whole paediatric population of Bangladesh. At the same time, other related factors of vitamin D status including intake of supplements, lifestyle, and food habit-related data

were not taken into account for the study. A further study based on subjects sampled on a population basis can be carried out and the possible relating factors of vitamin D can also be explored. Moreover, some authors warn about the prevalence of vitamin D deficiency was over estimated and the evidence of the role of vitamin D for extra-skeletal outcomes was inconsistent and inconclusive and for the conclusion, it need to be assessed by more randomized clinical trials.[34,35]

The prevalence of vitamin D deficiency and insufficiency among children in Bangladesh is very high and alarming. Further study is required to explore among the national representative samples. Since it is important for the growth and development of child, the country needs to develop comprehensive action plan to prevent such deficiency. We strongly recommend the vitamin D supplementation for Bangladeshi children from day 0 to adolescent and its implementation as early as possible from the government level. Besides that, developing awareness regarding Vitamin D should be expanded and fortifications of food like milk, oil, yogurt, cereal as well as quality controlling assurance of the fortification is the prime need for the prevention of vitamin D deficiency and its related consequences in Bangladesh.

Undiagnosed vitamin D deficiency is not uncommon, and 25-hydroxyvitamin D is the barometer for vitamin D status. Serum 25-hydroxyvitamin D is not only a predictor of bone health but is also an independent predictor of risk for cancer and other chronic diseases. Evidence suggests that the recommended adequate intakes are actually inadequate and need to be increased. Unless a person eats oily fish frequently, it is very difficult to obtain that much vitamin D_3 on a daily basis from dietary sources. Excessive exposure to sunlight, especially sunlight that causes sunburn, will increase the risk of skin cancer. Thus, sensible sun exposure (or ultraviolet B irradiation) and the use of supplements are needed to fulfill the body's vitamin D requirement.

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