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High Prevalence of Vitamin D Deficiency among Bangladeshi Children: An Emerging Public Health Problem

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Abstract

Background: Recent studies suggested that vitamin D deficiency among children is widespread worldwide. Most of the Asian countries are suffering from high prevalence of vitamin D deficiency, especially in children. However, the vitamin D deficiency of Bangladeshi children has not been investigated yet. The objective of the study was to assess the prevalence of vitamin D deficiency among children in Dhaka city, Bangladesh. **Methods:** A cross-sectional study was designed. Children aged 0 month to 16 years attended Pediatrics' clinics with minor illness were conveniently recruited. After obtaining informed written consent, venous blood was taken and serum 25(OH)D levels were determined by direct enzyme-linked immunosorbent assay. Descriptive statistics were performed for age, sex, biochemical parameters. 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. Serum 25(OH)D was categorized: deficient as <10 ng/ml, insufficient as 10 - 29 ng/ml and sufficient as 30 - 100 ng/ml. **Results:** 31.88% children of 0 - 1 year had deficient serum 25(OH)D level and 52.17% children had insufficient level. Among 2 - 5 years' group, 38.16% were deficient and 50% were insufficient. Among the 6 - 11 years group, 41.02% were deficient and 52.56% were insufficient. Among 12 - 16 years group, 46.75% were deficient and 51.95% were insufficient. That means, serum 25-hydroxyvitamin D deficiency and insufficiency rate is found very high among Bangladeshi children. **Conclusions:** The prevalence of vitamin D deficiency and insufficiency among children in Bangladesh is high. The study recommended that vitamin D supplementation in Bangladeshi children should be formally launched from first day of birth up to adolescence.

Keywords

Prevalence, Serum 25(OH)D, Vitamin D, Children, Deficiency, Bangladesh

1. Introduction

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 previtamin D3 [1]. Exposure to the amount of sunlight that causes a slight pinkness of the skin after 24 hours (1MED) is equivalent to ingesting approximately 20,000 IU of vitamin D [2]. Very few foods naturally contain vitamin D such as salmon, sardines, Tuna, Mackerel, shitake mushroom, hardboiled egg and foods that are fortified with vitamin D as like milk, cereal, orange juice, yogurt, and margarine. But those are inadequate to satisfy the requirement of vitamin D among children and adult [3]. Vitamin D deficiency causes rickets among children although rickets represents only the tip of the vitamin D deficiency iceberg. The vitamin D receptor is distributed in the osteoblasts, small intestine, colon, activated T and B lymphocytes, b islet cells, mononuclear cells and most other organs in the human body including the brain, heart, skin, gonads, prostate, and breast [4]. In recent years, there has been lots of study regarding the influence of vitamin D on extra skeletal health, besides skeletal health. Hypovitaminosis D may be associated with diabetes mellitus [5] [6], cancers [7], autoimmune diseases [8] [9], infectious diseases [10], multiple sclerosis [11] and other cardiovascular diseases [12].

Nowadays, 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 [13]. There is a misconception that vitamin D deficiency is prevalent only in western countries, but in practical field it is totally reverse. Previously, it was assumed that hypovitaminosis D is less frequent in tropical countries, as cutaneous vitamin D synthesis is stimulated by exposure to sun. But, 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 [14]. Rickets is still widespread in regions, in northern China where 42% of infants were found to suffer from Rickets which occurs as a consequence of vitamin D deficiency during winter and spring season [15]. According to Siddiqui and Rai in Northern Pakistan, despite of abundant sunlight, rickets was a common problem in infants and children due to malnutrition, lack of awareness and antenatal factors [16]. 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 [17]. In Japan, the status of vitamin D is relatively better

than other regions of South Asia due to high sea fish consumption [18].

Although there is no definite cut off point for the optimal levels of 25-hydroxyvitamin D as measured in serum. According to most expert opinion, vitamin D deficiency is defined as a 25-hydroxyvitamin D level of less than 50 nmol per liter [19], 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 [20] [21]. It is evident that biochemical squeal of vitamin D deficiency may appear at cutoff levels of 75 nmol/L [22] [23]. Expert opinion suggested that the minimal optimal circulating vitamin D level should be increased from 50 nmol/L to 75 nmol/L [24] [25]. 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.

As per above mentioned definitions, the prevalence of vitamin D insufficiency was 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%) [26]. Several other studies suggest that the prevalence of vitamin D insufficiency among children is 30% - 50% in Australia, Turkey, India, and Lebanon [27] [28] [29].

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. But there is no study regarding Vitamin D deficiency in infant, preschool, school age and adolescence stages. Therefore, we aimed to determine the prevalence of vitamin D deficiency in children of Bangladesh.

2. Methods

Study type: A cross sectional study was performed.

Sampling place: Study participants for this study were chosen from a Paediatrics clinic.

Sampling technique:

A convenience sampling technique was used. Study recruited a total of 300 children from February 2017 to July 2017.

3. Inclusion Criteria

The children age ranged from 0 month to 16 years who came to the child health care clinic with minor symptoms were examined and venous blood were collected for 25(OH)D measurement.

4. Exclusion Criteria

Children who were already diagnosed as case of rickets or hypocalcaemia or any abnormality in liver or renal function, which might affect hydroxylation of vitamin D, calcium and phosphorus metabolism were excluded.

Anthropometry measurement

Heights for all participants were measured using a wall mounted stadiometer and weights were measured using digital scales. Standard operational procedure (SOP) was followed to obtained anthropometric measurement. Standardization of all equipment was done on a regular basis for the consistency of data.

Information on socio-economic status was collected by questionnaire.

25-hydroxyvitamin D measurement

Measurement of circulating levels of 25-hydroxyvitamin D [25(OH)D] are the most reliable measure of overall vitamin D status [4]. There are several recognized methods available to measure serum 25 (OH)D. However, in Bangladesh, most commonly used technique is direct enzyme-linked immunosorbent assay. That's why this study chose this technique to measure the serum 25 (OH)D levels. Also there are many ways to define deficient, insufficient and sufficient and in our study we categorized deficient as <10 ng/ml, insufficient as 10 - 29 ng/ml and sufficient as 30 - 100 ng/ml.

Statistical analyses

Data were categorized and analyzed using SPSS for windows version 21.0. Descriptive statistics were performed for age, sex, biochemical parameters and lifestyle factors. Socio-economic status (SES) was estimated using a wealth index based on information about household assets and the related principal component analysis, producing a weighted score. Scores were categorized into quintiles, with category 1 representing the poorest and category 5 the richest.

Ethical consideration

This study was approved by the ethical review committee of North South University, Dhaka, Bangladesh. Privacy and anonymity of the participants were maintained.

5. Results

Characteristics of the study participants:

A total of 300 children aged 0 month to 16 years participated. The participants were divided into four groups according to their ages: 0 - 1 y, 2 - 5 y, 6 - 11 y and 12 - 16 y as infant, preschool, primary, and secondary school stages respectively. Table 1 shown that, female participants (51.33%) were little bit higher than the male participants (48.66%). Study participants were almost equally distributed in different groups, 23.00% were 0 - 1 year, 25.33% were 2 - 5 years, 26.00% were 6 - 11 years and 25.67% were 12 - 16 years. That means there were no major differences among the groups. Participants height and weight was 108.85 ± 55.86 cm (mean ± SD) and 18.2 ± 21.21 kg (mean ± SD) respectively. According to wealth index, participants were distributed almost equally in different socio-economic category (Table 1).

Serum 25-hydroxyvitamin D levels

The distribution of serum 25-hydroxyvitamin D levels according to different age groups. It has been shown that, among 0 - 1 year group, 31.88% were deficient, majority (52.17%) were insufficient and 15.94% were sufficient. Among 2 -

Table 1. Characteristics of the study participants.

Characteristics		n	%
Age	Category		
	0 - 1 y	69	23.00
	2 - 5 y	76	25.33
	6 - 11 y	78	26.00
	12 - 16 y	77	25.67
	Total	300	100.0
Sex	Category		
	Male	146	48.66
	Female	154	51.33
Socioeconomic status (calculated by asset score)			
	Poor	47	15.7
	Below middle	60	20.0
	Middle	62	20.3
	Upper middle	68	22.7
	Wealthy	63	21.0
Anthropometry		Mean ± SD	
Height (cm)		108.85 ± 55.86	
Weight (kg)		18.2 ± 21.21	

5 years, 38.16% were deficient, similar to previous group majority (50.00%) were insufficient and only 11.84% were sufficient. Among the 6 - 11 years group 41.02% were deficient, 52.56% were insufficient and few of them (6.41%) were sufficient. Lastly among 12 - 16 years group, 46.75% were deficient, 51.95% were insufficient and only 1.30% were sufficient. That means, serum 25-hydroxyvitamin D deficiency rate is very high among Bangladeshi children and insufficiency is increased as age progress (Table 2).

6. Discussions

The study found that on an average almost 80% of Bangladeshi children are vitamin D deficient where the study applied the definition of vitamin deficiency [25(OH)D < 10 ng/mL]. From this finding study 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 as the age of the children gradually increases so the prevalence of vitamin D deficiency increased as the children became older. There is augmentation of both maternal and cord-blood 25(OH)D by antenatal vitamin D supplementation [30]. According to another study, it is documented that the

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

Age	<10 ng/ml N, %	10 - 29 ng/ml N, %	30 - 100 ng/ml N, %
0 - 1 y	22 (31.88)	36 (52.17)	11 (15.94)
2 - 5 y	29 (38.16)	38 (50.00)	9 (11.84)
6 - 11 y	32 (41.02)	41 (52.56)	5 (06.41)
12 - 16 y	36 (46.75)	40 (51.95)	1 (01.30)

Bangladeshi infants start their life with poor vitamin D level due to low maternal antenatal 25(OH)D, documented in urban and rural Bangladeshi women of reproductive age [31]. A study of 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 [32]. 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 [33]. Furthermore, 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 [34]. If we compare our data with the data of an 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, that all children should receive 400 IU/day of vitamin D from their first day of life through adolescence [35]. 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.

We have some limitations in our present study. The subjects were not sampled from the whole paediatric population in Bangladesh. As well as possible relating factors of vitamin D status including intake of supplements, life style, food habit related data were not collected. A further study based on subjects sampled on a population basis would be carried out and the possible relating factors of vitamin D should be explored. On the other hand, some authors warned 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 [36] [37].

7. Conclusions

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. Moreover, since it is important for the growth and development of child, the country needs to develop comprehen-

sive 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 fortification 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.

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