International Journal of Research and Review
www.gkpublication.in E-ISSN: 2349-9788; P-ISSN: 2454-2237

Review Article

Calcium and Vitamin D Deficiency Situation in Bangladesh: A Review

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Received: 04/09/2016 *Revised: 11/09/2016* *Accepted: 11/09/2016*

ABSTRACT

This review shows that deficiency of Calcium (Ca) and vitamin D is prevalent in Bangladesh. During the past two decades, rickets has been considered as a public health problem in Bangladesh with 8%of children clinically affected in some areas. In Bangladesh rickets occurs mainly due to the deficiency of Ca and literature survey has proved that Ca supplement is capable of reducing the severity of this disease. The female population of Bangladesh have been found to be vulnerable to low bone density, osteopenia, hypovitaminosis D etc. due to the deficiencies of these two essential micronutrients. Low dietary intake of Ca and vitamin D, lifestyle, clothing, use of sunscreens, home-bound nature of female population has contributed to the deficiency situation. Hypovitaminosis D has been found as a common phenomenon in female population.

Key words: Rickets, Low Bone Density, Osteopenia, Hypovitaminosis.

INTRODUCTION

Malnutrition is a major problem in many developing countries. [1] The effects of malnutrition are passed from generation to generation because malnourished mothers give birth to infants who struggle to develop and thrive. If these children are girls, they often become malnourished mothers themselves. In Bangladesh malnutrition is extremely prevalent among women and children. [2] Malnutrition occurs mainly due to the micronutrient deficiencies. Although various factors contribute to micronutrient deficiencies, poor socio-economic condition of Bangladesh is considered to be the major cause. Among various micronutrients, vitamin D and Ca are two important micronutrients for our body. Vitamin D plays crucial role on bone mineralization and other metabolic processes in the human body such as Ca and phosphate home ostasis and skel et al growth. Due to the deficiency of vitamin D, rickets occur in children which leads to skeletal abnormalities, delayed development, short stature etc. Vitamin D deficiency in adults leads to osteomalacia, osteopenia, osteoporosis and subsequent risk of fractures. [3] It has been found from observational studies that increased risk for several extra-skeletal diseases including cancer, infections, autoimmune diseases and cardiovascular diseases are associated with low 25-hydroxy vitamin D (25-OHD) values. [4] There is a distinct relationship between the vitamin D and Ca uptake in body. The adjustment of the body to changing calcium supply and demand is influenced by vitamin D. The intestinal Ca absorption depends on active transport involving vitamin D-dependent TRPV6 and calmodulin-D in intestinal mucosal cells. [5] Calcium absorption has been found to reduce to 10-15% in vitamin D deficiency. [6] The Ca up take in our body

is dependent on vitamin D and due to the lack of these micronutrients a severe disease called rickets occurs preferably in children. In many of the developing countries nutritional rickets is prevalent**.** [7,8] Vitamin D is synthesized in our body upon the exposure to sun light but in some sunny countries such as Bangladesh, Nigeria and South Africa rickets is prevalent although there is adequate exposure of ultra-violet (UV) light. Studies indicated that the disease probably is attributable to low dietary Cain take which are characteristic of cereal-based diets with less diversity and little access to dairy products. In such situations, Ca supplement alone is effective in healing of bone disease. [9] As Ca and vitamin D deficiency have great public health impact, it is very important to visualize the overall deficiency situation of these two micronutrients among the population throughout the country. Since there is no literature report on the overall deficiency situation of Ca and vitamin D in Bangladesh, we are interested to review the deficiency situations and their cause. Based on their ported data it is al so necessary to find the effective pathway to come out of the situation.

MATERIALS AND METHODS

Any relevant study providing data on Ca and vitamin D deficiency situation in Bangladesh were selected for the review.

RESULTS AND DISCUSSION

The first national rickets survey in Bangladesh was carried out by Helen Keller International (HKI) in the year of 2000. In that survey, 9000 mothers were interviewed with about 21571 children aged 1-15 in 24 sub-districts and prevalence of rachitic deformities was found 0.26%. Rickets was found in more than half of the sub-districts with highest prevalence in Chittagong and then in Sylhet. According to this survey report, the highest prevalence of lower limb rickets was reported in Cox's Bazar sub-district (23/1381 or 1.66%) and in Hathazari (8/1143 or 0.70%) among children aged1-15. The survey was repeated in 2004 among 10005 children aged 1-15 where prevalence of rachitic deformities was found 0.12%. [8]

To measure the prevalence of lower limb rickets at Cox's Bazar, another study was performed by Karim et al. 2003using rapid assessment methodology. The study was conducted on 28 randomly selected villages of the Cox's Bazar district where data was collected from 25891 children and young people aged 1-20. According to their report the prevalence was 0.93% (931/100000) which was lower in comparison with Chakaria study (4.1%). The Chakaria study was conducted by the Institute of Child and Mother Health, Bangladesh. The Chakaria study detected cases using multiple examinations such as radiography and pathological tests whereas this rapid assessment study was based on clinically apparent signs of lower limb rickets. People might have been suffering from both clinically apparent and unapparent rickets but this present study could only detect clinically apparent rickets. The study reports also revealed that the prevalence of lower limb clinical rickets was highest among children aged 1-4 (1215/100000) and lowest among aged 17-20 (498/100000) and this declination was consistent with increase in age. Clinical signs of rickets may disappear with age creating problem in case detection which was the probable cause for the declination of rickets with age. A similar methodology was applied for investigating rickets in 5 other districts (Sunamganj, Noakhali, Bhola, Jessore and Gaibandha) of Bangladesh and clinical signs of lower limb rickets were observed in Sunamganj and Jessore district. [10]

The National rickets survey, 2008was conducted by Rickets Interest Group (RIG) with the leadership ofDr.SK Roy, Senior Scientist, International Center for Diarrheal Disease and Research, Bangladesh (ICDDRB) and in collaboration with Social Assistance and Rehabilitation for the Physically Vulnerable (SARPV), United Nations Children's Fund (UNICEF),

Cooperative American Relief Everywhere (CARE) Bangladesh, National Nutrition Program, Bangladesh Rural Advancement Committee (BRAC) and Plan Bangladesh. This nation-wide survey was performed among 20000 children aged 1-15 including 16000 from rural and 4000 from urban areas. In this survey, prevalence of rickets was found 0.99% and the nutritional status of the rachitic children showed that53.3% children had LAZ/HAZ (Length for Age Z-Score/Height for Age Z-Score) below -3SD (Standard Deviation) and 40.1% children had WAZ (Weight for Age Z-Score) below -3SD. The study reports also revealed that according to serum vitamin D level, 45.8% were severely deficit (0-14.9 ng/ml), 52.3% were moderately deficit (15.0-31.9 ng/ml) and only 1.9% was in normal (32.0-100.0 ng/ml) category. [11]

In 2008 and 2009, a study was conducted by SARPV to identify rickets in under- 5 children in Cox's Bazar. The study presented the number of affected children area-wise and the effect of nutrition education program. In 2008, a total of 886 children under 5 years were identified for nutritional therapy in which 286 were from Chakaria, 300 from Maheskhali and 300 from Cox's Bazar Sadar. Similarly in2009, a total of 855 children under 5 years were identified for nutritional therapy consisting of 274 children from Chakaria, 281 from Maheskhali and 300 from Cox's Bazar Sadar. After this observation, various attempts such as nutritional advice, medicine, brace and surgery were taken for the improvement of the situation. Only nutrition advice was effective in improving the condition of 70.5% of children where medicine, brace and surgery were needed for 25.4%, 1.4% and 2.7% children respectively. The better improvement of rachitic children was found in 2009 (80% in both Chakaria and Cox's Bazar Sadar and 62% in Maheskhali) compared to 2008 (69% in Chakaria, 79% Cox's Bazar sadar and 29% in Maheskhali). The better improvement was due to the fact that more families followed nutrition advice (Rice with lime, Ca-rich vegetables, Iodized salt, Small fishes, Safe drinking water, Sesame) in 2009 than 2008. [12]

Combs et al. 2007 conducted a study on 6 villages with relatively high prevalence of rickets in Chakaria Upazilla. A medical team screened a total of 1749 children and those not presenting rachitic signs and showing serum alkaline phosphate in the upper decile (>260 U/dl) were considered eligible to be randomized to the clinical intervention trial. In this study, the subjects aged 1-5 were at risk to develop rickets because these apparently healthy children were considered to be non-rachitic at screening but showed somewhat high alkaline phosphate levels and rachitic signs seemed to be developed among 12.6% children during the 7 months of pre-treatment period. After rescreening 158 children randomized to supplement which were milk-powder based beverage containing 50 mg, 250 mg, 500 mg Ca and 500 mg Ca plus multi-vitamin. By the end of the supplementation period, signs consistent with diagnosis of rickets were not found in any treatment group. No rachitic signs were observed through physical examination whereas radiographs of wrist and knee revealed only 8 cases and these cases were very mild with Thacher score of 1. This study found adequate circulatory level of Serum 25-OHD (S 25-OHD). This group of researchers also conducted a study in the immediately previous year of that study on Ca intake of that community and found that the Ca intake was a fifth of Adequate Intake (AI) and less than half of that recommended for children in Bangladesh. [13,14] From these two studies vitamin D was excluded as a factor of rickets in Chakaria and noted as the Ca-deficiency type. [15-21]

Although the subjects were in high risk of developing rickets before intervention trial but at the end of the intervention period, no subjects developed rachitic signs and it was quite interesting that even 50 mg Ca per day in bio available form were effective and no significant

differences were found among the treatment groups. This study explained that in Ca-deficient population in Chakaria, Boron (B) might contribute to the developments of rickets because experimental studies suggest that low B content may contribute to rachitic bone changes. According to Bangladesh Soil Research and Development Institute, the soil of Chakaria is deficient in B and locally produced pulses and fruits are also deficient in B. These foods are consumed little in Chakaria. Therefore, the study subjects showed low B level (32±27ng/ml). [22]

Women are also vulnerable group of vitamin D deficiency because of their dressing style, avoidance of sunlight and also for their home-bound nature. Several studies of vitamin D status were performed on them.

In 2001, a study was conducted in two regions of Bangladesh. [23] The studied regions were the Dhaka city area and west region of Nandail (Betagair Union), Mymen singh. The study was conducted among premenopausal (aged 16-40) Bangladeshi women of two socio-economic groups in rural and urban regions. The subjects were divided into low socio-economic group (L) and high socio-economic group (H) where each group comprised of 3 sub-groups (non pregnant-non lactating→1, pregnant→ 2 and lactating →3). In this study report Vitamin D deficiency (S 25-OHD<25 nmol/l) was detectedin17% of women in group L and 12% in group H. Hypovitaminosis D (S 25-OHD concentration ≤ 37.5nmol/l) was observed in 50% of subjects in group Land 38% of subjects in group H respectively. The prevalence of hypovitaminosis was higher in lactating subjects of the groups L and H (63% and 46% respectively) than in the other sub-groups in the same group. A number of factors affected the synthesis of cholecalciferol leading to inadequate vitamin D status among subjects such as avoidance of direct sunshine exposure, home-bound lifestyle, misconceptions, excess clothing, dark pigmented skin. [24] In dietary part, low fish consumption was found in both groups and food fortified with vitamin D was unavailable at the time the study was performed. Therefore, nutritional vitamin D intake was probably low. In the study groups Ca intake was inadequate and was mainly based on cereal sources. [23] The high phytic acid content of cereal-based diet can inhibit Ca absorption which may have an unfavorable effect on vitamin D status and bone metabolism. Besides, Ca deficiency causes an increase in catabolism of 25-OHD, thereby increasing the requirement of vitamin D. [25-27]

A study was designed to evaluate the vitamin D status among representative subjects of three groups of women aged 18-60 in Bangladesh by using S 25-OHD, Serum alkaline phosphatase (S-ALP), Serum Ca (S-Ca) and Serum phosphate (S-P). Sampling was undertaken at 3 locations in the Dhaka city of Bangladesh including apparently healthy young adult (non-veiled women) in group A where subjects were in first to fifth year of their university studies and came mainly from affluent families of high educational level (N = 36, mean ± SD age 22.3 ± 1.9 years), Group B consisted of women who would cover themselves with a thick black cloak in addition to their normal clothes when they go outdoors (N= 30, mean ± SD age 47.7 ± 9.4 years) and Group C non-veiled diabetic women (N = 55, mean ± SD age 50.2 ± 5.9 years). In the groups, the mean value of S 25-OHD was not significantly different and the distribution of S 25-OHD concentration was found toward the lower limit of the normal range in all groups. In this study, 39% of young women (University Students), 30% of veiled women and 38% of diabetic women were detected with Vitamin D deficiency (S 25-OHD level <25 nmol/l). S 25-OHD concentration < 40 nmol/l was used as a criterion for detecting vitamin D insufficiency and it was detected in 78% of group A, 83% in group B and 76% in group C respectively. The insignificant difference in S 25-OHD between veiled and non-veiled subjects might have been caused by lower dietary

intake of vitamin D as well as inadequate sunlight exposure to the skin due to a home-bound lifestyle. The study reported that healthy non-veiled young women with high income and educational levels usually spent very little time (49 min) daily in direct sunlight compared with veiled (83 min) and diabetic women (113 min). Significantly higher S-Ca concentration was found in group A than in groups B and C and significant differences were observed in the S-P concentration between groups A and B. According to this study, regardless of different age-groups, lifestyle and clothing, the women in Bangladesh were at risk of developing hypovitaminosis D. [28]

A study was conducted among Bangladeshi women to analyze the trend of the bone mineral densities of the local female population's at the lumbers pine and the femoral necks as well as to determine their hip axis length. The study involved 336 normal Bangladeshi females. Subjects were recruited from hospital staff, their relatives and friends. The study showed that, in normal female subjects, there was a distinct decline in bone mineral densities (BMD) of both the femoral necks and the lumbers pine with beginning of 45-49 years age band. The mean hip axial length was 10.27 cm with a maximum of 11.25 cm and a minimum of 8.25 cm. [29]

A study was conducted in a garment factory where two hundred female garment workers (aged 18-36) were randomly selected. S-25 OHD, serum intact parathyroid hormone (S-iPTH), S-Ca, S-P concentration and serum alka line phosphatase activity were measured from fasting samples. Bone indexes of hip and spine were measured by dual - energy X-ray absorptiometry. The study showed that the mean S 25-OHD was 36.7nmol/l that was below safe recommended limit (50 nmol/l). [30] According to Lips's and Vieth's classification, 141 (70.5%) subjects had mild vitamin D deficiency (S 25-OHD level 25-50nmol/l), 30 (15%) subjects had moderate deficiency (S 25-OHD level 12.5-24nmol/l) and 1subject (0.5%) had severe deficiency (S 25-OHD level 12.5nmol/l). [30,31] According to the study report vitamin D deficiency (S 25-OHD< 25nmol/l) was 16% and hypovitaminosis D (S 25-OHD<50 nmol/l) was 86%. The study subjects had low BMD at all sites. The mean T-scores of the femoral neck were -1.883 and lumbarspine was -1.644 and according to the criteria of WHO, the subjects were within osteopenic range. [32] The prevalence of osteopenia in the subject was predominantly high (80%). The study revealed a significant inverse relationship between S 25-OHD and S-Ipth that reduction in bone mineral density at the femoral neck and lumbar spine was associated with a decrease in S 25-OHD (<38nmol/l) and an increase in S-iPTH (21 ng/l). Higher S-iPTH concentrations (>21 ng/l) was observed in the subjects with significantly lower lumbar spine BMD whereas in subjects with high S 25-OHD concentrations (>38 nmol/l), progressive increase in femoral neck and lumbar spine BMD was observed. A trend of lower body weight, waist-hip circumference, mid upper arm circumference (MUAC) and S-25OHD levels, higher S-iPTH and S-ALP levels was observed in subjects with a T-score < -2·5. By dividing the subjects into three groups based on the WHO's recommended criteria of BMI for Asians, the study regarding the influence of BMI values on bone parameters was performed. [33] The study report revealed that the bone mass values were significantly higher among subjects with BMI ≥ 23. The possible reasons of lower level of vitamin D among subjects were attributed to low intensity of the sun in the morning or the shaded sunshine of an overcast sky or shadows of tall buildings and trees, the high pollution in the air, covered-up-style dresses and use of sunscreen on hands and face. [34]

CONCLUSION

In Bangladesh, due to the deficiency of Ca and vitamin D, a huge number of children are suffering from rickets whereas the female populations are facing the

problems of low bone density osteoporosis, hypovitaminosis D etc. Several studies have been carried out throughout the country including Cox's Bazar, Dhaka, Sylhet, Noakhali, Bhola, Jessore, Gaibandha and Mymen singh. However, major attention has been paid to the district Cox's Bazar including Cox's Bazar Sadar, Chakaria, Maheshkhali. This is because these are as are considered to be the endemic of rickets. However, no reports are available for the rest of the districts. As a result, further studies on all other districts in details are required to get the overall scenario of the country which should be based on systematic methods. The deficiency of Ca and vitamin D occurs mainly due to the poor socio-economic conditions of the people. Improvement of socio-economic conditions and raising awareness among people will help to overcome this situation. Government and non-government organizations (NGOs) should come forward to raise awareness among people all over the country with special preference to rural population as they have limited knowledge regarding the deficiencies of Ca and vitamin D.

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How to cite this article: Dey M, Dey SC. Calcium and vitamin D deficiency situation in Bangladesh: a review. Int J Res Rev. 2016; 3(9):58-64.

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