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ASSESSMENT OF NUTRITIONAL STATUS AND RISK FACTORS IN UNDER FIVE YEARS CHILDREN WITH NUTRITIONAL RICKETS ATTENDING A TERTIARY CARE CENTRE IN BANGLADESH

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ABSTRACT

Background: Nutritional rickets (NR) or vitamin D deficiency rickets remain prevalent in developing regions of the world and rank among the 5 most common diseases in children. In Bangladesh, it is the second most common micronutrient deficiency. **Objective:** This study was conducted to assess nutritional status of urban and rural Bangladeshi children associated with Nutrional rickets and the risk factors are also evaluated. **Materials and Methods:** This cross- sectional study was conducted at BSMMU, Bangladesh, in which 50 children aged <5 years with nutritional rickets were included. **Results:** Mean age of children were 15.16±11.18 months. All children were having one or more clinical signs and symptoms of nutritional rickets including rachitic rosary (14%), widely open anterior fontanel (22%), widening of wrist (14%), bowing of legs (14%), chest infection (22%), diarrhea (10%), delayed eruption of teeth (24%), failure to thrive (10%), seizure (4%), sweating (26%) and irritability (20%). The mean values of weight-for-age z-score (WAZ), height-for-age z-score (HAZ), weight-for height z-score (WHZ) and head circumference-for-age z-score (HCAZ) were -1.78 ± 0.95, -3.28 ± 0.56, -2.55 ± 0.92 and 0.79 ± 0.95, respectively. Majority of cases came from urban area (60%). 60% had no or little exposure to sunshine. Significant associations were detected with exclusive breast feeding for more than 4 months, exposure of children to sunlight for less than 30 minutes daily, dark skin color, urban slum residence, deficit monthly income, and father and mother's education in years. **Conclusion:** Nutritional rickets is prevalent among Bangladeshi children, urban children being more vulnerable. Adoption of a screening programme for children of all age group and implementation of preventive strategies through public health policies are strongly recommended.

KEYWORDS: Radiographic findings; Nutritional rickets; Delayed eruption.

INTRODUCTION

Rickets is a failure in mineralization of growing bone or bone tissue. There are many causes of rickets; among them nutritional vitamin D deficiency remains the most common cause globally.[1] A severe vitamin D deficiency impairs mineralization of bone tissue (causing osteomalacia in adult) and of growth plates (manifesting as rickets in children).[1]

Nutritional rickets is a major pediatric concern in the both developed and developing countries, having different aetiologies.[2] Worldwide it is considered the most common non-communicable disease in pediatric age group.[1,2] Although it was thought a disease of the west, but recent trends suggest that it is an emergent problem in developing part also.[2] In Bangladesh rickets is the second most common micronutrient deficiency.[3] Deficiency of vitamin D may occur due to insufficient intake or less exposure to sun or a combination of the two. The insufficiency of vitamin D is the main cause of the nutritional rickets but current reports suggest that an inadequate calcium or phosphorus intake is also an important cause of rickets.[4] The worldwide prevalence of vitamin D deficiency (VDD) is 30-50% among children and in tropical countries like India prevalence ranges from 70- 100.0% among all age group.[5-6]

Rickets which is the final stage of VDD represents only the tip of iceberg of huge vitamin D deficiency in children.[7] It may present with growth failure, irritability, lethargy, muscle weakness, limb pain, hypocalcaemic seizure and repeated respiratory tract infection during

infancy.[8-9] In Bangladesh, prevalence of vitamin D deficiency is frequently overlooked as it was assumed to be low risk due to cutaneous synthesis of vitamin D in exposure to abundant sunlight. Recently, it was found in one study that like elsewhere, vitamin D deficiency exist in high prevalent rate (80.0%) in Bangladesh.[10] Indoor based lifestyle and poor exposure to sunlight, air pollution and skin color, covering clothes of mother and child, educational status of mother are reported as important attributable factors for vitamin D deficiency, which lead to rickets. Exclusive breast feeding of infant also contributes to poor vitamin D status.[11-14]

Environmental pollution is one of the major health hazards in Bangladesh, which is also considered as a contributing factor for the development of rickets.[3] A study done in Bangladesh revealed that rickets is more common than suspected in some regions of Bangladesh; it was not generally associated with vitamin D deficiency but was related to insufficiency of dietary calcium.[7] In North America, rickets is most commonly seen in children with relatively more pigmented skin, who are exclusively breastfed.[8] In Australia[9] and Europe,[10] rickets is mostly identified in immigrant populations from the Middle East and the Indian subcontinent.[8] In the Middle East,[11] rickets is often seen in sun-protected children of vitamin D-deficient mothers, but it can present as bone-problems in later years of childhood.[8] In sun-exposed regions of Asia and Africa, rickets typically presents during the second or the third year of life.[8] Nonetheless, there had been reports of calcium deficiency associated with rickets in South Africa and Nigeria.[12]

In a nutshell, it indicates that the aetiology of rickets is diverse, multifactorial and dependent upon the environmental condition, socio-cultural aspects, dietary habits and geographical location, which are changing day by day. Therefore, it is quite rational to re-evaluate the aetiology or risk factors of rickets in Bangladesh despite having some studies regarding this aspect in past.

MATERIALS AND METHODS

It was an observational type of cross-sectional study conducted in Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangladesh for the duration of 2 years extending from April 2019 to March 2021. Total 50 children, aged 0-5 years were selected in according to the prior selection criteria. In this study child attending into the BSMMU outpatients department with clinical, radiological and biochemically consistent with nutritional rickets were selected. Participants who were acutely ill, suffering from chronic disease, already on vitamin D supplementation and whose parents did not complete the questionnaire were excluded. Purposive convenient sampling technique was followed during selection of the study participants and data was collected under the guidance of a preformed questionnaire. In depth interview was taken from parents or caregiver of the child by preparing a semistructured questionnaire which included age, gender, place of residence (urban or rural), exposure to sunlight, skin color, duration of exclusive breast feeding, maternal education. Sunlight exposure was defined sufficient if the children's skin were exposed to direct sunlight for more than 30 min/d for several days in a week exposing head, face and forearms (40% of body surface area). Weight and height were measure according to standard procedure and converted into Z score after standardizing with NCHS reference data. Data analysis was done by SPSS 23 version with 95% CI with acceptable 5% error. And in all cases p value <0.05 was considered as statistical significance.

RESULTS

Total fifty children of nutritional rickets were included in this study. Mean age of subjects were 15.16±11.18 months. Majority were male 33(66%). Table 1 shows the area and gender distribution subjects. Table 2 shows the important clinical features of the rickets patients. The most common clinical features included rachitic rosary (14%), widely open anterior fontanel (22%), widening of wrist (14%), bowing of legs (14%), chest infection (22%), diarrhoea (10%), delayed eruption of teeth (24%), failure to thrive (10%), seizure (4%), sweating (26%) and irritability (20%). The clinical results revealed that all children were having one or more clinical signs and symptoms of nutritional rickets. Table 3 shows the distribution of subjects according to socio-economic variables. Majority of patients came from urban slum area (50%). p value was significant ($p<0.05$). Skin color, exclusive breastfeeding and sunlight exposure were the important factors of rickets related to children themselves, which were assessed in this study (Table 4). Significantly more subjects (58%) had darker skin ($p<0.05$). Majority of the patients (72%) were exclusively breastfed for 4 to 6 months. p value was significant. 60% patients had exposure to sunlight less than 30 minutes ($p<0.05$).

Table 5 shows the assessment of different risk factors for rickets. Factors which were analyzed are: exclusive breast feeding for more than 4 months, exposure of children to sunlight for less than 30 minutes daily, dark skin color, urban slum residence, deficit monthly income, and father and mother's education in years. All the factors assessed showed significant odds of developing rickets ($p<0.05$). Table 6 showed the radiographic features of the subjects which indicates 84% had cupping, 28% splaying, 14% fraying and 40% widening of wrist.

Though serum vitamin D level is an appropriate indicator for diagnosing nutritional rickets, but due to financial constraints and lack of laboratory facilities, its determination was not performed in the present study. Therefore, biochemical assessment was done indirectly by serum calcium and alkaline phosphatase (ALP) levels. Table 7 presents the biochemical data of the selected patients including serum calcium and ALP levels. The

observed mean values of serum calcium and ALP were 8.11 ± 0.56 mg/dl and 1219 ± 566 IU/L. This showed that the mean value of serum calcium lies at the bottom of normal range whereas the value of ALP was very much raised above the normal range. The elevated serum ALP value could be an indication of the nutritional rickets among the subjects.

The anthropometric characteristics of the subjects are presented in the table 8. The results showed that the average age of subjects was 15.16 ± 11.18 months, mean weight was 7.87 ± 3.02 kg, mean height was 69.29 ± 10.62 cm and the mean head circumference was 46.41 ± 3.31 cm. Median values of the Z-score of weight-for-age (WAZ), of the Z-score of height-for-age (HAZ), of the Z-score of weight-for-height (WHZ) and of the principal Z-score of head circumference-for-age (HCAZ) were -1.78 ± 0.95, -3.28 ± 0.56, -2.55 ± 0.92 and 0.79 ± 0.95, respectively. The results clearly indicate the presence of stunting and wasting in subjects.

Table 1: Area and Gender Distribution.

Area	Male	Female	Total (%)
Urban	22	8	30(60)
Rural	11	9	20(40)
Total (%)	33(66)	17(34)	50(100)

Table 2: Clinical features of the subjects (N=50).

Signs and Symptoms	N (%)
Rachitic rosary	7(14)
Widely open anterior fontanel	11(22)
Widening of wrist	7(14)
Bowing of legs	7(14)
Chest infection	11(22)
Diarrhoea	5(10)
Delayed eruption of teeth	12(24)
Failure to thrive	5(10)
Seizure	2(4)
Sweating	13(26)
Irritability	10(20)

Table 3: Distribution of subjects according to socio-economic condition (N=50).

Variable	N (%)	p
Residence		
Rural	15(30)	0.02
Urban	10(20)	
Urban Slum	25(50)	
Father's Education		
None	23(46)	0.003
1 – 5 years	22(44)	
6 – 10 years	4(8)	
> 10 years	1(2)	
Mother's Education		
None	27(54)	<0.001
1 – 5 years	20(40)	
6 – 10 years	2(4)	
> 10 years	1(2)	
Occupation of family head		
Service	10(20)	0.03
Farmer	15(30)	
Business	4(8)	
Day Laborer	10(20)	
Rickshaw-puller	10(20)	
Other	1(2)	
Monthly Income		
Insufficient	40 (80)	0.02
Sufficient	10(20)	

Table 4: Distribution of subjects according to factors related to children (N=50).

Variable	N(%)	p
Skin color		
Fair	6(12)	0.02
Medium	15(30)	
Dark	29(58)	
Exclusive breastfeeding		
4 – 6 months	36(72)	0.001
< 4 months	14(28)	
Sunlight Exposure		
more than 30 min	20(40)	0.03
less than 30 min	30(60)	

Table 5: Odds ratio of risk factors for rickets.

Variable	Odd Ratio	95% CI	p
Exclusive breastfeeding (4 to 6 months)	3.59	1.67 – 7.74	0.001
Sunlight exposure <30 minutes	2.25	1.08 – 4.67	0.03
Skin color (dark)	2.76	1.24 – 6.14	0.01
Residence Urban Slum (in relation to rural)	2.57	1.03 – 6.41	0.04
Monthly Income (Deficit)	2.30	1.09 – 4.85	0.03
Father's education (<6 years)	3.92	1.81 – 8.52	0.001
Mother's education (<6 years)	5.72	2.44 – 13.33	<0.001

Table 6: Radiographic features of the subjects.

Radiographic Features	N (%)
Cupping	42(84)
Splaying	14(28)
Fraying	7(14)
Widening of wrist	20(40)

Table 7: Biochemical profile of the subjects (N=50).

Variables	Reference ranges	Mean ± SD
Serum calcium (mg/dl)	8.1 – 10.4	8.11 ± 0.56
Serum ALP (IU/L)	145 – 450	1219 ± 566

Table 8: Anthropometric characteristics of the subjects (N=50).

Measurements	Mean ± SD
Age (months)	15.16 ± 11.18
Weight (kg)	7.87 ± 3.02
Height (cm)	69.29 ± 10.62
Head Circumference (cm)	46.41 ± 3.31
Weight-for-age z score	-1.78 ± 0.95
Height-for-age z score	-3.28 ± 0.56
Weight-for-height z score	-2.55 ± 0.92
Head circumference-for-age z score	0.79 ± 0.95

DISCUSSION

Nutritional rickets is now considered a public health problem in Bangladesh. As many as 8% children aged less than 10 years are affected by nutritional rickets.[3] A national survey conducted in 2008 the prevalence of rickets was found 0.99%.13 Although calcium deficiency has been found to be the primary cause of nutritional rickets here.[3,7] The role of vitamin D deficiency is also under investigation.[14,15] Many factors have been found to be associated with increased risk of nutritional rickets. Prevalence of sunshine exposure, diet, number of siblings in the family, economic condition and residence has been evaluated in a recent study in the country.[16]

In this study 50 subjects were included for assessment of nutritional status and risk factors for rickets. Rachitic children were selected. Mean age of subjects were 15.16±11.18 months. Similar to the findings of other studies[16,17] a male prevalence was noted among rachitic children.

People in urban slum area live in a congested, unhealthy environment. They are more likely to be less educated and to have low income. In this study 50% of the rachitic children had come from urban slum area which was significantly high in relation to rural (30%, $p < 0.05$). A similar finding was noted by Bakeit and Megeid.[18] Talukder et el[16] found 38% of rachitic children coming from urban slum. But, as their study was not designed to assess the risk factors they did not comment on the risk.

Education of both father and mother of subjects was found to be significantly lower in years ($p<0.05$). Yassin and Lubbad[19] reported a similar finding in their study on risk factors of rickets. Education is important for health consciousness as well as for improvement of economic condition.

This study found that family heads of majority of cases had insufficient income ($p<0.05$). This confirms the findings Talukder et el[16] and Karim et el[17] and relates it as a risk factor for rickets. They found majority rachitic children coming from family with low income and chronic deficit respectively. An updated review on nutritional rickets around the world by Creo et el[14] also enlists poverty as a risk factor of rickets.

Dark color skin, exclusive breast feeding for 4 to 6 months and sunlight exposure less than 30 minutes was found to be significantly associated with rickets in this study. Association of increased skin pigmentation, exclusive breast feeding with delayed weaning and decreased exposure to sunlight to nutritional rickets has been well studied.[1,14,22] Although, Specker et al[23] showed that the vitamin D status of breast-fed infants is associated with sunlight exposure rather than the vitamin D content of maternal breast milk. But, Pettifor[1] noted that vitamin D content of breast milk was sufficient for infants up to two months. Hence nutritional deficiency rickets may occur in cases of extended and exclusive breast feeding.

Finally, exclusive breast feeding for more than 4 months, exposure of children to sunlight for less than 30 minutes daily, dark skin color, mother's dressing behavior, number of siblings, urban slum residence, deficit monthly income, and father and mother's education in years all were found to have significantly higher odds of developing rickets ($p<0.05$). Jose et el[24] and Thacher et el[21] found that children with family history of rickets had higher odds of developing rickets which was not evaluated in this study. Bakeit and Megeid[18] studied effect of gestational vitamin D and calcium supplementation on rickets and found those to be significant, too.

The anthropometric characteristics of the subjects revealed mean weight 7.87 ± 3.02 kg, mean height 69.29 ± 10.62 cm and the mean head circumference 46.41 ± 3.31 cm. Median values of the Z-score of weight-for-age (WAZ), of the Z-score of size-for-age (HAZ), of the Z-score of weight-for-size (WHZ) and of the principal Z-score of circumference-for-age (HCAZ) were -1.78 ± 0.95, -3.28 ± 0.56, -2.55 ± 0.92 and 0.79 ± 0.95, respectively. The results clearly indicate the presence of stunting and wasting in subjects. Prevalence of malnutrition in rickety children has also been reported by Pakistani researchers. Siddiqui and Rai (2005) reported that 24 (40 %) of children with rickets are underweight according Gómez classification of malnutrition.[25] Recently, Jan et al. (2011) reported 70% malnutrition in rickety children.[26]

CONCLUSION

Nutritional rickets is a multifactorial disease and several factors have been associated with it. However, to assess the nutritional status and to identify the risk factors responsible for nutritional rickets among the under 5 years Bangladeshi child was the objective of the study. In this study, several factors were identified and among those exclusive breast-feeding, poor sunlight exposure, and darker skin complexion are the child factors that are responsible for rickets in this age group. Moreover, residence in urban slum, deficit monthly income, and parent's education are also significantly associated with this disabling disease.

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