

## Risk Factor for Nutritional Rickets among 0-5 Years Children in Bangladesh

Dr. Shahnaz Pervin Sumi, Mbbs, Mcps (General Paediatrics) , Professor Md. Jahangir Alam, Dr. Md. Abu Tayab, Professor Dr. A. As. M. Nawshaduddin

Ahmed Dr. Md. Shahnur Islam , Dr. Md. Jahid Hasan, Mbbs, Mph

Resident Medical Officer Department of Paediatric Endocrinology Metabolic Disorder Dhaka Shishu (Children) Hospital, SHER-E-Bangla Nagar, DHAKA, Bangladesh

MBBS, MCPS, DCH, FCPS Department of Paediatrics Dhaka Shishu (Children) Hospital SHER-E-Bangla Nagar, DHAKA, Bangladesh

MBBS, DCH, MD (Paediatric) Associated Professor Dhaka Shishu (Children) Hospital SHER-E-Bangla Nagar, DHAKA, Bangladesh

MBBS, MCPS, DCH, FCPS, FRCP (Glasgo) Head of the Department of Paediatrics Endocrinology and Metabolic Disorder Dhaka Shishu (Children) Hospital SHER-E-Bangla Nagar, DHAKA, Bangladesh

Registrar (Medicine) Delta Medical College Hospital

Registrar (Medicine) Dr. Sirajul Islam Medical College Hospita

Corresponding auther: Dr. Shahnaz Pervin Sumi

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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. Despite scope of abundant sun exposure, increasing number rickets incite the mind to search for the risk factors associated with it. Therefore, to evaluate the risk factor for nutritional rickets among 0-5 years children in Bangladesh was the objective of the study. **Materials and Methods:** This observational study was conducted in Dhaka Shishu (child) Hospital for 2-year period following formal ethical clearance. Total 120 children were include into the study. Of all, 60 children of NR were considered as cases and another 60 age and sex matched children were taken as control. NR diagnosis was based on clinical, radiologic and biochemical parameters. In all cases, formal informed consent were taken from the parents. Detailed history taking were done based on a preformed questionnaire, which was made on the basis of prior studies in this topics. During interview, data collection was done in a separate case record form. Finally, recorded data was analyzed by a statistical software, SPSS 23. **Results:** Among the 120 study children, mean age of cases and controls were  $29.40 \pm 11.65$  &  $28.66 \pm 13.57$  months respectively. Significant difference were present in-between case and control for residence, parent's education, occupation of the family head, monthly income and number of siblings. Moreover, exclusive breast-feeding (OR= 3.59, 95% CI: 1.67 – 7.74,  $p < .001$ ), sun exposure (OR=2.25, 95% CI: 1.08 – 4.67,  $p < .03$ ) and skin color (OR=2.76, 95% CI: 1.24 – 6.14,  $p < .01$ ) were significantly associated with NR in comparison to control. **Conclusion:** Exclusive breast-feeding for >4 months, sunlight exposure <30 minutes/day, dark skin color, number of siblings, urban slum residence, deficit monthly income, and parent's education are the risk factors for NR in Bangladeshi child.

**Keywords:** Nutritional rickets, Risk factor of nutritional rickets,, vitamin D deficiency management, 0-5 years of age.

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### I. Main Body

#### Background

Nutritional rickets is a major pediatric concern in the both developed and developing countiers, having different aetiologies.<sup>1</sup> Worldwide it is considered the most common non-communicable disease in pediatric age group.<sup>1,2</sup> Although it was thought a disease of the west, but recent trends suggest that it is an emergent problem in developing part also.<sup>2</sup> In Bangladesh rickets is the second most common micronutrient deficiency.<sup>3</sup>

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.<sup>4</sup> A severe vitamin D deficiency impairs mineralization of bone tissue (causing osteomalacia in adult) and of growth plates (manifesting as rickets in children).<sup>4</sup>

The prevalence of malnutrition in Bangladesh is among the highest in the world.<sup>5</sup> Millions of children and women suffer from one or more forms of malnutrition. Today malnutrition not only affects individuals but its effects are passed from one generation to the next. Similarly, the vitamin D stores of the newborn depend entirely on the vitamin D stores of the mother. If the mother is vitamin D deficient, the infant will be deficient because of decreased maternal fetal transfer of vitamin D.<sup>5</sup> Inadequate exposure to sunlight and less dietary intake during pregnancy and lactation cause both inadequate body stores in the newborn and in breast-milk.<sup>6</sup> Despite having adequate sunlight throughout the year, a substantial number of children suffer from this preventable disease. Study shows that, several factors other than inadequate sunlight exposure, such as exclusive breast feeding, darker skin, poor housing, fully covered dressing style of mothers, large family size, poor socio-economic condition and multiparity have been implicated.<sup>4</sup>

Environmental pollution is one of the major health hazards in Bangladesh, which is also considered as a contributing factor for the development of rickets.<sup>3</sup> 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.<sup>7</sup> In North America, rickets is most commonly seen in children with relatively more pigmented skin, who are exclusively breastfed.<sup>8</sup> In Australia<sup>9</sup> and Europe<sup>10</sup>, rickets is mostly identified in immigrant populations from the Middle East and the Indian subcontinent.<sup>8</sup> In the Middle East,<sup>11</sup> 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.<sup>8</sup> In sun-exposed regions of Asia and Africa, rickets typically presents during the second or the third year of life.<sup>8</sup> Nonetheless, there had been reports of calcium deficiency associated with rickets in South Africa and Nigeria.<sup>12</sup>

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.

## **II. Materials And Methods:**

### **Design, subjects and Statistics:**

This study was carried out in Dhaka Shishu Hospital (DSH), SHER-E-Bangla Nagar, DHAKA, Bangladesh for the duration of 2 years extending from November 2015 to December 2017. Total 120 children, aged 0-5 years were selected in according to the prior selection criteria and they were divided into two groups denoted as case and control. In each group, total 60 consecutive child were interviewed. In this study child attending into the DSH outpatients department with clinical, radiological and biochemically consistent with NR were considered as case. Similarly, equal number of apparently healthy children were considered as control. Nutritional rickets was diagnosed in according to the study done by Sumi SP et al., (2018). Written informed consent was taken from the parents and formal ethical approval was taken before commencement of the study from the DSH. Purposive convenient sampling technique was followed during selection of the study participants and data was collected under the guidance of a performed questionnaire. The specialized questionnaire was made on the basis of prior studies undergone in this topics with scientific new insight. Chi-square test, Man Whitney U test, binary logistic regression analysis were considered for data analysis. 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.

## **III. Results:**

Total 120 subjects were included in this study. Sixty children of nutritional rickets were included as cases and another 60 (apparently healthy) age and sex-matched child were included as control. Mean age of cases and controls were respectively  $29.40 \pm 11.65$  months and  $28.66 \pm 13.57$  months. Majority were male in both groups (85% of cases and 80% of controls). Table 1 shows the distribution subjects according to age and sex.

Table 2 shows the distribution of subjects according to socio-economic variables. Majority of cases came from urban slum area (40%) and majority of control came from rural area (43.3%). The difference was significant ( $p < 0.05$ ). Both father and mother of rachitic children (cases) were significantly less educated than that of control group ( $p < 0.05$ ). Among cases prevalent occupation of family heads were day laborer (26.7%), farmer (25%) and rickshaw-puller (16.7%). Among controls, prevalent occupation was service (38.3%). This difference in occupation of family heads were significant ( $p < 0.05$ ). Monthly income was assessed by asking the parents if their monthly income were sufficient for monthly budget or not. Among cases majority had an insufficient income (68.3%). Among controls more than half (51.7%) had sufficient monthly income. This difference was also significant ( $p < 0.05$ ).

Table 3 shows the distribution of subjects according their mothers' dressing habit during pregnancy, and number of siblings. Mother's dressing habit showed a similar distribution across groups ( $p > 0.05$ ). Cases had significantly more siblings than control ( $p < 0.05$ ).

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 cases (43.3%) had darker skin than controls (21.7%,  $p<0.5$ ). Majority of the cases (73.3%) were exclusively breastfed for 4 to 6 months. But, more than half of the controls were breastfed exclusively less than 4 months. This difference was significant. Controls were significantly more frequently exposed to sunlight for more than 30 minutes than control ( $p<0.05$ ).

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, mother's dressing behavior, number of siblings, urban slum residence, deficit monthly income, and father and mother's education in years. All the factors assessed showed significant odds of developing rickets ( $p<0.05$ ) except mother's dress.

#### **IV. 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.<sup>3</sup> A national survey conducted in 2008 the prevalence of rickets was found 0.99%.<sup>13</sup> Although calcium deficiency has been found to be the primary cause of nutritional rickets here,<sup>3,7</sup> The role of vitamin D deficiency is also under investigation.<sup>14,15</sup> 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.<sup>16</sup>

In this study 120 subjects were included for assessment of risk factors for rickets. Rachitic children were taken as cases and age and sex matched control were taken as control. Mean ages of 60 cases and 60 controls were respectively  $29.40\pm 11.65$  months and  $28.66\pm 13.57$  months ( $p>0.05$ ). Similar to the findings of other studies<sup>16,17</sup> 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 40% of the rachitic children had come from urban slum area which was significantly high in relation to controls (18.3%,  $p<0.05$ ). A similar finding was noted by Bakeit and Megeid.<sup>18</sup> Talukder et al<sup>16</sup> 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 cases was found to be significantly lower in years than control ( $p<0.05$ ). Yassin and Lubbad<sup>19</sup> 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 were doing low income jobs. In comparison to control significantly higher proportion had insufficient income ( $p<0.05$ ). This confirms the findings Talukder et al<sup>16</sup> and Karim et al<sup>17</sup> 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 Creolet et al<sup>14</sup> also enlists poverty as a risk factor of rickets.

Number of family members is important for health. Within a given economic condition increase in family member is associated increased division of available food and therefore, nutrition. This study found a significantly higher proportion of rachitic children (46.7% compared to 26.7% of control) had three or more sibs ( $p<0.05$ ). This finding conforms to that of Molla et al.<sup>20</sup> But, Thacher et al<sup>21</sup> found no differences of family size of cases and control. It could be due to their place of study where they reported a larger average family size.

Fully covering the body for maximum time of day may cause decreased exposure to sunshine and may act as a risk factor for rickets.<sup>14</sup> In Middle-East mothers with daily exposure to sunlight less than 1 hour during pregnancy was found to be associated with nutritional rickets.<sup>18</sup> In this study also, mothers wearing fully covered dresses were found higher in cases than that of control.

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.<sup>1,14,22</sup> Although, Specker et al<sup>23</sup> 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<sup>1</sup> 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 ( $p<0.05$ ) except mother's dressing in this study. Jose et al<sup>24</sup> and Thacher et al<sup>21</sup> found that children with family history of rickets had higher odds of developing rickets which was not evaluated in this

study. Bakeit and Megeid<sup>18</sup> studied effect of gestational vitamin D and calcium supplementation on rickets and found those to be significant, too.

## V. Conclusion:

Nutritional rickets is a multifactorial disease and several factors have been associated with it. However, to identify the risk factors responsible for nutritional rickets among the 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, increased number of siblings, residence in urban slum, deficit monthly income, and parent's education are also significantly associated with this disabling disease.

### Limitation of the study

- Long term and repeated follow up were beyond scope due to lack of fund
- Impact of genetic influence and sun exposure cannot be considered

### List of abbreviations:

ALP- Alkaline phosphatase  
DSH-Dhaka Shishu Hospital  
NNR-Non-nutritional rickets  
NR-Nutritional rickets  
PTH- Parathyroid hormone  
SD-Standard Deviation  
SPSS-Statistical package for social science

## VI. Declarations:

### Ethical consideration

The researcher was duly concerned about the ethical issues related to the study. Formal ethical clearance was taken from the ethical review committee of the Dhaka Shishu Hospital for conducting the study. Confidentiality was maintained properly and study did not violate any human right and protects health rights at first instance.

**Consent of Publication:** Not applicable

**Availability of data and material:** Data and materials supporting our findings in the manuscript will not be shared. It was not in accordance with participants' verbal consent

**Competing Interests:** The authors declare that there is no conflict of interests regarding the publication of this paper.

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### Author Contributions:

SPS conceived and developed the concept of the study. Conception and design of this Research were made by MJH, SPS and MJA. MJH & SPS wrote the first draft of the manuscript and MJA, AASMNA, MMA, MAT and MSI reviewed the draft. All authors read and revised the article and SPS approved the final manuscript.

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**Supplementary Materials:** Not Applicable.

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**13. List of Tables:**

**Table 1. Age and Sex distribution of subjects (n=120)**

Variable	Case (n=60)	Control (n=60)	p
<b>Age in years</b> (mean±SD)	29.40±11.65	28.66±13.57	0.75*
<b>Sex, n(%)</b>			
Male	51 (85)	48 (80)	0.47**
Female	9 (15)	20 (12)	

\* p determined by Mann Whitney U test  
\*\* p obtained by  $\chi^2$  test

**Table 2. Distribution of subjects according to socio-economic condition (n=120)**

Variable	Case (n=60)	Control (n=60)	p*
<b>Residence, n(%)</b>			
Rural	22 (36.7)	26 (43.3)	0.02
Urban	14 (23.3)	23 (38.3)	
Urban Slum	24 (40)	11 (18.3)	
<b>Father's Education, n(%)</b>			
None	23 (38.3)	12 (20)	0.003
1 – 5 years	22 (36.7)	14 (23.3)	
6 – 10 years	11 (18.3)	19 (31.7)	
> 10 years	4 (6.7)	15 (25.0)	
<b>Mother's Education, n(%)</b>			
None	27 (45)	12 (20)	<0.001
1 – 5 years	23 (38.3)	16 (26.7)	
6 – 10 years	8 (13.3)	20 (33.3)	
> 10 years	2 (3.3)	12 (20.0)	
<b>Occupation of family head, n(%)</b>			
Service	10 (16.7)	23 (38.3)	0.03
Farmer	15 (25)	10 (16.7)	
Business	8 (13.3)	9 (15)	
Day Laborer	16 (26.7)	6 (10)	
Rickshaw-puller	10 (16.7)	8 (13.3)	
Other	1 (1.7)	4 (6.7)	
<b>Monthly Income</b>			
Insufficient	41 (68.3)	29 (48.3)	0.02
Sufficient	19 (31.7)	31 (51.7)	

\* p obtained by  $\chi^2$  test

**Table 3. Distribution of subjects according to maternal dressing habit and number of siblings (n=120)**

Variable	Case (n=60)	Control (n=60)	p*
<b>Mother's dress, n(%)</b>			
Fully covered	49 (81.7)	44 (73.3)	0.27
Partially covered	11 (18.3)	16 (26.7)	
<b>Number of Siblings, n(%)</b>			
< 3	32 (53.3)	44 (73.3)	0.02
≥ 3	28 (46.7)	16 (26.7)	

\* p obtained by  $\chi^2$  test

**Table 4. Distribution of subjects according to factors related to children (n=120)**

Variable	Case (n=60)	Control (n=60)	p*
<b>Skin color, n(%)</b>			
Fair	6 (10)	18 (30)	0.02
Medium	28 (46.7)	29 (48.3)	
Dark	26 (43.3)	13 (21.7)	
<b>Exclusive breastfeeding, n(%)</b>			
4 – 6 months	44 (73.3)	26 (43.3)	0.001
< 4 months	16 (26.7)	34 (56.7)	
<b>Sunlight Exposure, n(%)</b>			
more than 30 min	24 (40)	36 (60)	0.03
less than 30 min	36 (60)	24 (40)	

\* p obtained by  $\chi^2$  test

**Table 5. Odds ratio of risk factors for rickets**

Variable	Odds Ratio	95% CI	p*
Exclusive breastfeeding (4 to 6 months)	3.59	1.67 – 7.74	0.001
Sunlight exposure <30 min	2.25	1.08 – 4.67	0.03
Skin color (dark)	2.76	1.24 – 6.14	0.01
Mother's dress (fully covered)	1.62	0.68-3.86	0.28
Number of siblings ≥3	2.41	1.12 – 5.16	0.02
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)	5.71	2.44 – 13.33	<0.001

\* p obtained by binary logistic regression analysis

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