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Original Research Article

Social dilemma and vitamin D deficiency: a cross-sectional study of nutritional rickets in children ages 6 months to 24 months

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ABSTRACT

Background: In developing countries, malnutrition's is one of the challenges that still need to be addressed. Undernutrition is usually a result of the unavailability of food and/or repeated infections in children. Countries with comparatively lower per-capita incomes as well as those with middle per-capita income have its increased prevalence in younger age. Social dilemma of mothers, like exclusively breastfeeding, heavy clothing's and practice of keeping babies inside the doors, lead vitamin D deficiency and ultimately into nutritional rickets. The objective of this study was to determine the frequency of factors leading to nutritional rickets in children ages 6 months to 24 months.
Methods: This cross-sectional study was conducted at Department of Pediatrics, Ayub Teaching Hospital, Abbottabad, Pakistan from March to December 2017. After inclusion/exclusion criteria, total 160 patients of rickets were observed. Detailed history followed by vitamin D level (<15 ng/ml) was measure. Data was analyzed by SPSS-22 and all documents were locked with principal author.
Results: Present study showed that 62% children were in age ranged 6-12 months and 38% children were in age range 13-24 months. Mean age was 12 months with SD±2.16. Seventy nine percent children were male, and 21% children were females. More over 52% children had exclusive breast feeding, and 48% children did not have exclusive breast feeding. Similarly, 15% children had limited sun-light exposure and 85% children did not have limited sun-light exposure.
Conclusions: Present study concluded that a lack of health education and sunlight exposure and exclusive breastfeeding were the significant risk factors contributed to nutritional rickets among children of Abbottabad, Pakistan.

Keywords: Children, Lower respiratory tract infections, Nutritional rickets

INTRODUCTION

In developing countries, malnutrition's is one of the challenges that still need to be addressed. The term malnutrition encompasses both over nutrition as well as under-nutrition. Under nutrition is usually a result of the unavailability of food and/or repeated infections in children.[1] When compared with well-nourished children, undernourished children have an increased risk of disease and death. Countries with comparatively lower per-capita incomes as well as those with middle per-capita income have an increased prevalence of under nutrition with about 129 million underweight children younger than five years of age living in this country.[2] They constitute 25% of the total undernourished child population worldwide. Most of these children belong to Asian (27%) and African (21%) countries. About 195 million or 28% of child population worldwide is stunted, and almost all of

this population is living in Africa and Asia.[3] Nutritional rickets develops as a result of disturbance of the equilibrium of calcium and phosphors in the body. Major clinical features of this disease include deformation of long bones, enlargement of wrist bones and costochondral junctions among other features. The most common cause of nutritional rickets is vitamin D deficiency rickets occur most commonly in exclusively breast-fed infants who do not have any vitamin D supplementation and maternal vitamin D deficiency. It is also present in those infants who have had limited exposure to sun light due either to poor social conditions such as overcrowding, adverse climatic conditions such as living at high altitude, or because of religious reason that necessitates over clothing.[4]

Delayed introduction of complementary foods in infants has also been reported as predisposing risk factors in nutritional rickets due to vitamin D deficiency. Other risk factors that have been known to be associated with nutritional rickets include poverty and illiteracy, technical reasons (working in garment factories), skin pigmentation and addictive habits (chewing betel nut) and increased parity of the mother. Although nutritional rickets have long been known to be present in children spending long time indoors watching television or using computers, it is also common in geographical areas of the world with rich sunlight.[5,6]

It has been reported that, 11.8% of children who were under exposed to sunlight developed nutritional rickets while its prevalence among children exclusively breast fed for one year or less was 58%. In northern Pakistan, the prevalence of nutritional rickets has been attributed to malnutrition, antenatal factors and lack of awareness.[7] Nutritional rickets is present in healthy infants too. Vitamin D deficiency is prevalent in South Asia with 40% of total population severely deficient in vitamin D. In this setup, social dilemma of mothers, like exclusively breastfeeding, heavy clothing's and practice of keeping babies inside the doors, lead Vit-D deficiency and ultimately into nutritional rickets.

The rationale of this study was to identify the risk factors associated with nutritional rickets in vitamin D deficient children between these ages of 6 months and 2 years in this region. The early recognition of such risk factors may prevent subsequent bone damage and fractures and the complications of late onset respiratory distress and delayed growth. This study will serve the purpose of serving as a baseline for future studies targeting early diagnosis and prevention of nutritional rickets. The objective of this study was to determine the frequency of factors leading to nutritional rickets in children ages 6 months to 24 months.

METHODS

This cross-sectional study was conducted at Department of Pediatrics, Ayub Teaching Hospital, Abbottabad, Pakistan from March to December 2017. Total 160 patients were observed by using the WHO software of sample size determination in health study software and keeping the prevalence of decreased sun-light exposure as 11.8% in children with nutritional rickets, 95% confidence interval to achieve a precision level of 5%. Consecutive non-probability sampling technique was used for sample collection. All the children presenting with symptoms of rickets and associated biochemical abnormalities (vitamin D levels <15 ng/ml), aged 6 months to 24 months and either gender were included while all the children with chronic illness like hepatic or renal disease, children on anticonvulsant medicines for more than six months, children had evidence of skeletal dysplasia and pre-term children with hypocalcemia were excluded. Informed consent was taken from their parents/ guardians. A detailed history was taken from the parents/attendants accompanying the ill child was noted. A blood specimen drawn from the children under strict aseptic conditions were sent to the hospital laboratory of Ayub Teaching Hospital, Abbottabad, Pakistan for measurement of vitamin D levels for confirmation of diagnosis.

Data collected on pro forma was analyzed in SPSS version 22. Mean±SD was calculated for quantitative variables like age, percentages, and frequencies were computed for categorical variables like gender, the presence of the risk factors, e.g., limited exposure to sunlight and exclusive breast feeding. Stratified analysis of outcome variable, i.e., nutritional rickets on limited exposure to sunlight and exclusive breast feeding were done. Chi-square test was used at 5% significant level to determine the association between the outcome measure and the risk factors.

RESULTS

Total n=160 (100%) children suffering from nutritional rickets with mean age of 12±2.16 years participated in the study. N=126 (78.8) were male and n=34 (21.3%) were female whereas n=99 (61.9%) were from 6-12 months and n=61 (38.1%) were 13-24 months. N=83 (51.9%) were exclusively breast fed and n=136 (85%) were not properly exposed to sunlight (Table 1).

Table 1: Frequencies and percentages of studied variables.

Variable		Frequencies	%
Gender	Male	126	78.8
	Female	34	21.3
Age-group (months)	6-12	99	61.9
	13-24	61	38.1
Exclusive breast feeding	Yes	83	51.9
	No	77	48.1
Limited sunlight exposure	Yes	24	15.0
	No	136	85.0
Total		160	100.0

About 78.8% of male and 50.0% from 6-12 years of age were deprived of sunlight. Age-group resulted in significant correlation with sunlight exposure (p <0.005) whereas, gender had no positive correlation (Table 2).

Table 2: Cross tabulation of gender and age-group with limited sunlight exposure (chi-square test).

Variable		Limited sunlight exposure			P value
		Yes	No	Total	
Gender	Male	19 (11.9%)	107 (78.8%)	126 (78.8)	0.957
	Female	5 (3.1%)	29 (18.1%)	34 (21.3%)	
Age-group (months)	6-12	19 (11.9%)	80 (50.0%)	99 (61.9%)	0.049
	13-24	5 (3.1%)	56 (35.0%)	61 (38.1%)	
Total		24 (15.0%)	136 (85%)	160 (100%)	

More males 41.3% infants 31.9% were exclusively breast fed the females 10.6% and elder children 20.0%. Pearson chi-squared test was insignificant for both (Table 3).

Table 3: Cross tabulation of gender and age-group with exclusive breastfeeding (chi-square test).

Variable		Exclusive breast feeding			P value
		Yes	No	Total	
Gender	Male	66 (41.3%)	60 (37.5%)	126 (78.8%)	0.805
	Female	17 (10.6%)	17 (10.6%)	34 (21.3%)	
Age-group (months)	6-12	51 (31.9%)	48 (30.0%)	99 (61.9%)	0.908
	13-24	32 (20.0%)	29 (18.1)	61 (38.1%)	
Total		83 (51.9%)	77 (48.1%)	160 (100%)	

DISCUSSION

Nutritional rickets caused by a deficiency of vitamin D has been strongly associated with lower respiratory tract infections. Deformities in the chest like Harrison grove occurs from pulling off the softened ribs by diaphragm during inspiration. Softening of the ribs impairs air movement and predisposes patient to atelectasis and pneumonia. Besides, vitamin D deficiency which is the primary cause of nutritional rickets is also associated with an increased incidence of lower respiratory tract infections. Vitamin D has a role in innate immune system.[3]

Present study showed that 62% children were in age ranged 6-12 months and 38% children were in age range 13-24 months. Mean age was 12 months with SD±2.16. Seventy-nine percent children were male, and 21% children were females. More over 52% children had exclusive breast feeding and 48% while children didn't. Similarly, 15% children had limited sun-light exposure and 85% children didn't had limited sun-light exposure.

Similar results were found in another study conducted by Siddiqui TS et al, in which 11.8% of children who were under exposed to sunlight developed nutritional rickets while its prevalence among children exclusively breast fed for one year or less was 58%.[7] In northern Pakistan, the prevalence of nutritional rickets has been attributed to malnutrition, antenatal factors and lack of awareness. Nutritional rickets is present in healthy infants too. Vitamin D deficiency is very common in South Asia with 40% of total population severely deficient in vitamin D.

Infants who are breast-fed but do not receive supplemental vitamin D or adequate sunlight exposure are at increased risk of developing rickets.

However, in light of growing concerns about sun- light and skin cancer, it seems prudent to recommend that all breast-fed infants be given supplemental vitamin D. It is interesting to find out that rickets was more frequent even among children who were breast-fed for more than one year that is, the longer duration of breast feeding, the higher frequency of rickets.[8]

The gradient effect of breastfeeding duration also persists. However, exclusive breastfeeding was not reported within a time frame, and this needs further investigation. Exclusive breast feeding beyond six months without vitamin D supplementation was identified as a risk factor for rickets in children. In Alaska, the contribution of breast feeding to vitamin D deficiency has likely increased in recent years with an increase in the proportion of women who breast feed longer than six months from 28% of infants during 1990 to 50% during 2000.[9] The recent breastfeeding promotion may have led to the belief that the exclusively breast-fed infant is in need of no further supplements. However, this belief does not coincide with these findings that the early introduction of complementary food (starts at three months as reported by mothers) has a protective effect against rickets.[10]

The gradient effect of introducing complementary food persists when adjusting for other independent variables. Low rate of rickets was reported among children whom their mothers have better and improved child-rearing practices in terms of being more aware of the weaning food, its quality and the appreciate age for starting to wean. Delayed complementary feeding may lead to a breast milk depended child who prefers breast milk over complementary food.

Nevertheless, the exact age at which to introduce complementary food, duration of complementary, appropriate frequency of feeding, content and factors affecting intake of complementary food are beyond the scope of the current study and require further investigation.[11]

As reported by mothers, rickets was more frequent among children who did not receive eggs, fishes, and milk. In our culture, most of mothers either stayed with their children or taking care of them most of the time. So, they can easily recall what they fed their children even since long period which minimize the recall bias. This result was true for children whom their mothers did not consume the same food stuff.

Only the gradient effect of egg and fish persists. However, foods consumed were not reported within a time frame, and this needs further investigation. Such food stuff are exogenous sources of vitamin D. Therefore, consumption of the above foodstuff protects against the development of rickets.[12] A previous study revealed high prevalence of vitamin D deficiency among nursing mothers without fish in their diet. Most of the Palestinian people especially the poor ones consume inadequate amount of fish due to its high price. Instead, mothers could depend on eggs, milk and its derivatives as an available and cheap source of vitamin D to feed herself and her child. However, economic, social and cultural factors should not be excluded. Rickets was higher in children who were not exposed to sunlight than in those who were exposed. This was also true for children whom their mothers were not exposed to sunlight implying that sunlight exposure is a key factor in the development of vitamin D deficiency rickets. The gradient effect of child exposure to sunlight persists when adjusting for other independent variables. It is known that endogenous vitamin D is produced in the skin from sunlight exposure.[13]

However, many factors in health-related behavior for good and ill, are operated and result in decrease production of vitamin D in the skin. Fear of the sun, especially in summer, is based on the community knowledge of sunstroke. This fear may become exaggerated, and measures are taken to avoid direct sunlight. During winter measures are taken to avoid an open well-ventilated place to protect the child from drafts and then common cold or respiratory infection. Therefore, women intended to dress their children heavy clothes. Moreover, infants are wrapped for long period. Thus, clothes absorb most ultraviolet radiation, and this will prevent the cutaneous production of vitamin D. Many studies showed that lack of sunlight exposure increases the risk of rickets. Distribution of rickets among children was decreased with increasing frequency of exposure to sunlight. The more the times the child had been exposed to sunlight, the more production of vitamin D in the skin.[14]

Similar results were obtained. Therefore, mothers are strongly advice to expose their children daily to sunlight. In this context, distribution of rickets was higher among children who had been fully dressed than those who had been worn diaper only or children to whom certain areas had been exposed during the time of exposure.

In the case of complete wrapping of the child, the skin source of vitamin D becomes cut off. Breast milk being a weak source of vitamin D, the neonate becomes gradually depleted of all vitamin D, and thus clinical signs of rickets appear sometimes later. Traditional cultural habits affected sunlight exposure that will decrease vitamin D synthesis in the skin.[15] The above results are supported with the conclusion that increase frequency of exposure to sunlight combined with being undressed is an important factor in the prevention of rickets.

Regarding house type, none of the control children were found to live in the basement compared to 11.8% cases. Of course, lack of sunlight exposure is the major cause reside behind such finding. Children who lived in flats were also found more likely to have rickets. Urbanization may lead to more congested living, less space, external courtyard. In addition, fear of accidents whether car accidents or falling down make parents not to allow their children to play either outdoors or in the veranda and this restricts their access to sunlight exposure.[16]

In Saudi Arabia, a survey showed lower serum 25-hydroxy vitamin D levels in urban areas than in rural areas, lower levels were among occupants of mud or

brick houses than tents. The sunlight frequently enters tents better than mud or brick houses. This supports this finding that the longer duration the house being sunlit, the lower prevalence of rickets among children.[17]

Another result revealed that the more deliveries the mothers had, the more rickets was found among their children. The gradient effect of deliveries number persists but with P value at the border line of significance (P=0.051). This could be attributed to the idea that increase number of deliveries may be associated with increase mother dietary intake. Despite that, increase number of siblings affect vitamin D, it may be a cause for vitamin D deficiency leading to nutritional rickets.[18]

In addition, association between obstetric factors and vitamin D deficiency rickets was reported. In view of this finding, the mother may not have enough time to replete her nutritional status particularly vitamin D and calcium after pregnancy, and she enters the next pregnancy in a worse state. Additionally, baby of such mother has little vitamin D stored in the liver, breast milk provides little more, and then rickets occurred.[19]

Hence, health education programs to enhance woman awareness on frequent pregnancy would be fruitful. The necessity of such health education was obvious when author found that rickets was more likely 41.3 times higher among children of mothers who did not receive health education. The gradient effect of health education persists when adjusting for other independent variables.

Mothers, who had sought advice from both doctors and mother- and child-care workers, were found to have the lowest number of rachitic children.[20]

CONCLUSION

Present study confirms that lack of mother education, exposure to sunlight and exclusive breast feeding plays a subtle role in nutritional rickets especially in males of 6-12 years of age. In present setup, typical mothers pay more attention to their children clothing's, believe in social myths so, kept them warm and protected all the time which leads to less sunlight exposure. Secondly, either due to poverty or lack of education, many mothers exclusively breast feed their children. This doesn't provide basic nutritional needs of the rapidly growing child and leads to rickets type of diseases.

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