

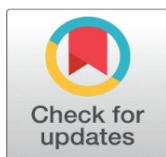
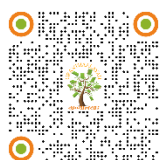
CHARACTERISTICS AND ASSOCIATED RISK FACTORS AMONG CHILDREN DIAGNOSED WITH RICKETS PRESENTING TO A TERTIARY CARE HOSPITAL IN SRI LANKA

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ABSTRACT

Objective: This study aimed to identify characteristics and associated risk factors among children diagnosed with rickets in a tertiary care hospital.

Methodology: A descriptive cross-sectional study was conducted, in children diagnosed with rickets who attended the University Pediatric clinic at Teaching Hospital Karapitiya, Sri Lanka. Data was collected on sociodemographic factors, pregnancy-related factors, birth-related factors, breastfeeding, complementary feeding practices, playing environment, exposure to sunlight, clinical signs, and laboratory investigations. Known risk factors were identified through literature and assessed in the study.

Results: A total of 36 patients diagnosed with rickets were included in the study. Majority (58.3%) were males, and from rural areas (77.8%). It was observed that 72.2% of children were vitamin D deficient and 25% had insufficient level, while serum calcium and phosphate levels were normal in the majority 72.2% (n=26) and 47.2% (n=17) respectively. Indoor physical activities and inadequate sun exposure (75%), prolonged breastfeeding (69.4%) and low socio-economic status (61.1%) were identified as the most common risk factors for rickets.

Conclusion: This study concludes that all rickets patients in the study sample were Vitamin D deficiency rickets and is a significant health problem particularly in rural areas. Inadequate sun exposure, prolonged breastfeeding, and low socio-economic status are the most significant risk factors associated with Vitamin D deficiency rickets. Early diagnosis and management of rickets are crucial to prevent complications and to improve outcomes.

Keywords: Rickets, Vitamin D, Deficiency, Risk Factors

1. INTRODUCTION

Rickets is a childhood bone disorder that results from inadequate vitamin D, calcium, or phosphorus [Chibuzor et al. \(2020\)](#). It is characterized by soft, weak bones, which can lead to skeletal deformities, stunted growth, and other health complications. Rickets is a relatively rare condition in developed countries, but it

still affects many children worldwide, particularly in regions with limited access to sunlight, nutritious food, or medical care.

Rickets begins during childhood, typically between 3-18 months of age [Leveille et al. \(2017\)](#). Incidence is almost equal among males and females. Bone tenderness and increased risk of bone fractures, particularly green stick fractures, are the common symptoms at the early ages [Meštrović \(2018\)](#). Infants might show early skeletal deformities such as craniotabes, i.e., soft skull bones [Harvey et al. \(2014\)](#), [Prentice \(2013\)](#) delayed closure of fontanelle, and frontal bossing. Children diagnosed with rickets often exhibit specific characteristics and risk factors that may contribute to the development or exacerbation of the disease. Some common features of rickets include delayed motor milestones, bow-legs or knock knees, skeletal pain, muscle weakness, and dental problems. These symptoms can vary in severity depending on the underlying cause and duration of the disease.

The risk factors associated with rickets can be classified into two main categories: environmental and genetic. Environmental risk factors include low exposure to sunlight, poor nutrition, Malabsorption disorders, and certain medications. Genetic risk factors include inherited disorders that affect vitamin D metabolism, such as hypophosphatemic rickets and X-linked hypophosphatemia [Leveille et al. \(2017\)](#), [National Institutes of Health. \(2013\)](#).

Radiograph of untreated, advanced rickets show bow legs, deformed chest, and skull changes, which give a classic square-headed appearance described as caput quadratum. Epiphyseal changes at the long bones are cupping, splaying, and fraying [Chibuzor et al. \(2020\)](#). Blood tests reveal high levels of parathyroid hormone (PTH) and alkaline phosphatase (ALP) and low levels of calcium, phosphorus, and 25(OH)D, which is a marker for vitamin D levels.

This paper discusses characteristics and risk factors of rickets among children at the University pediatric clinic at the Teaching Hospital Karapitiya. Understanding these factors is essential for preventing and managing rickets, improving children's bone health, and minimizing the long-term complications of this disease.

2. METHODOLOGY

2.1. STUDY DESIGN & SETTING

A descriptive cross-sectional study was conducted, among children diagnosed with rickets who attended the University Pediatric clinic at Teaching Hospital Karapitiya Karapitiya which is one of main tertiary care hospitals in Sri Lanka during the period between 2021 and 2022.

2.2. ETHICAL CLEARANCE

The ethical approval was obtained from the Ethics review committee of the Faculty of Medicine, University of Ruhuna [2021/P/026].

2.3. EXCLUSION & INCLUSION CRITERIA

Children with at least one skeletal feature and the radiological evidence of rickets were included in the study sample. The skeletal features include bowlegs, epiphyseal widening, rachitic rosary, craniotabes, and knocked knee. Radiological features included cupping, splaying, and spraying at the metaphysis. At the same time, children with other medical conditions that may affect bone health and non-consenting patients were excluded from the study.

2.4. DATA COLLECTION

Written informed consent was obtained from the parents of the children. The data extraction/collection was carried out using an interviewer-administered structured questionnaire. Collected data included sociodemographic factors, pregnancy-related factors, birth-related factors, breastfeeding, and complementary feeding practices, playing environment, exposure to sunlight, clinical signs, and laboratory investigations. Existing risk factors for rickets were identified through literature and assessed in the questionnaire

2.5. PARTICIPANTS

A convenient sample of 36 children attended to the University Paediatric Unit, Teaching Hospital Karapitiya during two years' duration (2021 to 2022) was considered as the study sample. Sample size was calculated using formula used for descriptive studies with finite population correction [Lwanga et al. \(1991\)](#).

2.6. STATISTICAL ANALYSIS

The data was analyzed using SPSS software (version 22.0). Descriptive statistics were used to summarize the characteristics of the study participants. Frequency and percent distributions were computed for qualitative data, and mean and standard deviation was used to present quantitative variables.

3. RESULTS

Among the 36 children diagnosed with rickets, majority were males (58.3%). Majority were from rural area (77.8%) and had unsatisfactory monthly income (61.1%). Sociodemographic, pregnancy related, birth related, breastfeeding and complementary feeding related and other relevant factors were assessed and given in the [Table 1](#). Around 75.0% of children had indoor physical performances and unsatisfactory exposure to direct sunlight. Moreover, 69.4% of children were on exclusive breastfeeding up to 6 months and 47.2% had continued breast feeding beyond 2 years of the age. Weight, height, and occipital- frontal circumference (OFC) were assessed under anthropometric parameters of the children. Mean (SD) of the weight, height and OFC were 12.3 (4.6) kg, 84.1 (14.4) cm and 48.1 (2.8) cm respectively.

Table 1

Table 1 Characteristics of Children with Rickets (n=36)		
Variables		Frequency (%)
Sociodemographic factors		
Gender	Male	21(58.3)
	Female	15(41.7)
Area of Residence	Rural	28(77.8)
	Urban	8(22.2)
Income	Unsatisfactory (<60,000 Rupees)	22(61.1)
	Satisfactory (≥ 60,000 Rupees)	14(38.9)
Siblings	Yes	32(88.8)
	No	4(11.1)
Family history	Rickets	3(8.3)

	Osteoporosis	1(2.8)
	Rheumatoid arthritis	1(2.8)
Pregnancy-related factors		
Complicated pregnancy	Yes	15(41.6)
	No	21(58.4)
Multivitamins taken during pregnancy	Yes	33(91.7)
	No	3(8.3)
Exposure to sunlight during pregnancy	Satisfactory	13(36.2)
	Unsatisfactory	23(63.8)
Diet	Vegetarian	2(5.6)
	Non-veg	34(94.4)
Birth related factors		
Mode of delivery	Normal vaginal delivery	11(30.5)
	Caesarian section	25(69.5)
Birth weight	<3000 grams	17(47.2)
	Above 3000 grams	19(52.8)
Maturity at birth	Pre-term	3(8.3)
	Term	33(91.7)
Postnatal complications	Neonatal Sepsis	3(8.3)
	Respiratory distress	6(16.7)
	Neonatal jaundice	5(13.9)
	Breastfeeding difficulties	4(3.1)
The age that the deformities were noticed	<1 year	6(16.7)
	1 – 2 years	24(66.6)
	>2 years	6(16.7)
Age at the diagnosis	<1 year	1(2.8)
	1 – 2 years	26(72.2)
	>2 years	9(25.0)
Breastfeeding and complementary feeding factors		
Exclusive breastfeeding	< 4 months	5(13.9)
	4 to 5 months	6(16.7)
	Up to 6 months	25(69.4)
Formula milk given during the first 6 months	Yes	3(8.3)
	No	33(91.7)
Breastfeeding continuation	Up to 6 months	1(2.8)
	Up to 1 year	3(8.3)
	Up to 2 years	15(41.7)
	More than 2 years	17(47.2)
Other Factors		
Playing environment	Indoor	27(75.0)
	Outdoor	9(25.0)
Exposure to sunlight	Unsatisfactory	27 (75.0)
	Satisfactory	9(25.0)

Radiological features, clinical features and laboratory findings were assessed. Among the radiological features, all the children had cupping, splaying, and fraying

at the time of diagnosis. Genu varus and epiphyseal widening were identified as common clinical presentations (Table 2).

Table 2

Table 2 Radiological and Clinical Signs Among Children with Rickets at the Diagnosis (N=36)		
Variables	Frequency	Percentage
Cupping	36	100
Splaying	36	100
Fraying	34	94.4
Genu varus	32	88.9
Epiphyseal Widening	32	88.9
Frontal bossing	26	72.2
Waddling gate	14	38.9
Osteopenia	9	25.0
Rachitic rosary	6	16.7
Genu Vulgum	4	11.1
Bone Pain	4	11.1
Fractures	4	11.1

The biochemical results that support the patients' diagnosis of rickets are shown in Table 3. It was observed that 72.2% of children were vitamin D deficient and 25% were insufficient. Serum calcium and phosphate levels were normal in most cases while PTH (97.2%) and alkaline phosphatase (97.2%) levels was high in the majority.

Table 3

Table 3 Laboratory Findings of Children with Rickets at the Diagnosis (N=36)	
Investigation	Frequency (%)
Serum calcium level (mmol/L); mean (SD) 2.24(0.32)	
Low	7(19.5)
Normal	26(72.2)
High	3(8.3)
Serum Phosphate level (mmol/L); mean (SD) 1.68(0.34)	
Low	4(11.1)
Normal	17(47.2)
High	15(41.7)
Serum ALP level (U/L); mean (SD) 842.66(484.14)	
Low	0(0.0)
Normal	1(2.8)
High	35(97.2)
Serum PTH level (pg/ml); mean (SD)* 214.34(115.08)	
Low	0(0.0)
Normal	1(2.8)
High	31(97.2)
Vitamin D level (ng/ml); mean (SD) 35.79(19.93)	
Deficient	26(72.2)
Insufficient	9(25.0)
Sufficient	1(2.8)

*PTH levels available for 32 children only

4. DISCUSSION

The present study investigated the characteristics and associated risk factors among patients diagnosed with rickets. Our findings suggest that rickets is still a significant public health issue among children. Sri Lankan children still experience vitamin D deficiency rickets despite year-round sunshine and food fortified with vitamin D.

Children need vitamin D to develop their bones and for the linear growth [Holick \(2007\)](#). Nutritional rickets is a disorder where a developing child's growth plate and osteoid are not properly mineralized. In extreme situations, it is linked to fragility fractures and can cause deformities of the bones commonly lower limbs [Munns et al. \(2016\)](#), [Pettifor and Prentice \(2011\)](#). Nutritional rickets can be brought on by dietary calcium deficiency, vitamin D deficiency or a combination of the two [Munns et al. \(2016\)](#). Insufficient food intake and inadequate skin exposure to sunshine are the two main causes of vitamin D deficiency [Bikle \(2014\)](#), [Prentice \(2013\)](#). Singleton et al. highlight lack of vitamin D supplementation as risk factors for rickets [Singleton et al. \(2015\)](#). An Indian study reported that 78.34% of children with rickets experienced unbalanced nutrition whereas children whose mothers had poor nutritional status comprised about 67% [Akram et al. \(2022\)](#). We also consistently identified that vitamin D was deficient among most enrolled children diagnosed with rickets.

Rickets is caused by vitamin D deficiency, which is usually obtained through exposure to sunlight. It was discovered that children who were fully dressed when exposed to sunlight had a 48% incidence of rickets, compared to 31% of infants who were not oil-massaged during sunlight exposure. We observed in our study, that 75% of patients diagnosed with rickets had a low level of sunlight exposure, a known risk factor for rickets. This finding highlights the importance of promoting outdoor activities and increasing awareness of the importance of sunlight exposure among children.

The nutritional value of breast milk is very important for the child's growth and development; however, prolonged exclusive breastfeeding is linked to under-nutrition, short stature and inadequate weight gain due to its low vitamin content [Syeda et al. \(2021\)](#). As demonstrated in the present study, 69.4% of children were on exclusive breastfeeding up to 6 months, and most of them were not given formula milk, continued frequent breastfeeding after 6 months might result in vitamin D deficiency, particularly in the absence of maternal vitamin D sufficiency and/or sufficient supplementation in the complementary diet [Uday et al. \(2021\)](#). According to a French study, most infants with rickets were nursed exclusively without getting enough vitamin D supplements [Flot et al. \(2020\)](#).

There are limitations in our study that should be considered. First, the study's cross-sectional design does not allow for the establishment of causality between the risk factors and the development of rickets. Second, the study was conducted in a single geographical area, limiting the findings' generalizability to other populations.

Despite these limitations, our study provides important insights into the characteristics and associated risk factors among patients diagnosed with rickets. The findings of this study can be considered in public health interventions that are aimed at preventing rickets among children and improving the population's overall health. Further research is needed to confirm this study's findings and identify other risk factors that may contribute to the development of rickets.

5. CONCLUSION

In conclusion, our study provides valuable insights into the characteristics and associated risk factors among patients diagnosed with rickets. The findings of this study highlight the importance of promoting sunlight exposure, ensuring adequate vitamin D and calcium intake, and discouraging prolonged breastfeeding without adequate vitamin D in the complementary food. Health education campaigns targeting parents, healthcare professionals, and the general public can be useful in preventing the occurrence of rickets and reducing their prevalence.

CONFLICT OF INTERESTS

None.

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