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Determinants of Rickets among Under Five Children in Yekatit 12 Hospital, Case Control Study Addis Ababa, Ethiopia

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Abstract

Background: Rickets resulting from vitamin D deficiency is seen in infants and young children in many African countries including Ethiopia. Vitamin D deficiency due to low exposure to sun light, sub optimal exclusive breast feeding and low vitamin D intake is one of the health problems in Ethiopia. This study assessed the determinants of rickets in Yekatit 12 hospital Addis Ababa.

Methods: Facility based case control study was conducted among under five children at Yekatit 12 hospital, Addis Ababa, from November 2016-April 2018. A total of 270 (91 cases and 179 controls) were included in the study. Medical records of cases and controls were revised for anthropometric measurement, clinical signs of rickets and radiologic evidence. Additional information about the study participants was obtained from care givers through questionnaire. Data were analyzed using SPSS version 23.00. The association between dependent and independent variables were assessed by multiple logistic regressions. Factors with P-value <0.05 were taken as statistically significant.

Results: A total of 270 under five children were enrolled in the study, 91 were cases and 179 were controls and the response rate was 92%. Significant variables associated with rickets were children who exposed to sunlight more than 30 minutes per day (AOR=7.7,95% CI 1.95-30.72),children who were not exposed to direct exposure to sun light (AOR=3.99,95% CI 1.33-11.98), children with applied baby oil before sun exposure (AOR=10.6,95%CI 3.76-30.138), children who had dark brown skin (AOR=18.7, 95%CL 3.3-106.3), children with age group of 12-23 months (OR=4.9 95%CI 1.57-15.45) and mother whose occupational status of house wife (AOR=6.47 95%CI 1.04-40.11) identified factors.

Conclusion: This study showed that sun exposure is significantly associated with rickets. Duration of sun exposure per minutes, direct exposure, application of baby oil, skin color of the baby and occupational status of the mother were significantly associated. Health education should be given to increase awareness about sun exposure and on the proper techniques of sun exposure.

Keywords: Rickets; Vitamin D; Sun Exposure

Introduction

Rickets is the failure of mineralization of growing bone and cartilage [1]. Vitamin D is a prohormone that is essential for normal absorption of calcium from the gut, and deficiency of vitamin D is associated with rickets in growing children and osteomalacia in adults. Vitamin D plays an essential role in maintaining bone health through regulating calcium concentrations in the body [2].

Nutritional rickets remains an endemic problem in many developing countries and has re-emerged in a number of developed countries, where it was thought that the disease had been almost eradicated [3]. Vitamin D deficiency is considered to be the most common nutritional deficiency and also one of the most common undiagnosed medical conditions in the world [4].

Despite a large part of Africa lying within the tropics and subtropics, vitamin D deficiency rickets is still seen in infants and young children in many African countries. Social and religious customs which prevent adequate sunlight exposure probably play a major role, but rickets has also been associated with severe under nutrition and poverty [3].

The most important source of vitamin D is the skin's synthesis of the vitamin from sunlight [5]. The amount of vitamin D synthesized by our skin depends on a number of factors: the age of the individual, the amount of skin exposed, the duration of exposure, geographic-related factors, sun block use, and the skin pigment of the individual [2]. Case control study done in Jimma university showed significant difference observed between case and controls in terms of frequency of exposure to sunlight per week, which reflects that vitamin D deficiency emanating from poor exposure to radiant energy is the main cause of rickets in Ethiopian children [6].

A high prevalence of vitamin D deficiency exists in tropical countries, particularly in children. In Ethiopia, prevalence of vitamin D deficiency (serum 25(OH) D <50 nmol/L) was 42% in all school children in Adama city, with students in urban setting being more likely to be deficient than their rural counterparts. Serum 25(OH) D levels <50 nmol/L was seen in 61.8% and 21.2% of urban and rural children, respectively with the general assumption that rural populations are outdoor workers [7].

The amount of skin that is exposed to the sun is important. At least 20% of the body's surface should be exposed to UV-B for blood vitamin D concentrations to increase [1]. Increased urbanization and increased time spent indoors at work may lead to decreased time spent outdoors and, therefore, decreased vitamin D synthesis, even in light-skinned populations. Cloud Cover, Air Pollution, and Altitude, increasing water vapor, and industrial pollution can reduce the amount of UV-B that reaches the earth's surface, and industrial pollution has been associated with a greater prevalence of vitamin D–deficiency rickets. People with a naturally dark skin tone have natural sun protection and require at least three to five times longer exposure to make the same amount of vitamin D as a person with a white skin tone [8].

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Decreased nutritional intake of Vitamin D Lower intake of vitamin D-fortified foods, particularly milk and fortified cereals, may result in vitamin D-deficiency rickets in certain populations, particularly in dark-skinned people who live in higher latitudes and in the winter months. The decreased intake may be from choice or from necessity in societies poor enough to be unable to afford these foods. Reduced intake of fortified milk is common among adolescents and young women of childbearing age, which results in decreased vitamin D concentrations in blood [1]. Decreased vitamin D levels in the mother result in decreased Tran's placental transfer of vitamin D and reduced stores at birth. Serum 25(OH)-D levels in infants correlate with maternal serum 25(OH)-D [9]. This study addressed the determinants of vitamin D deficiency rickets at yekatit 12 hospital

Methods and Materials

The study was conducted at yekatit 12 hospital located in Arada sub city, Addis Ababa which is one of the government general hospitals of Addis Ababa found near to Addis Ababa University College of Social Science. The study was conducted in pediatrics outpatient and inpatient wards of the hospital.

Unmatched case control study was conducted to identify determinants of rickets among under five children. Total sample size was 295, 99 cases and 196 controls.

Cases were under five children in the study area during the study period who has rickets. Cases were identified based on the confirmation of the diagnosis of rickets clinically and radio logically and were defined by the presence of two or more clinical signs (rachitic rosaries, chest wall deformity, frontal bossing, wide anterior fontanel, craniotabes, caput quadratum wide wrist and double maleoli), and radiological evidence of rickets, i.e. cupping and fraying of the ends of the ulna and radius, and widening of the epiphysis, on wrist X-ray. Controls were all under five children in the study area during the study period who are not diagnosed with rickets and don't have any sign of rickets.

Hospital registration book was revised and cases of rickets who attended the hospital between November 2016-April 2018 were selected. Each case medical record was revised for evidence of rickets and anthropometric records. Every rickets cases who were taking treatment during the study period were all also included. Controls were selected from children who came to Yekatit 12 for other medical purpose during the study period. Medical record of controls was revised for absence of rickets and for anthropometric records.

The questionnaire were prepared in English and translated to Amharic, then back translated to English to keep the consistency of the questions. For all Controls questionnaires were filled at the time of data collection. For some of the cases who were taking treatment at the time of data collection and come for follow up questioners were filled at that time and for others complete information was obtained by calling to the care givers. During data collection, the supervisors followed data collectors and performed quality checks with the principal investigator. The data were coded, cleaned, entered using EPI data version 3.1 and analyzed using SPSS version 23 for descriptive and inferential analysis. Relationships between variables analyzed by means of simple cross-tabulations, scatter plots, and see measures of association rickets and associated factors of vitamin D deficiency rickets for cases and controls. Finally, multivariable logistic regression model was done to identify their independent predictors of rickets. Parameter estimates presented using adjusted odds ratios and 95% confidence intervals. All test were two sided and P values <0.05 was used to declare statistical significance. Ethical clearance was obtained from Jimma University Institute of Health Ethical Review Board. Data was collected after getting informed written consent signed by the parents/guardian.

Result

Socio demographic characteristics

A total of 270 under five children were enrolled in the study, 91 were cases and 179 were controls and the response rate was 92%. Out of which 160 were males and 110 were females. The mean ± SD age of the respondents was 1.80 ± 0.50 years for cases and 1.86 ± 0.52 years for controls. Regarding occupation of mother's 51.6% cases and 45.3% of controls were housewives and concerned with occupation of fathers, 36.9% cases and 37.4% controls were government workers. Regarding educational status mothers, 38.5% were cases and 45.3% were controls above grade 12 (Table 1).

Sun Exposure status, reasons not to use sun exposure and frequency of sun exposer per week

Concerned with status of exposure to sun light 53.8% of cases and 5% of controls did not have sun exposure. The reasons which were identified for lack of exposure to sunlight were: lack of adequate space (28.8%), fear of bad weather (27.1%) , lack of awareness (27.1%), inconveniences of the mother due to different reasons; business, loneliness and mothers who have twin children accounts (10%) and fear of evil eye (6.8%).

There direct exposure of sun light was 43.8% in cases and 85.1% in controls. With regard to application of baby oil, 78.6% of cases applied baby oil before sun exposure, while only 26.6% controls applied baby oil before sun exposure Figure 1.

The dietary diversity of children, the mean ± SD diversity score of cases and controls was 4.25 ± 1.17 and 5.03 ± 2.02, respectively. Majority of children in the cases (57.1%) and controls (72.6%) were exclusively breastfed for the first 6 months. Analysis of their nutritional status showed that 52% of the cases and 33.5% the controls were wasted.

Determinant factors associated with rickets

On cross tabulation of different variables with the dependent variable, age of child, educational status of mother, duration of exclusive breast feeding, intake of milk , fish intake, egg intake, cheese intake, yoghurt intake, duration and frequency of exposure to sunlight , body part exposed, skin color, direct exposure , application of baby oil, type of house, place for where children were playing, whether the child played or not, DDS and MUAC of the child were the variables which showed association with rickets (p<0.25).

Table 2 Nutritional intake showing frequency of egg, fish, milk& milk products intake per week among under 5 children who attended Yekatit 12 hospital, Addis Ababa, Ethiopia.

On multivariable logistic regression analysis. Significant variables associated with rickets were children who exposed to sunlight for more than 30 minutes per day were 7.7 times higher than who exposed less than 30 minutes (AOR=7.7,95% CI 1.95-30.72),children who exposed to direct exposure to sun light were 3.99 times higher than who didn't exposed (AOR=3.99,95% CI 1.33-11.98), the odds of having rickets was 10.6 times higher in children baby oil was applied before sun exposure than in children who didn't apply (AOR=10.6,95%CI 3.76-30.138), children who had dark brown skin were 18.7 times higher than children who had light brown skin (AOR=18.7, 95%CL 3.3-106.3), rickets was

Characteristics	Case (91)	Control (179)
Sex		
Male	50(54.9%)	11.9(61.5%)
Female	41(45.1%)	69(38.5%)
Age		
0-11months	22(24.2%)	38(21.2%)
12-23 months	48(52.7%)	53(29.6%)
24-60 months	21(23.1%)	88(49.2%)
Religion		
Christian	66(72.5%)	137(76.5%)
Muslim	25(27.5%)	42(23.5%)
Educational status of mother		
Illiterate	23(26.3%)	44(24.6%)
Primary school	25(27.5%)	24(13.4%)
Secondary school	8(8.8%)	30(16.8%)
Above 12	35(38.5%)	81(45.3%)
Educational status of father		
Illiterate	9(9.9%)	21(11.7%)
Primary school	16(17.6%)	27(15.1%)
Secondary school	17(18.7%)	40(22.3%)
Above 12	49(53.8%)	91(50.8%)
Occupation of mother		
Private and government	37(40.7%)	89(49.7%)
Merchant	7(7.7%)	9(5%)
Housewife	47(51.6%)	81(45.3%)
History sun exposure		
Yes	42(46.2%)	170(95%)
No	49(53.8%)	9(5%)
Type of house		
Story	73(80.2%)	136(76%)
Villa	12(13.2)	12(6.7%)
Condominium	6(6.6%)	31(17.3%)

Table 1: Socio-demographic characteristics of under-five children in Yekatit 12 hospital, Addis Ababa, Ethiopia.

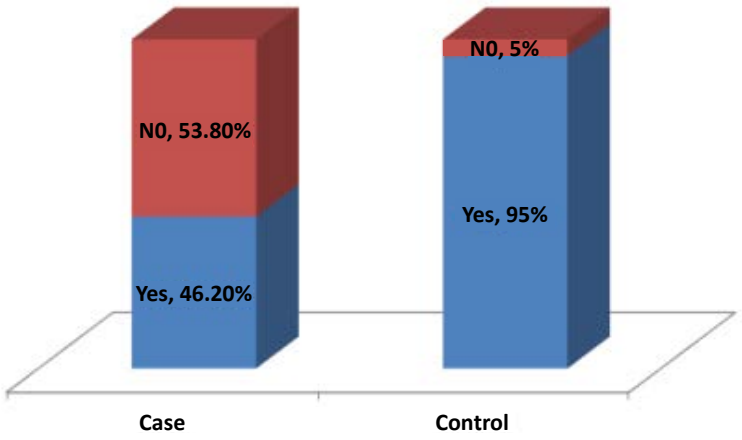

Figure 1: Sun exposure statuses of cases and control in Yekatit 12 hospital, Addis Ababa, Ethiopia.

4.9 times higher in children with age group of 12-23 months than age group of 24-39 months (OR=4.9 95%CI 1.57-15.45) and Conversely, the odds of rickets in children whose mother had occupational status of house wife was 6.4 times higher as compared to mothers whose occupational status was private and government employed (AOR=6.47 and 95%CI 1.04-40.11) Table 3.

Variable	Frequency per week	Case	Control	P
Milk	None	31(34.1%)	37(20.7%)	0.022
	1 to 3 times	39(42.9%)	77(43%)	
	>3 times	21(23.1%)	65(36.3%)	
Fish	None	77(84.6%)	106(59.2%)	<0.001
	1 to 3 times	9(9.9%)	62(34.6%)	
	>3 times	5(5.5%)	11(6.1%)	
Egg	None	43(47.3%)	52(29.1%)	0.003
	1 to 3 times	39(42.9%)	85(47.5%)	
	>3 times	9(9.9%)	42(23.2%)	
Cheese	None	71(78%)	136(76%)	0.002
	1 to 3 times	6(6.6%)	33(18.4%)	
	>3 times	14(15.4%)	10(5.6%)	
Yogurt	None	72(79.1%)	146(81.6%)	0.003
	1 to 3 times	7(7.7%)	27(15.1%)	
	>3 times	12(13.2%)	6(3.4%)	

Table 2: Nutritional intake.

Variables	Cases	Controls	AOR
Age of child			
0-11 months	22(24.2%)	38(21.2%)	3.879(.990-15.199)
12-23 months	58(42.7%)	53(29.6%)	4.935(1.576-15.45)
24-59months	21(23.1%)	88(49.2%)	1
Occupation of mothers			
Housewife	47(51.6%)	81(45.3%)	6.47(1.04-40.111)
Merchant	37(40.7%)	89(49.7%)	1.1 28(.349-3.648)
Private and government employee	7(7.7%	9(5%)	1
Educational status of mother			
Illiterate &primary	48(42.8 %)	68(37.1%)	.314(.0910-1.09)
Secondary& above	43(47.3%)	111(62.1%)	1
Yogurt intake per week			
None	72(79.1%)	146(81.6%)	.647(.063-6.6)
1-3 days	7(7.7%)	27(15.1%)	.748(.056-9.93)
Above three	12(13.2%)	6(3.4%)	1
Duration of exposure to sunlight			
< 30 minutes	39(90.6%)	111(65.7)	7.747(1.95-30.71)
30 minutes and above	4(8.4%)	58(34.3%)	1
Skin color			
Very dark	19(20.9%)	6(3.4%)	1.675(.608-4.61)
Dark Brown	37(40.7%)	61(34.2%)	18.704(3.29-106.2)
Light brown	35(38.5%)	112(62.2%)	1
Direct exposure to sunlight			
No	20(45.9%)	25(14.8%)	3.99(1.33-11.98)
Yes	22(43.8%)	144(85.1%)	1
Application of baby oil before sun exposure to sunlight			
Yes	33(78.6%)	45(26.6%)	10.638(3.75-30.14)
No	9(21.4%)	124(73.4%)	1
Maximum Standard error= 1.32, Homer Lemeshaw test (P=0.52			

Table 3: Multivariable logistic regression model fitted to identify significant independent predictors of having rickets among children who attended Yekatit 12 hospital, Addis Ababa, Ethiopia.

Discussion

Vitamin D is an essential nutrient for linear growth of bones and for reaching peak bone mass among children and adolescents. Vitamin-D-deficiency rickets is still a major health problem in developing countries. Inadequate direct exposure to ultraviolet rays of sunlight is the predominant cause of rickets [10]. The major cause of nutritional rickets in Ethiopian children is lack of exposure to sunshine and/or inadequate intake of vitamin D. Lack of awareness and traditional beliefs are major causes for not exposing infants to sunshine [11]. In this study the direct exposure of sun light was 43.8% in cases and 85.1% in controls.

The identified reasons for lack of exposure to sunlight were: lack of adequate space (28.8%), fear of bad weather (27.1%), lack of awareness (27.1%), inconveniences of the mother due to different reasons; business, loneliness and mothers who have twin children accounts (10%) and fear of evil eye (6.8%).

In this study, sunlight exposure for more than 30 minutes per day (AOR=7.7,95% CI 1.95-30.72), children who were not exposed to direct exposure to sun light (AOR=3.99,95% CI 1.33-11.98), children with applied baby oil before sun exposure (AOR=10.6,95%CI 3.76-30.138), children who had dark brown skin (AOR=18.7, 95%CL 3.3-106.3), children with age group of 12-23 months (OR=4.9 95%CI 1.57-15.45) and mother whose occupational status of house wife (AOR=6.47 95%CI 1.04-40.11) were significant variables associated with rickets.

In our finding the odds of having rickets was 7.7 times higher in children who were exposed to sun light for less than 30 min than those exposed for 30 min and above per day. The odds of having rickets was 3.9 times higher in children who didn't get direct exposure to sun light than those who got direct sun exposure. This finding was in line with the study done in black lion hospital also showed that lack of sun exposure 3.5 times increase prevalence of rickets than who were exposed [6].

With regard to application of baby oil, 78.6% of cases applied baby oil before sun exposure, while only 26.6% controls applied baby oil before sun exposure. Rickets was 10.6 times higher in children with applied baby oil before sun exposure than in children who didn't apply. The study done in Debre Markos, East Gojjam showed, almost all mothers (98.4%) apply lubricants on the infant's body during the time of sunlight exposure [12-15]. This makes prevalence of rickets in children was high.

Skin color was also significant predictor of rickets. In our study children who have dark brown skin were 18.7 times higher having rickets than children who had light brown skin. This finding was supported with people with a naturally dark skin tone have natural sun protection and require at least three to five times longer exposure to make the same amount of vitamin D as a person with a white skin tone [8].

Rickets was 4.9 times higher in children with age group of 12-23 months than age group of 24-59 months. This finding was line with the study done in Jimma which showed children in the age group12-23 months were 4.5 times more likely to develop rickets as compared to the other age groups [6]. Lack of adequate exposure to sunlight is one of the reasons at this age and prolonged exclusive breast feeding without proper complimentary feeding may predispose children to the development of rickets at this age.

Conclusion

This study showed that sun exposure is significantly associated with rickets. Duration of exposure per minutes, direct exposure, and application of baby oil, skin colors and mother's occupational status were identified variables associated with rickets. Health education should be given to increase awareness about sun exposure and on proper techniques of sun exposure such as the duration of exposure, body part exposed, application of baby oil.

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