Rickets and Its Associated Factors among Under-Five Children in Selected Public Hospitals in Eastern Ethiopia

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Abstract

Background: Rickets affects the rapid growth of children. It is prevalent in low-income countries, and ranks among the five most common diseases in children. However, its magnitude and associated factors are not well studied and documented in eastern Ethiopia. Therefore, the aim of this study was to assess the magnitude and the associated factors of rickets among under-five children in selected public hospitals of eastern Ethiopia.

Methods: A hospital based cross-sectional study was conducted from February 23 to March 10, 2017 among 590 under-five children in Hiwot Fana Specialized University Hospital, and Haramaya and Dilchora General Hospitals. Consecutive sampling was used to reach the actual respondents. Data were collected using a pre-tested questionnaire and the presence of rickets was assessed based on clinical signs and symptoms. Data were entered into EpiData Version 3.1 and exported into SPSS Version 22.0 for analysis. Bivariable and multivariable logistic regression models were fitted. Level of significance was considered at p-value less than 0.05.

Results: The magnitude of rickets was 7.8% (95% CI: 5.70, 10.20). Being under the care of caregivers (AOR=4.21; 95% CI: 1.31, 13.52), dressing fully during sun exposure (AOR=10.36; 95% CI: 3.37, 31.80), no oil massage during sun exposure (AOR=4.94; 95% CI: 2.01, 12.12), and being sick one month prior to the study (AOR=3.56; 95% CI: 1.51, 8.40) were positively associated with rickets.

Conclusion: One in every thirteen children had rickets in the study area. Being under the care of caregivers, dressing fully and no oil massage during sun exposure, and being sick one month prior to the study were significantly associated with rickets. Therefore, the health sectors should work to prevent rickets through counseling and encouraging of proper sunlight exposure and disease prevention.

Keywords: *Eastern Ethiopia; Rickets; Under-five Children*

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Introduction

Rickets is a disease of children characterized by a failure or delay in endochondral calcification of the growth plates (physis) of long bones during times of rapid growth. It results in widening and splaying of the growth plates and leads to enlargement of the wrists and costochondral junctions, bowed legs and knock-knee (Pettifor and Prentice, 2011). There are various causes responsible for the different forms of rickets (Prentice, 2013), but it is primarily caused by the lack of vitamin D, calcium and phosphate (Ahmed *et al.*, 2011).

Rickets is a universal problem and contributes to the high burden of illness and death among children below five years (Wondale *et al.*, 2005). It is reported worldwide (Matsuo *et al.*, 2009), including in the countries with a year-round opportunity for skin exposure to sunlight (Prentice, 2013). The problem is the most

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common non-communicable diseases affecting children, particularly in developing countries (Hatun *et al.*, 2005; Bishop, 2006; Bereket, 2010). It is most commonly seen in children from countries in Africa, the Middle East and Asia, although many of these countries are in the tropics with abundant sunshine (Craviari *et al.*, 2008; Bener and Hoffmann, 2010; Aggarwal *et al.*, 2012; Thacher *et al.*, 2012; Prentice, 2013). The magnitude of rickets varies in different studies in the world, ranging from 3.4% in Kenya to 70.9% in Pakistan (Najada *et al.*, 2004; Hatun *et al.*, 2005; Bener and Hoffmann, 2010; Theuri, 2012; Uush, 2013; Khalil, 2014; Aziz *et al.*, 2016; Sakr *et al.*, 2016; Alshammari *et al.*, 2018). In Ethiopia, the magnitude varies from 4% to 21.4% (Belachew *et al.*, 2005b; Kenenisa *et al.*, 2014; Derseh *et al.*, 2018). There is one report from Ethiopia which found lack of exposure to sunshine and inadequate intake of vitamin D might be the cause for rickets (Wondale *et al.*, 2005).

Rickets has the potential to produce an epidemic outbreak (Al-Atawi *et al.*, 2009), and if left untreated, it results in delay in developmental milestones, bone deformity and long term disability, pain, pathological fractures, obstructed labor, risk of falls and death (Misra *et al.*, 2008; Högler, 2015; Munns *et al.*, 2016), lower respiratory tract infections (Wondale *et al.*, 2005), restlessness, lack of sleep, underweight, and retarded growth (Nield *et al.*, 2006; Kenenisa *et al.*, 2014).

Many studies have shown that the development of rickets is related with low socioeconomic status (Agarwal *et al.*, 2002; Wondale *et al.*, 2005; Baroncelli *et al.*, 2008; Manaseki-Holland *et al.*, 2008; Bishay *et al.*, 2016). In addition, being male (Bereket, 2006; Lips, 2007; Aziz *et al.*, 2016), urban residence (Harinarayan *et al.*, 2007; Lips, 2007), insufficient family income (Bishay *et al.*, 2016), overcrowded living situation (Agarwal *et al.*, 2002; Bereket, 2006; Grant *et al.*, 2009), protein energy malnutrition (Wondale *et al.*, 2005; Wagner and Greer, 2008), dark skin pigmentation (Bereket, 2006), reduced sunlight exposure (Bela-chew *et al.*, 2005a; Bereket, 2006; Yassin and Lubbad, 2010; Kenenisa *et al.*, 2014; Bishay *et al.*, 2016; Mahmoud *et al.*, 2016) and air pollution (Agarwal *et al.*, 2002; Bereket, 2006) were significantly associated with the development of rickets.

Despite its burden and recommendations from many industrialized countries, there are no public health initiatives to address rickets prevention in resource-limited countries (Munns *et al.*, 2006; Mutlu *et al.*, 2011). Studies from some areas of Ethiopia indicate rickets is an important child health problem in the country (Belachew *et al.*, 2005b; Prentice, 2008; Pettifor, 2009; Kenenisa *et al.*, 2014; Derseh *et al.*, 2018). However, the magnitude and the associated factors of rickets in the eastern part of the country are not well studied and documented. Therefore, this study was aimed to assess the magnitude of rickets and the associated factors among under-five children in selected public hospitals of eastern Ethiopia.

Materials and Methods

Study design, area and period

A hospital based cross-sectional study was conducted among under-five children from February 23 to March 10, 2017 in selected public hospitals in eastern Ethiopia (Dilchora General Hospital, Haramaya General Hospital, and Hiwot Fana Specialized University Hospital).

Dilchora Hospital is one of the two public hospitals in Dire Dawa city, which is located at a distance of 515 kilometers to the east of Addis Ababa; capital city of Ethiopia. The hospital had 220 beds and 12 case teams to provide both inpatient and outpatient health care services to its catchment area. On the other hand, Haramaya Hospital is a general hospital, which is found in Haramaya town at a distance of 507 kilometers to the east of Addis Ababa. The hospital had 110 beds and 9 case teams to provide inpatient and outpatient health care services to the residents of Haramaya district and other neighboring districts. Hiwot Fana Hospital is a specialized University hospital which is found in Harar town at a distance of 526 kilometers to the East of Addis Ababa. The hospital had 163 beds and 12 case teams to provide referral inpatient and outpatient services to the residents of Harari Regional State and others surrounding it.

Sample size determination and sampling procedure

The sample size for this study was calculated by using a single population proportion formula considering the following assumptions: 95% confidence level, 2.5% margin of error, and the proportion of rickets among

under-five children from previous study in Jimma University Specialized Hospital, Southwestern Ethiopia (10.5%) (Kenenisa *et al.*, 2014). This resulted in sample size of 578. The final sample size was fixed at 636 after adding 10% for non-respondents.

The final sample size was allocated to each hospital proportionally based on number pediatrics patients attending each hospitals. The average number of pediatric patients flow for the past 15 days (i.e. data collection period of this study) was 450, 375 and 225 for Dilchora, Hiwot Fana and Haramaya Hospitals, respectively. Finally, all the children who visited the selected hospitals during the data collection were included in the study until the allocated sample size was attained.

Inclusion and exclusion criteria

Under-five children and their mothers/caregivers, who visited the Maternal and Child Health (MCH) clinic, pediatric Outpatient Department (OPD), nutrition rehabilitation unit and pediatrics inpatient ward of the selected public hospitals for health care services, were included. Seriously ill children and/or their mother/caregiver during the period of data collection were excluded from the study.

Data collection methods

Data were collected by the following methods;

Face-to-face interview: the children's mothers/caregivers were interviewed using semi-structured questionnaire by nine nurses who were supervised by three medical doctors. The questionnaire was developed by reviewing literatures, and it was used to collect data on socio-demographic and economic, associated factors, and dietary and non-dietary practices. A food frequency questionnaire was used to collect data on the consumption of different food groups during seven days before the study (CSA and WFP., 2019).

Anthropometric measurements: were done by the nurses who interviewed the mothers/caregivers. Digital weight scale was used to measure the weight of the children aged below two years, and their length was measured by wooden measuring board in lying position. For those who were two years old and above, digital weight scale, which had an attached height scale, was used to measure their weight and height. The weight scale was readjusted to zero and calibrated daily before data collection. During weight and height measurements, heavy clothes, shoes, bags or any other material were avoided. Body weight was measured to the nearest 0.1 kg, and length/height was measured to the nearest 0.1 cm (Fryar *et al.*, 2012; Casadei and Kiel, 2019).

Clinical diagnosis of rickets: The clinical diagnosis of rickets was made by the joint decision of the data collectors (nurses) and the supervisors (medical doctors) using an instrument containing five clinical features which was used by various studies (Strand *et al.*, 2007; Uush, 2013; Edwards *et al.*, 2014). The clinical features include; age <5 years, length/height-for-age z-score <-2 Standard Deviation (SD), leg pain/ bow legs/knock-knees, wrist enlargement, and costochondral enlargement. The presence of at least three clinical features was used to diagnose rickets. The instrument had been reported of having sensitivity=87%, specificity=76%, positive predictive value=73%, and negative predictive value=89% (Thacher *et al.*, 2002).

Data quality control

To maintain the consistency of the data collection tool, the questionnaire was first prepared in English language and translated to Afan Oromo, Amharic and Somali languages, and back to English language by professional translators. An intensive training was provided to the data collectors and the supervisors for four days. In order to evaluate the acceptability and applicability of the procedures and tools, a pre-test was done on 32 (5%) of the sample in Sabian Hospital (Dire Dawa) one week before the actual data collection. To check the completeness and consistency of the questionnaire, the data collectors were closely supervised during the data collection process by the supervisors. Double data entry was done to minimize errors during data entry by checking the consistency between the two data sets.

Data analysis

The data were cleaned and entered into computer using EpiData Version 3.1 and exported into Statistical Package for the Social Sciences (SPSS) Version 22.0 for analysis. Categorical variables were described using frequency and percentage. Continuous variables were described using appropriate summary measures after they had been assessed for normality. To categorize the average family income, the Ethiopian national payroll and taxation guide was used (The Global Payroll Association, 2108).

Anthropometric indices with z-score values were computed using the World Health Organization (WHO) Anthro Version 3.2.2 in order to analyze the nutritional status of the children. A low height-for-age, below -2 SD of the reference population, indicates stunting while below -3 SD indicates severe stunting. A low weight-for-height, below -2 SD of the reference population, indicates wasting, while below -3 SD indicates severe wasting. A child with a weight-for-age z-score below -2 SD of the reference population is underweight while a child below -3 SD is severely underweight (WHO, 2006; Olack *et al*., 2011).

In the bivariate analysis, Crude odds Ratio (COR) was computed to assess the association between each independent and the outcome variables. Then, the variables with p-value < 0.25 were included to multi-variable logistic regression analysis and the associated factors were identified by estimating Adjusted odds Ratio (AOR) with 95% Confidence Interval (CI). The final model was checked for goodness-of-fit using Hosmer-Lemeshow goodness-of-fit test. Finally, statistical significance was considered at p-value < 0.05.

Ethical considerations

Ethical clearance was secured from Institutional Health Research Ethics Review Committee (IHRERC) of the College of Health and Medical Sciences at Haramaya University. An official letter was written from Haramaya University to Dire Dawa City Administration Health Bureau, Hiwot Fana Specialized University Hospital and Haramaya District Health Office. Informed, voluntary, written and signed consent was obtained from each hospital's head, and child's parent/caregiver. The interviews and measurements were carried out privately in a separate room. Names and personal identifiers were not included in the questionnaire and checklist to ensure the confidentiality of participants' information. The mothers/ caregivers whose children had rickets were counseled by the data collectors and the supervisors. The children with acute under-nutrition were linked to the nutritional rehabilitation units of the respective hospitals.

Results

Socio-demographic characteristics of the study participants

Five hundred ninety under-five children with their mothers/caregivers were included in the final analysis yielding a response rate of 92.8%. Three hundred two (51.2%) of the children were male. The mean (± SD) age of the children was 24.2 (±15.9) months and 132 (24.2%) were in the age group of 12-23 months. More than half, 333 (56.4%), of the children were residents of rural area. Three hundred eighty seven (65.6%) of the children were from Muslim families. Three hundred (51.5%) of the children were from households with family size of 5-7. Two hundred twelve (38.8%) of the children were from families with an average monthly income of 1651-3200 Ethiopian Birr (ETB). The mean (± SD) age of the mothers/caregivers was 30.9 (±9.0) years and 519 (88.0%) were married. Half of them (51.2%) were housewives. Regarding educational status of the mothers/caregivers, 286 (48.7%) of them were unable to read and write (Table 1).

Child feeding practice

Two-hundred eighty (47.5%) of the children were on breastfeeding during the study period; the frequency of feeding was 8-12 times per day for 93 (33.2%) of the children. The duration of breastfeeding was two years and above for 183 (59.0%) of the children who were not on breastfeeding during the study period. Many of the children (56.2%) started complementary feeding at the age of six months, and 297 (57.8%) were initiated with breast milk at birth. Most of the study participants (86.9%) reported that there was no recommendation of special foods for children, while 569 (96.4%) reported as there were no food restrictions in their communities such as uncooked/raw foods, meat, fish and egg (Table 2).

The results of this study revealed that milk/milk products and cereals/grains/tubers were the most frequently consumed food groups by the children. Accordingly, 391 (79.1%) and 290 (58.7%) of the children consumed milk/milk products and cereals/grains/tubers every day in the last seven days prior to the study, respectively. Fish/fish oil, 13 (2.6%), fruits, 19 (3.8%), and meat, 32 (6.5%), were the least frequently consumed food groups in the study area (Table 3).

Table 1: Socio-demographic characteristics of mothers/caregivers and their children who visited Hiwot Fana, Ha-ramaya and Dilchora hospitals in eastern Ethiopia, 2017 (n=590).

Variables	Categories	Frequency	Percentage
Child birth order	First born	130	22.0
	Second born	159	26.9
	Third born	142	24.1
	Fourth and above	159	26.9
Child age (in completed months)	0-5	75	12.7
	6-11	88	14.9
	12-23	132	22.4
	24-35	128	21.7
	36-47	90	15.3
	48-59	77	13.1
Maternal/caregiver marital status	Married	519	88.0
	Single	30	5.1
	Divorced	20	3.4
	Widowed	21	3.5
Religion	Muslim	387	65.6
	Orthodox	141	23.9
	Protestant	62	10.5
Maternal/caregiver's occupation	Housewife	301	51.2
	Unemployed	26	4.4
	Self employed	73	12.4
	Government employed	86	14.6
	Farmer	102	17.3
Maternal//caregiver education	Unable to read and write	286	48.6
	Able to read and write	117	19.9
	Primary school(grade 1-8)	78	13.3
	Secondary school (grade 9-12)	37	6.3
	College and above	70	11.9
Family size (in number)	1-4	221	37.5
	5-7	304	51.5
	≥8	65	11.0
Average monthly income (in ETB)* (n=547)	≤600	20	3.7
	601-1650	124	22.7
	1651-3200	212	38.8
	3201-5250	127	23.2
	5251-7800	44	8.0
	7801-10900	20	3.7

**1US$ = 29.93 ETB*

Table 2: Child feeding practices among mothers/caregivers of under-five children who visited Hiwot Fana, Haramaya and Dilchora hospitals in eastern Ethiopia, 2017.

Variable	Categories	Frequency	Percentage
Frequency of breastfeeding (n=280)	Per need	29	10.4
	<8 times	84	30.0
	8-12 times	93	33.2
	>12 times	74	26.4
Duration of breastfeeding (n=310)	Never	21	6.8
	6 months	31	10.0
	One year	75	24.2
	≥ 2 years	183	59.0
Time of initiation for complementary feeding (n=494)	Before six months	113	22.9
	At six months	278	56.2
	After 6 months	103	20.9
First food given at birth (n=514)	Breast milk	297	57.8
	Water	151	29.4
	Other foods*	66	12.8
Special foods recommended for children in the community (590)	Yes**	77	13.1
	No	513	86.9
Special foods restricted for children in the community (590)	Yes ***	21	3.6
	No	569	96.4

Butter, formula milk, honey, porridge, and fruits (juice); ** Milk, porridge and potato; * uncooked/raw foods, meat, fish and egg*

Non-dietary practices

Out of the 590 children included in this study, 556 (94.2%) of them were directly exposed to the sunlight. Among the children who were exposed to the sunlight, 232 (41.7%) were initiated exposure at the age of one month and above, and 277 (49.8%) were partially undressed during the exposure. Besides, 295 (53.1%) of the children were exposed openly to the sky, and 260 (46.8%) were exposed for 10-15 minutes. The common practice during the sun exposure was massaging the child with oil in 348 (62.6%) of the children. Four-hundred sixty-seven (79.2%) of the children were found to be fully vaccinated for their age; while 191 (32.4%) were sick in the last month prior to the study (Table 4).

Nutritional status of children

Concerning the nutritional status of the children, 76 (12.9%) of them were found severely stunted. In addition, 130 (22.0%) were severely underweight. Furthermore, 175 (30.3%) of the children were severely wasted (Table 5).

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Table 3: Consumption of different food groups (in frequency and percentage) in the seven days preceding the study among under-five children who visited Hiwot Fana, Haramaya and Dilchora hospitals in eastern Ethiopia, 2017 (n=494).

Variable	Frequency of consumption				
	Never	< Once a week	1-2 times a week	3-6 times a week	Daily
Cereals/grains/tubers	52 (10.5%)	17 (3.4%)	11 (2.2%)	124 (25.1%)	290 (58.7%)
Legumes/pulses	102 (20.6%)	19 (3.8%)	22 (4.5%)	251 (50.8%)	100 (20.2%)
Fruits	266 (53.8%)	32 (6.5%)	99 (20.0%)	78 (15.8%)	19 (3.8%)
Vegetables	130 (26.3%)	115 (23.3%)	54 (10.9%)	80 (16.2%)	115 (23.3%)
Eggs	199 (40.3%)	145 (29.4%)	34 (6.9%)	45 (9.1%)	71 (14.4%)
Fish/fish oil	395 (80.0%)	73 (14.8%)	7 (1.4%)	6 (1.2%)	13 (2.6%)
Meat	296 (59.9%)	126 (25.5%)	14 (2.8%)	26 (5.3%)	32 (6.5%)
Milk/milk products	37 (7.5%)	24 (4.9%)	2 (0.4%)	40 (8.1%)	391 (79.1%)

Table 4: Non-dietary practices towards the prevention of rickets among under-five children who visited Hiwot Fana, Haramaya and Dilchora hospitals eastern Ethiopia, 2017.

Variable	Categories	Frequency	Percentage
Age at first sun exposure (n=556)	First week	61	11.0
	Second week	179	32.2
	Third week	84	15.1
	After one month	232	41.7
Dressing during sun exposure (n=556)	Undressed	173	31.1
	Partially undressed	277	49.8
	Fully dressed	106	19.1
Way of sun exposure (n=556)	Open to the sky	295	53.1
	Under shade	156	28.1
	Inside home	109	18.9
Duration of sun exposure in minutes (n=556)	<10	86	15.5
	10-15	260	46.8
	15-20	169	30.4
	>20	41	7.4
Common practice during sun exposure (n=556)	Oil massage	348	62.6
	Breast feeding	72	12.9
	Nothing	136	24.5
Child vaccinated for his/her age (590)	Yes	467	79.2
	No	123	20.8
Child sickness one moth prior to the study (590)	Yes*	191	32.4
	No	399	67.6

**Pneumonia, upper respiratory tract infections, diarrhea and vomiting*

Table 5: Nutritional status of under-five children who visited Hiwot Fana, Haramaya and Dilchora hospitals in eastern Ethiopia, 2017.

Nutritional indices	Nutritional status	Frequency	Percentage
Height-for-Age (z-score) (n=590)	Normal (≥ -2)	462	78.3
	Moderate stunting (-3 to < -2)	52	8.8
	Severe stunting (< -3)	76	12.9
Weight-for-Age (z-score) (n=590)	Normal (≥ -2)	346	58.6
	Moderate underweight (-3 to < -2)	114	19.3
	Severe underweight (< -3)	130	22.0
Weight-for-Height (z-score) (n=577)	Normal (≥ -2)	262	45.4
	Moderate wasting (-3 to < -2)	140	24.3
	Severe wasting (< -3)	175	30.3

Magnitude of rickets and associated factors

The magnitude of rickets among the under-five children who visited the three hospitals was 46 (7.8%) (95% CI: 5.7, 10.2). In the bivariable analysis, late initiation of complementary feeding, full dressing during sun exposure, no oil massaging during sun exposure, being sick one month prior to the study, and underweight were the significantly associated factors with rickets among the under-five children (P<0.05).

In the multivariable analysis, being under the care of the caregiver, full dressing during sun exposure, no oil massaging during sun exposure, and being sick one month prior to the study were identified as the significantly associated factors of rickets among the under-five children (P<0.05).

The odds of rickets was 4.21 times higher among the children who were under the care of caregivers compared to those who were under the care of their mothers (AOR=4.21, 95% CI: 1.31, 13.52). Those children

who were exposed to sunlight with full dressing were 10.36 times more likely to have rickets compared to the undressed ones (AOR=10.36, 95% CI: 3.37, 31.80). The occurrence of rickets was 4.94 times higher in the children who were not on oil massaging during sun exposure compared to those who were on oil massage (AOR=4.94, 95% CI: 2.01, 12.12). Moreover, the children who were sick in the last one month preceding the study were 3.56 times more likely to develop rickets compared to children who were not sick (AOR=3.56, 95% CI: 1.51, 8.40) (Table 6).

Table 6: Factors associated with rickets among under-five children who visited Hiwot Fana, Haramaya and Dilchora hospitals in eastern Ethiopia, 2017.

Variables	Categories	Rickets		COR (95% CI)	AOR (95% CI)ϕ
		Yes (%)	No (%)		
Relation of respondent to the child	Caregiver	8 (11.3)	63 (88.7)	1.61 (0.72, 3.60)	**4.21 (1.31, 13.52)***
	Mother	38 (7.3)	481 (92.7)	1	1
Age of mother/caregiver	≤ 30 years	32 (9.2)	315 (90.8)	1.66 (0.87, 3.19)	1.86 (0.75, 4.58)
	>30 years	14 (5.8)	229 (94.2)	1	1
Marital status of mother/caregiver	Non-married	8 (11.3)	63 (88.7)	1.61 (0.72, 3.60)	1.53 (0.46, 5.08)
	Married	38 (7.3)	481 (92.7)	1	1
Time for complementary feeding initiation	< 6 month	9 (8.0)	104 (92.0)	1.33 (0.57, 3.08)	0.42 (0.13, 1.35)
	> 6 month	13 (12.6)	90 (87.4)	2.22 (1.04, 4.75)	1.78 (0.66, 4.77)
	At six month	17 (6.1)	261 (93.9)	1	1
Recommended foods for children in the community	Yes	9 (11.7)	68 (88.3)	1.70 (0.79, 3.68)	0.33 (0.12, 1.02)
	No	37 (7.2)	476 (92.8)	1	1
Way of dressing during sun exposure	Dressed fully	23 (21.7)	83 (78.3)	6.57 (2.71, 15.94)	**10.36 (3.37, 31.80)****
	Partially undressed	9 (3.2)	268 (96.8)	0.80 (0.29, 2.18)	0.81 (0.25, 2.62)
	Undressed	7 (4.0)	166 (96.0)	1	1
Common practice during sun exposure	No oil massage	28 (13.5)	180 (86.5)	4.77 (2.32, 9.80)	**4.94 (2.01, 12.12)****
	Oil massage	11 (3.2)	337 (96.8)	1	1
Immunization	No	13 (10.6)	110 (89.4)	1.55 (0.79, 3.05)	1.42 (0.52, 3.91)
	Yes	33 (7.1)	434 (92.9)	1	1
Sick in last one month	Yes	30 (15.7)	161 (84.3)	4.46 (2.37, 8.41)	**3.56 (1.51, 8.40)***
	No	16 (4.0)	383 (96.0)	1	1
Underweight	Yes	26 (10.7)	218 (89.3)	1.94 (1.06, 3.57)	2.38 (0.99, 5.73)
	No	20 (5.8)	326 (94.2)	1	1

*AOR: Adjusted Odds Ratio; CI: Confidence Interval; COR: Crude Odds Ratio; ϕfinal model goodness-of-fit using Hosmer-Lemeshow test (p=0.11); *significant at p<0.05; **significant at p<0.001*

Discussion

The magnitude of rickets was 7.8% in the study area. Being under the care of caregiver, full dressing during sun exposure, no oil massaging during sun exposure, and being sick in the last one month prior to the study were identified as positively associated factors of rickets among the under-five children.

The magnitude of rickets in this study is similar with the studies conducted in Ethiopia (10.5%) (Kenenisa *et al.*, 2014), Turkey (6%) (Hatun *et al.*, 2005), and Jordan (10.6%) (Najada *et al.*, 2004). However, it is higher than the magnitudes reported from Kenya (3.4%) (Theuri, 2012) and Saudi Arabia (3.5%) (Khalil, 2014). The possible explanation for these variations may be due to differences in socio-economic, demographic and cultural characteristics, sample size, study period and diagnostic parameters.

Odds of rickets in our study was higher among the children under the care of caregivers than those under their mothers. This is consistent with the finding in Ethiopia (Belachew *et al.*, 2005b). This can be expressed as the affection between children and caregivers is not as strong as the affection between children and mothers, which results in poor child care like feeding and sunlight exposure.

One of the potential sources of vitamin D is synthesis in the skin from the ultraviolet-B light fraction of the sunlight. Decreased sunlight exposure occurs when sunlight is attenuated by clouds, air pollution, or shade. Lifestyles or cultural practices that decrease time spent outdoors or increase the amount of body surface area covered by clothing when outdoors further limit sunlight exposure. The effects of sunlight exposure on vitamin D synthesis are also decreased for individuals with darker skin pigmentation and by the use of sunscreens (Fuller and Casparian, 2001; Roth *et al.*, 2005). The effect was seen in the current study; those children who were exposed to sunlight with full dressing were more likely to have rickets compared to fully undressed ones. This is supported by various previous studies (Belachew *et al.*, 2005a; Belachew *et al.*, 2005b; Bereket, 2006; Yassin and Lubbad, 2010; Kenenisa *et al.*, 2014; Bishay *et al.*, 2016; Mahmoud *et al.*, 2016). However intense exposure to the solar ultraviolet rays during childhood and adolescence increases a person's risk of developing melanoma and basal cell carcinoma (Etzel *et al.*, 2003).

The occurrence of rickets in this study was higher in children who were not on oil massage during sun exposure compared to their counterparts. There one report which indicates practice of oil massage and sunbath helps in the synthesis of vitamin D in the skin (Balasubramanian and Ganesh, 2008).

According to the current study, the odds of rickets was higher among the children who were sick in the last one-month preceding the study compared to their counterparts. This result is in line with study reports from Ethiopia (Wondale *et al.*, 2005) and Jordan (Najada *et al.*, 2004). This can be explained as rickets is a risk factor for infections particularly lower respiratory infection (Wondale *et al.*, 2005). This is because vitamin D may play a role in activating the innate immune system which the endogenous antimicrobial peptide can attracts monocytes and neutrophils and prevents viral and bacterial infections (Leikina *et al.*, 2005).

The study has some limitations; it might not show the temporal relation between the independent and dependent variables since it is a cross-sectional study. There is also the possibility that some of the responses might suffer from recall bias since the questions for the dietary practices were based on recall. To minimize this bias, the data collectors were trained on how to probe the respondents by starting with the most recent food items consumed. In addition, the study participants were given sufficient time for adequate recall of long term memory. Also, sub-clinical rickets patients might have been missed since the diagnosis was based on clinical signs and symptoms. Furthermore, some children with other bone problems might have been diagnosed as having rickets as a result of similar signs and symptoms.

Conclusion

The study revealed that nearly one in thirteen children had rickets in the study area. Being under the care of the caregiver, full dressing during sun exposure, no oil massaging during sun exposure, and being sick in the last one month prior to the study were identified as positively associated factors of rickets among the under-five children. Therefore, the health sectors/health personals should work on the prevention of rickets through appropriate provision of information on sun exposure, oil messaging at time sun exposure and disease prevention. In addition, large scale studies supported by laboratory and radiological investigations should be conducted to produce more accurate magnitude estimates of rickets and its associated factors.

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Conflict of Interest

The authors declare that they have no competing interests.

Contribution of Authors

KS initiated the research, and all of the authors contributed in proposal writing, data entry and analysis, drafting and revising the paper, and manuscript writing.

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