Vol. 16(2), pp. 30-43, July-December 2024
DOI: 10.5897/IJMMS2024.1513
Article Number: D1D3E6472648
ISSN 2006-9723

http://www.academicjournals.org/IJMMS

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International Journal of Medicine and Medical Sciences

Full Length Research Paper

Assessment of the practice of exposing infants to sunlight and associated factors among caregivers attending Asella Teaching and Referral Hospital, Southeast Ethiopia

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Received 24 July, 2024; Accepted 11 September, 2024

This study is an overview of a previous study conducted in Debre Berhan town in 2021, which highlighted that a significant percentage of participants had poor practice in sunlight exposure for infants. It mentions that mothers, particularly housewives or government employees aged 33 and above, believe that sunlight strengthens infant bones and improves their health. Additionally, it states that mothers who received information from healthcare professionals were more likely to have good practice in sunning their infants. The background highlights the worldwide Vitamin D deficiency pandemic due to the lack of awareness about the importance of sensible sunlight exposure. This study aims to assess the practice of exposing infants to sunlight and the associated factors among caregivers attending Asella Teaching and Referral Hospital during a specific time frame. The materials and methods explain the study design, which is a facility-based cross-sectional design conducted at Arsi University, College of Health Sciences Asella Teaching and Referral Hospital. It mentions the data collection method using structured questionnaires and the individuals involved in collecting the data. The analysis was performed using SPSS version 21, and the results were presented using text, tables, and graphs. According to the results, all the caregivers were interviewed, and 50.8% of them had good practice in sunning their infants. The section mentions that caregivers' and husbands' educational status, caregivers' perception, and sources of information were significantly associated with the practice of exposing infants to sunlight. This indicates that these factors play a role in determining the caregivers' practices. The conclusion states that nearly half of the participants had poor practice in sunning their infants, emphasizing the need for attention from health professionals and other concerned bodies regarding sunlight exposure for infants.

Key words: Rickets, sunlight exposure, ultraviolet index, vitamin D, vitamin D deficiency (VDD).

INTRODUCTION

The healing power of the sun and its use in medical treatment (heliotherapy) has extended back into ancient times vstarting from about 1400 BC (Wunsch, 2006; Pathak et al., 1959). In 1919, the first scientifically established health benefit of sun exposure was that sunlight can be used to prevent and cure rickets (Hoel et

al., 2016). Recently being exposed to ultraviolet radiation has been a subject of epidemiological interest due to both its beneficial and detrimental effects. Excessive ultraviolet radiation (UVR) is associated with skin cancer, sunburn, accelerated skin aging, and cataracts and it also reduces the effectiveness of the immune system. Contrary to the adverse effect, exposure to solar UVR is an essential step for the production of Vitamin D, and also the main source of vitamin D in the human body (World Health Organization, 2009; Beadle, 1977; Holick, 2008, 2003; Hess and Unger, 2016). Ultraviolet B (UVB) rays in the solar UVR spectrum produce vitamin D in the human body. UVB rays penetrate uncovered skin and convert cutaneous 7-dehydrocholesterol to pre-vitamin D3, which in turn becomes vitamin D3 (Mullin and Dobs, 2007; Wharton and Bishop, 2003). Sunlight exposure also still has inadequately explored benefits, which include release of nitric oxide, production of beta-endorphin, and regulation of circadian rhythms (Baggerly et al., 2025).

Vitamin D is used for maintaining the plasma concentration of calcium and phosphate in the normal physiologic range and it interacts with parathyroid hormone to support bone mineralization (DeLuca, 2004). Around 80–90% of vitamin D in humans is sunlight-derived production in the skin and the residual from dietary sources and/or supplementation (Tehrani and Behboudi-Gandevani, 2017). But, to get such an amount of vitamin D there are different factors to consider, such as time spent outdoors, skin pigmentation, degree of latitude, season, the amount of cloud cover, the extent of air pollution, the amount of skin exposed, and the extent of ultra-violet B (UVB) protection, including clothing and sunscreens (Holick, 2007, 2004; Wacker and Holick, 2013). For efficient production of vitamin D, regular exposure of unprotected skin (without the use of sunscreen and/or without clothing) to the available UVB radiation is recommended (Webb, 2006). UVB (short-wave ultraviolet rays) is found maximum in the midday sun thus, the best time of day for vitamin D production is near solar noon from 10 a.m to 2 p.m (Baggerly et al., 2015; Webb, 2006; Meena et al., 2017). Below latitudes of approximately 35°north, UVB radiation is sufficient for vitamin D_3 synthesis throughout the year, however, at higher latitudes (above 35°north) vitamin D3 is not produced during the winter months and people may be predisposed to vitamin D deficiency unless taking vitamin D supplementation (Holick, 2004).

Vitamin D deficiency (VDD), which is serum 25-hydroxyl vitamin D (25OHD) level less than 30 nmol/l, is a major public health problem with numerous health consequences in many countries of the world (Holick, 2012). Around 1 billion people worldwide, across all age groups, have a VDD. Epidemiological studies in different countries revealed that VDD is highly prevalent among infants, regardless of age, ethnicity, geographic location, and climatic conditions, and is believed to range from 2.7 to 45% (Almeida et al., 2018; Atas et al., 2013). Ethiopia is not an exception to this burden. A study done in Addis Ababa revealed that 41% of children below three years of age visiting an outpatient department had vitamin D deficiency rickets and the frequency was higher in infants. (Aust-Kettis et al., 1965). Another study done in Jimma town also found that the prevalence of vitamin D deficiency rickets in infants was 11% (Getaneh et al., 1998).

Vitamin D plays a crucial role in preventing rickets by promoting calcium and phosphate absorption in the gut, which is essential for healthy bone development. Without adequate vitamin D, bones can become weak and deformed. Supplementation is especially important in populations at risk of deficiency due to limited sun exposure or dietary intake (Holick, 2006; Phelan et al., 2020).

The randomized controlled trial evaluates the effectiveness of high-dose vitamin D supplementation in preventing rickets among children. The study found that high-dose supplementation significantly reduced the incidence of rickets compared to standard dosing, highlighting the importance of adequate vitamin D levels (Saadi et al., 2020).

While sunlight is a natural source of vitamin D, excessive exposure poses several risks like skin cancer (melanoma and non-melanoma cancers), skin aging (photoaging), sunburn, and immune suppression (WHO, 2021).

Studies worldwide identify lack of sun exposure as the main cause of rickets (Holick, 2007; Getaneh et al., 1998). In many rich industrialized countries, the prevalence of rickets in the general population diminished after the introduction of dietary supplementation. However, in such countries, vitamin D deficiency rickets have re-emerged in recent years, particularly among groups with limited exposure to UVB-containing sunshine. Infants at risk of rickets are those whose mothers had poor vitamin D status during pregnancy and those exclusively breastfed for a prolonged period with little skin exposure to UVB. Contrary to general belief, rickets are widely prevalent in many tropical and subtropical regions despite abundant sunshine. A study conducted at Kenyatta National Hospital showed that 58.8% of premature infants develop rickets by the age of 6 months (Oyatsi et al., 1999). A recent study conducted in Kiambu District Hospital states that the prevalence of rickets in children 0–59 months is 3.4% (Muriuki, n.d). In Ethiopia, a review of rickets stated that the prevalence of rickets was as high as 40%, making it

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one of the highest in the world, vitamin D deficiency in rickets is also common in Ethiopian children (Woldeyohannes et al. 2023).

Decades have now elapsed since the pioneering studies on rickets in Ethiopia (Aust-Kettis et al 1965; Mariam and Sterky, 1973; Lulseged, 1990) showed that lack of exposure to sunshine was the single most important cause of rickets in Ethiopian children. Some pioneering studies as well as more recent work (Getaneh et al., 1998; Abate, 2016) suggested that daily exposure to sunshine remains the cheapest, safest, and most effective method of preventing the disease (Höjer et al., 1977). Although Ethiopia is a country with 13 months of sunshine, the prevalence of Rickets remains high in Ethiopia this is probably due to the poor mothers' practice status as shown in different studies.

A study done in Debre Markos showed 93% of mothers exposed their infants to sunlight but only 57.9% of them were exposed daily and 55.4% of them had poor practice about sunlight exposure. Mothers' age, mothers' educational status, mothers' occupation, fathers' educational status, evil eye, cold, and pneumonia had a statistically significant association with sunlight exposure practice (Bedaso et al., 2019).

In a study done in Aleta Wondo Health Center, 62.2% were knowledgeable about sunlight exposure and only 32.6% of mothers had good practices of exposing their infants to sunlight (Bezabih et al., 2021).

A study done in Yirgalem Hospital shows more than 45% and more than one-third of lactating mothers had poor practice and exposed infants to sunlight for inadequate time, respectively. Unemployed women and husbands' education levels were associated with poor practice (Teklehaimanot et al., 2021).

A study done in Debre Berhan shows that 34.3% of participants have poor practice in sunlight exposure of infants. Mothers who are housewives or government employees, have a maternal age of 33 and above, perceive that sunlight strengthens infant's bones, perceive that sunlight makes their infants healthier, and who got information from health-care professionals were significantly associated with good practice in sunning of their infant (Kenenisa et al., 2014).

Although it is fairly simple to obtain vitamin D, a lack of appreciation for the importance of sensible sunlight exposure to meet the vitamin D requirements of children and adults has led to a worldwide VDD pandemic (Wacker and Holick, 2013). Furthermore, social and religious norms and also health practices of mothers might lead to vitamin D deficiency by preventing infants from sunlight exposure. Previous studies revealed that maternal age, maternal educational status, maternal occupation, family size, and fathers' educational status were significantly associated with the practice of sunlight exposure (Bedaso et al., 2019). Efforts to prevent VDD with supplementation of vitamin D, fortification of milk or other foods with vitamin D, and/or adequate sunlight exposure are recommended worldwide (Almeida et al, 2022). Guidelines in Ethiopia recommend sunning of neonates starting from 2 weeks old for 15–20 min per day. Although health education to change maternal behavior by exposing infants to sunshine was adopted as the main strategy to combat rickets in the early 1960s, the implementation of this strategy is inconsistent (Muriuki, n.d). Despite all these efforts, lack of sunlight exposure continues to be the major risk factor of VDD rickets in Ethiopian children (Wondale et al., 2005; Prentice, 2008). It contributes to infant mortality and morbidity and carries long-term consequences.

Caregivers play a key role in the prevention of rickets by exposing their infants to sunlight adequately. Sunlight is abundant in Ethiopia throughout the year, but studies indicating the practice of mothers sunning their infants and factors barring infants from getting adequate sunshine are insufficient, and especially no evidence is available in the study area.

MATERIALS AND METHODS

Study setting

The study was conducted at Arsi University's College of Health Sciences (COHS) and the Arsi Teaching and Referral Hospital (ATRH), located in Asella town, 175 km from Addis Ababa. Established in 2014, Arsi University is a relatively young institution. ATRH, on the other hand, has served over 3.5 million people in Arsi and surrounding zones since 1964. The hospital is well-equipped, boasting 321 beds and over six departments. The pediatric ward alone has 102 beds, including 42 in the Neonatal Intensive Care Unit (NICU), 54 in the pediatric medical ward, and 10 for emergency pediatric care.

ATRH plays a crucial role in training undergraduate and postgraduate trainees in various disciplines. The pediatric ward is further divided into five distinct units which are the EPI clinics, regular outpatient department (OPD), emergency OPD, the ward itself, and the NICU. The pediatrics and child health unit currently employs eight pediatricians and 21 residents.

Study period and design

A facility-based cross-sectional study was conducted among caregivers of infants attending the Asella Teaching and Referral Hospital from June 1 to August 31, 2022.

Study population

The study included caregivers whose infants were under 12 months of age and who visited the Pediatrics and Child Health Department at the Asella Teaching and Referral Hospital during data collection. These caregivers also fulfilled the study's inclusion criteria.

Inclusion criteria and exclusion criteria

Inclusion criteria

The study included caregivers of infants who attended the Pediatrics and Child Health Department at Asella Teaching and

Referral Hospital during the study period and who volunteered to participate in the research.

Exclusion criteria

Caregivers with infants who were unable to mentally or physically participate in the study were excluded.

Sample size determination

The sample size for this study was determined using a single-population formula. Based on a 2021 study in Debre Berhan, 34.3% of mothers exhibited poor practices regarding infant sunlight exposure. A 95% confidence interval was chosen, with a margin of error of 5% (α = 0.05, α/2 = 1.96).

$$ni = \frac{\left(z\alpha_{/2}\right)^2 \times p(1-p)}{d^2}$$

where ni= initial sample size, p= proportion of poor practice (34.3%) =0.343, a= confidence interval (95%), d= is the margin of sampling error tolerated (5%) = 0.05, and ni= (1.96)2 (0.343) (1-0.343)/ (0.05)2 =3.8416(0.343) (0.657)/.0025 =346.

For possible dropout rate, 10% (34) is added to the sample size. Sample size = 346 + 34 = 380.

Sampling procedure

A systematic random sampling technique was used to select among caregivers of infants attending ATRH during the study period. Using a formula K= N/n where N is the total number of infants who visited ATRH over 3 months and n is the sample size. 740 infants visited ATRH over the past 3 months (Between January 01, 2022 and March 31, 2022). So, K=740/380 = 1.9 ~ 2. Every 2nd caregiver of infants visiting ATRH was selected until the required sample was achieved.

Study variables

Independent variables

The independent variables are as follows:

1) Socio-demographic factors (caregiver age group, infant's age group, caregiver religion, marital status, caregiver's educational status, occupational status, family size, husband's educational level).
2) Perception of caregivers (benefit or harm).
3) Caregiver's source of information (physician, nurse/midwife, TV/radio, neighbors/elders).
4) Health service utilization of mothers during antenatal care (ANC), Delivery, and postnatal care services (PNC).

Dependent variables

1) The practice of exposing infants to sunlight

Key words and operational definitions

(1) Good practice: Caregivers that responded to practice questions and scored above median values.
(2) Poor practice: Caregivers responded to practice questions and scored below median values.
(3) Completely covered: Infant wearing clothes that cover the whole body except the face.
(4) Unclothed: Infant wearing no clothes except pants.
(5) Partly covered: Infant wearing minimal clothing (pants and vest) and not long shorts such that legs, arms, and face are not covered.
(6) Got antenatal care: Caregivers who had at least one visit to a health facility before the onset of labor.
(7) Got postnatal care: Caregivers who had at least one return visit to a health facility for postnatal care within six weeks of the postpartum period (Bedaso et al., 2019; Kenenisa et al., 2014).

Data collection instrument

A structured questionnaire, adapted from studies conducted in Jimma (24), Debre Berhan (36), and Turkey (47), was used for data collection. The questionnaire was modified to include sections on:

1) Socio-demographic characteristics (10 questions)
2) Infant sunning practices (7 questions)
3) Sources of information (1 question)
4) Perceived consequences of sunlight exposure (4 questions)
5) Health service utilization (6 questions)

Data collection procedure

Data was collected through face-to-face interviews using structured questionnaires. Each interview was expected to take approximately 30 min. Medical interns and nurses served as data collectors (DCs). All DCs received two days of training on their responsibilities, which included explaining the study's purpose, data collection procedures, and the importance of honest and genuine responses from participants. A resident physician at the outpatient department (OPD) provided daily supervision of the data collection process.

Data quality assurance

The questionnaire was initially prepared in English, then translated into Amharic and Afan Oromo, and subsequently back-translated to ensure accuracy. The supervisor reviewed the collected data daily for completeness, and the principal investigator monitored the overall quality of data collection.

Data processing and analysis

Completed questionnaires were checked for completeness and consistency. Data were then coded and entered into EpiData version 4.6 software before being exported to SPSS version 21 for analysis. Categorical variables were summarized using proportions, while continuous variables were summarized using means. Cross-tabulations comparing cases and controls were performed. Associations between groups were evaluated using Chi-square tests (Fisher's exact test was used when appropriate). Statistical significance was defined as a p-value less than 0.05 (two-sided).

A crude logistic regression model was initially constructed. This model was then adjusted for known confounders. Variables with a p-value less than 0.25 in the bivariate analysis and a pre-selected key variable were included in a multivariate logistic regression model. The use of a p-value cutoff of 0.25 for selecting variables in the multivariate logistic regression model is a common practice in the initial stages of model building. This threshold allows for the inclusion of potentially important variables that might not meet the

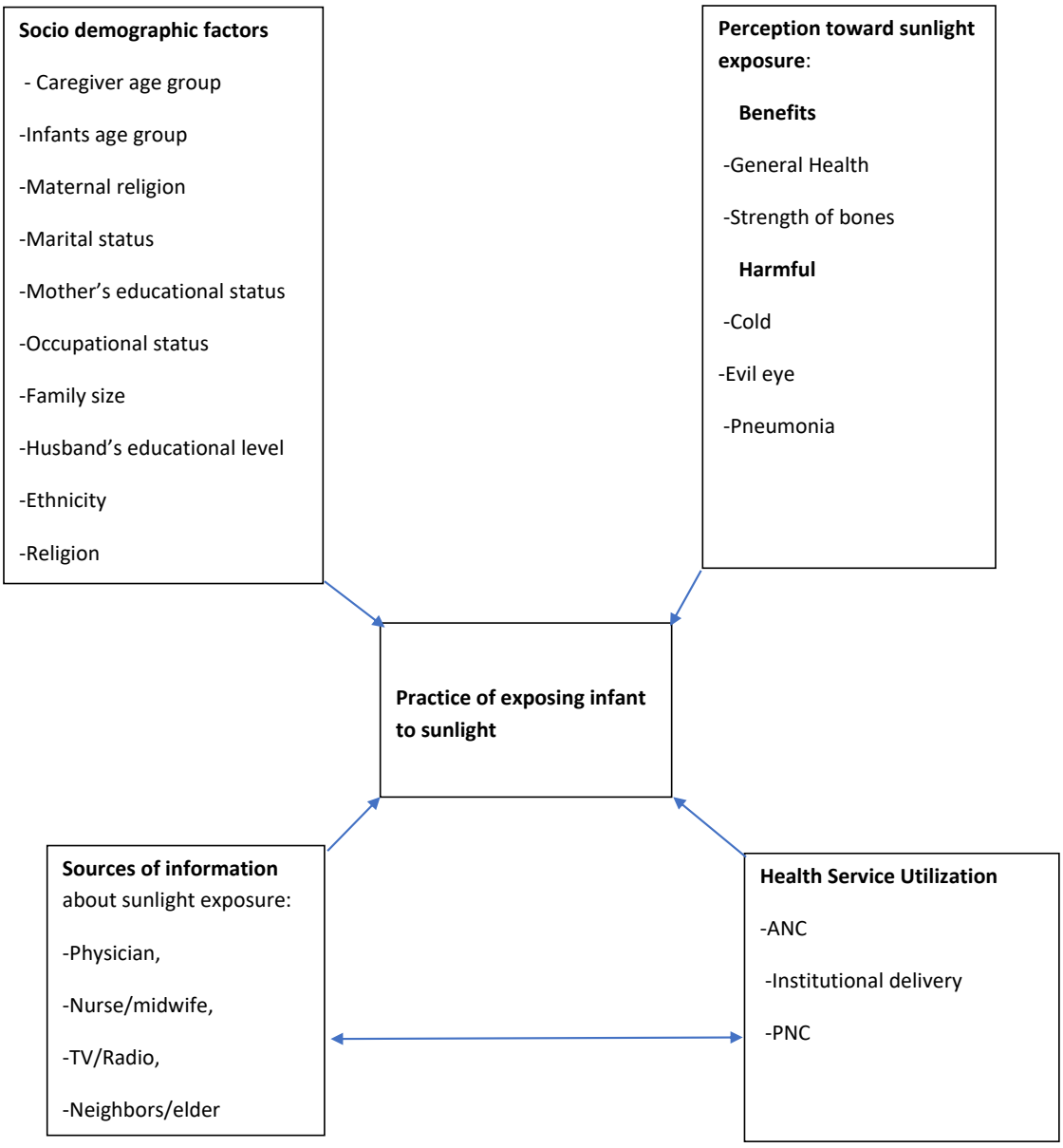

Figure 1. The conceptual framework shows the linkage between practice and its associated factors of infants' sunlight exposure among caregivers attending ATRH (Abate,2015; Teklehaimanot. 2021).

more stringent criteria (e.g., $p < 0.05$) but could still be relevant for the model. The approach aims to include variables that have a moderate association with the outcome in the bivariate analysis, as well as those deemed key based on prior research.

Model fit was assessed using the Hosmer-Lemeshow test. A p-value less than 0.05 in the multivariate logistic regression was considered statistically significant. The strength of associations was determined using adjusted odds ratios (AOR) with corresponding 95% confidence intervals.

Ethical considerations

Ethical clearance was obtained from the research unit of Arsi University, and a letter of permission was secured from the College of Medicine and Health Sciences. Before administering the questionnaire, the study objectives were clearly explained to participants, and oral informed consent was obtained. Participants were informed that their participation was voluntary and they had the right to decline participation without affecting any services or benefits they would receive from the institution.

RESULTS

Socio-demographic characteristics of the respondent

A total of 380 caregivers were interviewed. Here is a breakdown of the demographic characteristics of the

participants and their infants:

1) Infant age: 185 (48.7%) infants were under 6 months of age and 195 (51.3%) infants were over 6 months of age.
2) Infant sex: 213 (56.1%) infants were male, and 167 (43.9%) infants were female.
3) Caregivers age: Caregivers aged 27-32 years and those over 33 years each comprised approximately 31.8% of the sample.
4) Caregiver occupation: About 37.1% of caregivers were housewives but 1.6% of caregivers were daily laborers.
5) Caregiver education: 31.3% of caregivers had no formal education.
6) Caregiver marital status: 338 (88.9%) caregivers were married, 4.5% were single, 3.4% were divorced and 3.2% were widowed.
7) Caregiver ethnicity: About 70.3% of caregivers were Oromo and 22.9% were Amhara.
8) Caregiver religion: About 50.3% of caregivers were Muslim and 41.3% of caregivers were Orthodox.
9) Husbands' education: Among the 363 husbands for whom data was available, 35.8% had at least a Diploma (Table 1)

The practice of caregivers about sunlight exposure of their infants

The majority of respondents 264 (69.5%) intentionally expose infants to direct sunlight. Of them, 94 (35.6%) were exposed daily and 101 (38.3%) started exposing infants to sunlight at the age of 45 days of life. Furthermore, 251 (95.1%) caregivers were exposed in the morning before 10 a.m., and 118 (44.7%) caregivers exposed their infants for 15-20 min. Regarding the condition of clothing during the sunning of infants, 113 (42.8%) caregivers were exposed by only wearing diapers or naked. Only 17 (17%) of respondents did not apply any lubricant/body lotion during sunning of their infant (Table 2).

Caregiver's level of practice about sunlight exposure of their infants

For the above seven practice questions the median value is 3. Out of 380 respondents, 187 (49.2%) scored less than the median value. Therefore, depending on the operational definition 49.2% of mothers had poor practice (Figure 2).

Associated factors of the practice of exposing infants to sunlight among caregivers

Caregiver's source of information for intentional exposure of their infant to sunlight

Regarding the source of information for sunlight exposure of infants, 178 (46.8%) caregivers got information from neighbors whereas 138 (36%) of them got the information from the midwife/nurses. (Figure 3)

Perception of caregivers towards sunlight exposure of infants

The majority 313 (82.4 %) of caregivers perceived that sunlight exposure is beneficial but 4.7% of them are not, while the rest 12.9% were not sure of it. Out of 313 caregivers, 35.8% believed that it strengthens infant bones, 13.4% for healthier infants, 12.1% for fast growth, and 8.9% for other benefits (Table 3).

Health service utilization of caregivers

Of all caregivers, 267 (70.3%) delivered in a health facility, out of them 138 (51.5%) were advised to expose their child to sunlight while 289 (76.1%) caregivers had ANC follow-up, 157 (54.3%) were advised about sunning of their infant. Though only 56 (14.7%) caregivers had PNC follow-up, 52 (91.2%) were advised about sunning of their infant (Figure 4).

Bivariable and Multivariable Analysis of Practice of exposing infants to sunlight among caregivers

In this study infant age, sex, family size, occupational status, caregiver's and husband's educational status, religion, source of information, caregiver's perception related to the benefit of sunning specifically to being healthier and to growing faster, and regarding harmful effect of sunlight exposure, ANC, health facility delivery and PNC follow-up were found on candidate variables on bivariable analysis at p-value < 0.25 for multivariable analysis.

Multivariate analysis of factors associated with maternal practices of infant sunlight exposure

Multivariate analysis identified several factors significantly associated with maternal practices of infant sunlight exposure in following.

Caregiver characteristics

Education: Caregivers with grade 1-8 education were 3 times more likely to have good sunning practices (AOR = 3.07, 95% CI: 1.41, 6.68). Caregivers with grade 9-12 education were 3 times more likely to have good sunning practices (AOR = 3.33, 95% CI: 1.15, 9.60). Caregivers with a diploma or higher education were 11 times more likely to have good sunning practices (AOR = 11.38, 95%

Table 1. Distribution of socio-demographic characteristics of study participants in ARTH, Arsi zone, Ethiopia, 2022 (n=380).

Variable	Categories	Frequency	Percent
Caregivers age group	15-20 years	35	9.2
	21-26 years	103	27.1
	27-32 years	121	31.8
	33 and above years	121	31.8
Infants age group	0-180 days	185	48.7
	181-365 days	195	51.3
Occupational status	Student	28	7.4
	Housewife	141	37.1
	Private employee	66	17.4
	Daily laborer	6	1.6
	Government employee	61	16.1
	Farmer	44	11.6
	Merchant	34	8.9
Educational background of caregiver?	No formal education	119	31.3
	Grade 1-8	107	28.2
	Grade 9-12	57	15.0
	Diploma and above	97	25.5
Family size	<3	176	46.3
	3-4	123	32.4
	≥5	81	21.3
Ethnicity	Oromo	272	71.6
	Amhara	92	24.2
	Others	16	4.2
Religion	Muslim	191	50.3
	Orthodox	157	41.3
	Protestant	22	5.8
	Catholic	10	2.6
Marital status	Single	17	4.5
	Married	338	95.5
Husband’s educational level	No formal education	81	22.3
	Grade 1-8	98	27.0
	Grade 9-12	54	14.9
	Diploma and above	130	35.8

CI: 3.47, 37.32). These findings were compared to caregivers with no formal education.

Occupation: Caregivers whose occupations were daily laborer (AOR = 0.05, 95% CI: 0.003, 0.83), farmer (AOR = 0.11, 95% CI: 0.02, 0.53), and merchant (AOR = 0.17, 95% CI: 0.04, 0.72) were less likely to practice good sunning compared to students.

Husband's education: Caregivers whose husbands had grade 1-8 education were 2.4 times more likely to have good sunning practices compared to caregivers whose husbands had no formal education (AOR = 2.46, 95% CI: 1.14, 5.28).

Perception of sunlight exposure benefits: Caregivers who perceived sunlight exposure as beneficial for their infant's health were more likely to practice good sunning (AOR = 2.11, 95% CI: 1.02, 4.35).

Table 2. Distribution of caregivers by their practice concerning sunlight exposure of infants in ARTH, Arsi zone, Ethiopia, 2022.

Variable	Categories	Frequency	Percent
Caregivers who intentionally expose infants to direct sunlight (n=380)	Yes	264	69.5
	No	116	30.5
Age of the infant at the time of starting sunlight exposure (n=264)	0-15 days	43	16.3
	16-30 days	47	17.8
	31-45 days	73	27.7
	45 days and above	101	38.3
Frequency of sunlight exposure (n=264)	Daily	94	35.6
	1-3 days/week	93	35.2
	4-5 days /week	77	29.2
Time of the day caregivers expose the infant outdoors (n=264)	Morning before 10:00 am	251	95.1
	Mid-day 10:00 am-2:00 pm	13	4.9
Condition of clothing during sunlight exposure (n=264)	Completely covered	54	20.5
	Only Diapers/naked	113	42.8
	Partly covered	97	36.7
Duration of exposure to sunlight (n=264)	5-10 min	21	8.0
	10-15 min	70	26.5
	15-20 min	118	44.7
	Above 20 min	55	20.8
Apply lubricants/lotion on the infant's body during sunlight exposure	Yes	219	83.0
	No	45	17.0

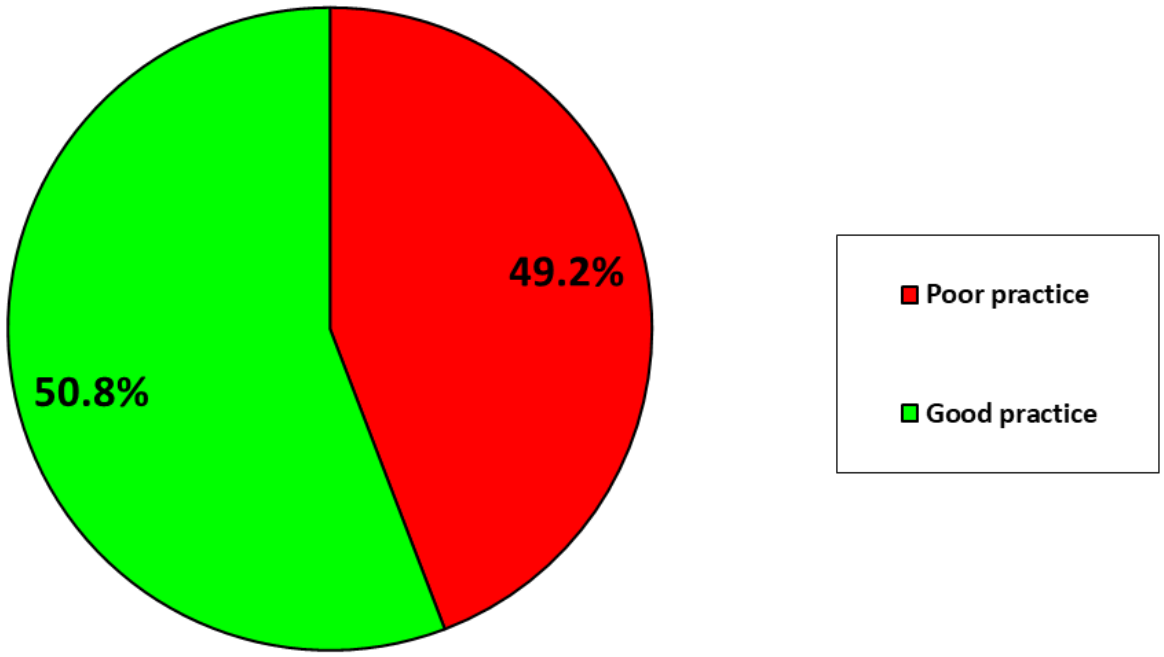

Figure 2. A pie chart showing the caregiver's level of practice about sunlight exposure of their infants.

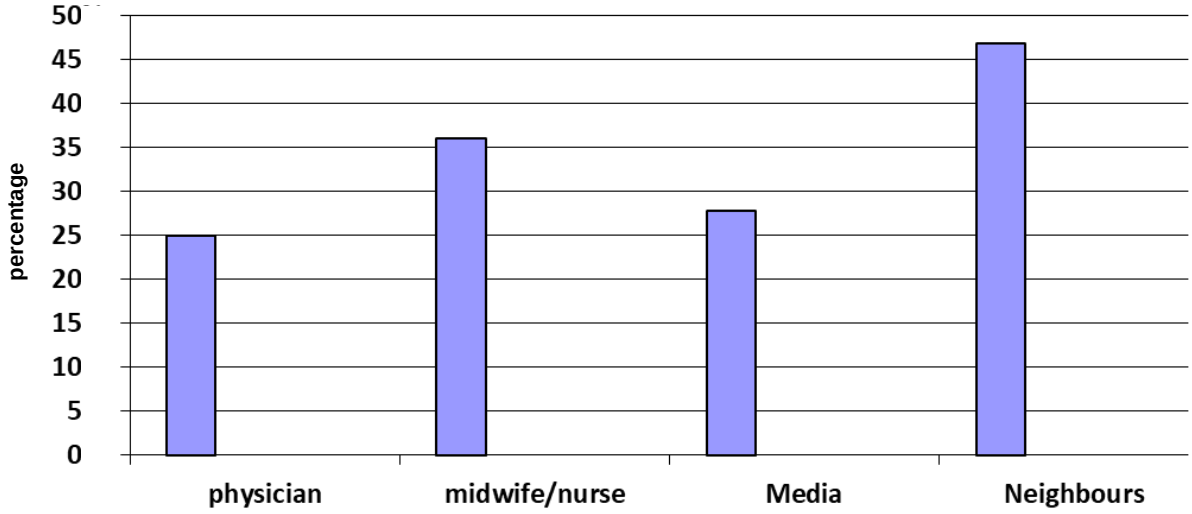

Figure 3. Distribution of mothers by their source of information about sunlight exposure of infants in ARTH, Arsi zone, Ethiopia, 2022 **(**n = 380 to each).

Table 3. Distribution of caregivers by their perception related to sunlight exposure of infants in ARTH, Arsi zone, Ethiopia, 2022

Variable	Categories	Frequency	Percent
Sunlight exposure is beneficial for infants (n=380)	Yes	313	82.4
	No	18	4.7
	Not sure	49	12.9
perceived benefit (n=313)	To strengthen the infant's bones	158	32.1
	To get good sleep	92	18.6
	To be a healthier infant	102	20.7
	To grow faster	104	21.1
	Other benefit (Closure of fontanels, prevent blurring of vision)	36	7.3
Sunlight exposure has a harmful effect	Yes	131	34.5
	No	249	65.5
perceived harm (n=131)	Predispose to pneumonia	73	55.7
	Predispose to blindness	32	24.4
	Other harm (fever, crossed eye)	33	25.1

Notes: *Each caregiver did perceive two or more benefits. **Each caregiver did perceive two or more harms.

Source of information: Caregivers who received information about sunning from a physician were more likely to practice good sunning (AOR = 2.85, 95% CI: 1.37, 5.94).
Health service utilization (delivery location): Caregivers who delivered at a health institution were more likely to practice good sunning (AOR = 4.92, 95% CI: 2.25, 10.76).

Infant characteristics

Age: Infants under 6 months were more likely to be exposed to sunlight by their caregivers (AOR = 2.68, 95% CI: 1.49, 4.81).
Sex: Female infants were more likely to be exposed to sunlight by their caregivers (AOR = 2.44, 95% CI: 1.43, 4.16).

DISCUSSION

Despite Ethiopia experiencing ample sunshine (an average of 13 months per year), rickets remain a prevalent issue among children. A 2005 systematic review highlighted a lack of sun exposure and inadequate

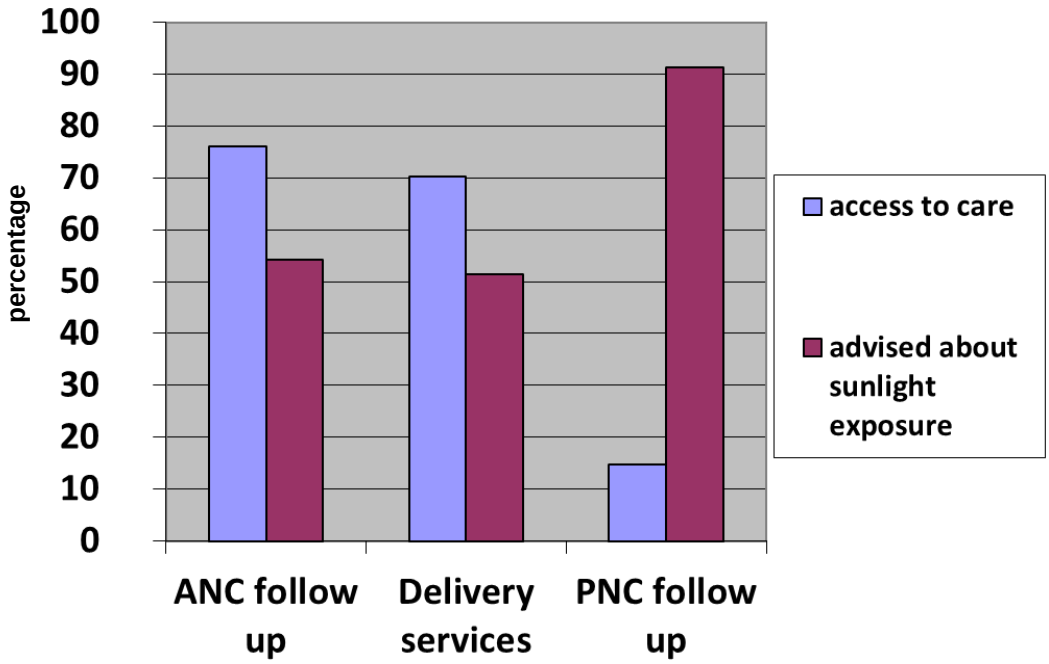

Figure 4. Distribution of caregivers by health service utilization in ARTH, Arsi zone, Ethiopia, 2022.

vitamin D intake as key contributing factors to nutritional rickets in Ethiopia (Prentice, 2008). This study aimed to assess caregivers' practices regarding infant sunlight exposure and identify associated factors at the Arsi Teaching and Referral Hospital (ATRH) in southeast Ethiopia. The findings revealed that 49.2% of participants exhibited poor practices regarding infant sunlight exposure, highlighting a significant public health concern. These findings underscore the critical need for targeted health education programs focused on mothers and caregivers of young children to promote optimal sun exposure practices and improve vitamin D status (Hoel et al., 2016; Ekbote et al., 2010).

This study found that 69.5% of caregivers intentionally exposed their infants to direct sunlight. This finding is slightly higher than a study conducted in Debre Tabor town (61.5%) (Bedaso et al., 2019), but lower than studies conducted in Debre Berhan town (99.1%), Debre Markos town (93%), and Jimma town (100%) (Kenenisa et al., 2014; Sisay et al., 2019; Feleke et al., 2020). These discrepancies could be attributed to socio-demographic differences among the study populations.

Furthermore, a study in Townsville, Australia, reported a much lower rate of intentional sun exposure among infants (20%) (Harrison et al., 1999). This disparity may be related to the Australian Cancer Prevention Society's recommendations against infant sun exposure due to the high prevalence of skin cancer in the region. Regarding the age at which sun exposure begins, only 16.3% of respondents in this study-initiated sun exposure within the first 15 days of their infants' lives. This finding contrasts with a study in Debre Berhan, which showed a much higher rate of early sun exposure initiation (85.7%) (Kenenisa et al., 2014). This discrepancy could be explained by differences in the primary sources of information regarding infant sun exposure. In this study, the majority of respondents received information from neighbors, which was not significantly associated with sun exposure practices. However, the Debre Berhan study found that healthcare professionals were the primary source of information for most participants, and this source was significantly associated with sun exposure practices

This study found that 35.6% of caregivers sunned their infants daily. This rate is lower than studies conducted in Debre Markos town (57.9%), Debre Berhan town (60.8%), and Jimma town (92%) (Bedaso et al., 2019; Kenenisa et al., 2014; Sisay et al., 2019).

While 95.1% of respondents exposed their infants to sunlight in the morning before 10 a.m., this practice deviates from the optimal time for vitamin D production, which is near solar noon, between 10 a.m. and 2 p.m. (Baggerly et al., 2015; Webb, 2006; Meena et al., 2017). Ethiopian IMNCI guidelines from 2015 recommend 15-20 min of daily sun exposure for infants (Ministry of Health, Ethiopia, 2015). Experts emphasize the importance of exposing unprotected skin (without sunscreen or clothing) to UVB radiation for optimal vitamin D production (Webb, 2006). However, only 42.8% of respondents sunned their infants in only a diaper or naked, and only 44.7% sunned their infants for the recommended duration of 15-20 min per day. Furthermore, 87% of respondents applied body lotion or lubricants during sun exposure.

Prioritizing sun exposure for infants should balance the

Table 4. Bivariable and multivariable analysis of caregivers' practice towards sunlight exposure of their infants in ATRH, Arsi zone, Ethiopia, 2022.

Variable		Practice		95% CI (COR)	95% CI (AOR)
		Good N (%)	Poor N (%)		
Infants age group	1-180 days	86 (46.5)	99 (53.5)	1	1
	181-365 days	107 (54.9)	88 (45.1)	1.40 (0.93,2.09)*	2.68 (1.49,4.81)*****
Sex	Male	93 (43.7)	120 (56.3)	1	1
	Female	100 (59.9)	67 (40.1)	1.92 (1.27, 2.90)*	2.44 (1.43,4.16)*****
Educational status of mothers/caregivers	No formal education	29 (24.4)	90 (75.6)	1	1
	Grade 1-8	51 (47.7)	56 (52.3)	2.82 (1.60,4.97)*	3.07 (1.41, 6.68)*****
	Grade 9-12	32 (56.1)	25 (43.9)	3.97 (203,7.76)*	3.33 (1.15, 9.60)*****
	Diploma and above	81 (83.5)	16 (16.5)	15.7 (7.95,31.01)*	11.38 (3.47,37.32)*****
Occupational status of mothers/care givers	Student	20 (71.4)	8 (28.6)	1	1
	Housewife	60 (42.6)	81 (57.4)	0.29 (0.12,0.71)*	0.37 (0.11, 1.29)
	Private employee	38 (57.6)	28 (42.4)	0.54 (0.20,1.41)	0.35 (0.10,1.24)
	Daily laborer	2 (33.3)	4 (66.7)	0.20 (0.03,1.31)	0.05 (0.003,0.83)*
	Government employee	51 (83.6)	10 (16.4)	2.04 (0.70,5.91)	0.37(0.08,1.60)
	Farmer	10 (22.7)	34 (77.3)	0.11 (0.04,0.34)*	0.11 (.02,0.53)*
	Merchant	12 (35.3)	22 (64.7)	0.21 (0.07,0.64)*	0.17 (.04,0.72)*****
Husband's educational status	No formal education	20 (24.7)	61 (75.3)	-	-
	Grade 1-8	38 (38.8)	60 (61.2)	1.93 (1.01,3.69)*	2.46 (1.14,5.28)*****
	Grade 9-12	31 (57.4)	23 (42.6)	4.11 (1.96,8.60)*	1.40 (0.54,3.67)
	Diploma and above	98 (75.4)	32 (24.6)	4.90 (4.90,17.77)*	1.95 (0.71,5.37)
Sunlight exposure is beneficial	Yes	172 (55)	141 (45)	2.67 (1.52,4.68)*	-
	No/not sure	21 (31.3)	46 (68.7)	1	-
Sunlight Exposure is perceived to be healthier for Infant	Yes	36 (70.6)	15 (29.4)	2.22 (1.16,4.25)*	2.11 (1.02,4.35)*****
	No	136 (51.9)	126 (48.1%)	1	-
Sunlight exposure is perceived to help infants grow faster	Yes	20 (43.5)	26 (56.5)	0.58 (0.31,1.09)	0.52(0.24,1.09)
	No	152 (56.9)	115 (43.1)	1	-
Sunlight exposure is harmful	Yes	60 (45.8)	71 (54.2)	1	-
	No	133 (53.4)	116 (46.6)	1.35 (0.88,2.07)	-
Sources of information about sunlight exposure	Physician	62 (72.9)	23 (27.1)	6.22 (3.38,11.43)*	2.85(1.37,5.94)*****
	Nurses/Midwives	70 (60.9)	45 (39.1)	3.59 (2.11,6.10)*	1.60(.84, 3.05)
	Media	22 (43.1)	29 (56.9)	1.75 (0.89,3.42)	0.71(.30,1.63)
	Neighbors	39 (30.2)	90 (69.8)	1	
Those who had ANC follow-up	Yes	172 (59.5)	117 (40.5)	4.90 (2.85,8.42)*****	.71(.29,1.74)
	No	21 (23.1)	70 (76.9)	1	
Delivered at health institution	Yes	166 (62.2)	101 (37.8)	5.23 (3.18,8.61)*	4.92(2.25, 10.76)*****
	No	27 (23.9)	86 (76.1)	1	
Had PNC follow-up	Yes	42 (75)	14 (25)	3.43 (1.80,6.53)*	1.99(.94, 4.21)
	No	151 (46.6)	173 (53.4)	1	

*p-value<0.05 for multivariate analysis; p-value<0.25 for bivariate analysis. COR, Crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval.

need for vitamin D synthesis with the risk of skin damage. Recommendations typically suggest minimal sun exposure due to infants' sensitive skin and increased risk of melanoma. For infants under 6 months, it is generally advised to avoid direct sun exposure as much as possible and use protective clothing and shade (American Academy of Pediatrics, 2019). For older infants, 15-30 min of sunlight exposure several times a week is often deemed sufficient for vitamin D synthesis, while minimizing melanoma risk (Holick, 2007). Factors such as skin type, geographic location, and season should also be considered (Diffey, 1991).

These findings highlight a critical need to raise community awareness about appropriate sun exposure practices for infants to maximize cutaneous vitamin D production.

Key findings on factors associated with sun exposure practices

This study found a strong association between caregiver education levels and infant sun exposure practices which are as follows:

1) Caregiver education: Caregivers with grade 1-8 education were 3 times more likely to practice good sun exposure compared to caregivers with no formal education (AOR = 3.07, 95% CI: 1.41, 6.68). Caregivers with grade 9-12 education were also 3 times more likely to practice good sun exposure (AOR = 3.33, 95% CI: 1.15, 9.60). Caregivers with a Diploma or higher education were 11 times more likely to practice good sun exposure (AOR = 11.38, 95% CI: 3.47, 37.32).
2) Husband's education: Caregivers whose husbands had grade 1-8 education were 2.4 times more likely to practice good sun exposure than caregivers whose husbands had no formal education (AOR = 2.46, 95% CI: 1.14, 5.28).
3) Caregiver occupation: Caregivers whose occupations were daily laborer, farmer, and merchant were less likely to practice good sun exposure compared to students. These occupations were associated with 94.8, 89, and 83% decreased likelihood of good sun exposure practices, respectively.

Comparison with previous research

These findings align with a study conducted in Debre Berhan town, which also found a statistically significant association between maternal education and occupation and sun exposure practices.

This study also found significant associations between sun exposure practices and:

1) Caregiver perception of benefits: Caregivers who perceived sunlight exposure as beneficial for their infant's health were more likely to practice good sun exposure.
2) Source of information: Caregivers who received information about sun exposure from a physician were more likely to practice good sun exposure.
3) Delivery location: Caregivers who delivered at a health institution were more likely to practice good sun exposure.

Conclusions

This study revealed that nearly half (49.2%) of participating caregivers exhibited poor practices regarding infant sunlight exposure. This finding underscores a critical need for enhanced attention to promoting optimal sun exposure practices among infants. The Federal Ministry of Health, healthcare professionals, and other relevant organizations should prioritize providing comprehensive information about the importance of infant sunlight exposure.

The study identified several factors associated with positive sun exposure practices among caregivers which are as follows:

1) Caregiver education: Higher levels of education among caregivers were significantly associated with an increased likelihood of practicing good sun exposure.
2) Husband's education: Similarly, husbands with higher levels of education were associated with an increased likelihood of caregivers practicing good sun exposure.
3) Perceived benefits: Caregivers who perceived sunlight exposure as beneficial for their infant's health were more likely to practice good sun exposure.
4) Physician as source of information: Caregivers who received information about sun exposure from a physician were more likely to practice good sun exposure.

RECOMMENDATIONS

The study's findings highlight a significant gap in knowledge and practice regarding infant sun exposure, with a majority of caregivers relying on neighbors for information rather than healthcare professionals. This underscores the need for a multifaceted approach to address this public health issue as follows:

1) Prioritize infant sun exposure: The Federal Ministry of Health, along with healthcare professionals, should prioritize providing comprehensive information about the importance of infant sun exposure as part of routine health services.
2) Train healthcare workers: Invest in training for nurses, midwives, and health extension workers on the appropriate practices for infant sun exposure. This

training should include demonstration of techniques and clear communication strategies.
3) Integrate sun exposure counseling: Incorporate counseling on optimal infant sun exposure into existing healthcare services, including antenatal care (ANC), delivery, and integrated management of newborn and childhood illness (IMNCI) programs.
4) Develop standardized counseling materials: The Federal Ministry of Health should collaborate with relevant stakeholders to develop detailed counseling materials and guidelines outlining the appropriate practices for sun exposure.
5) Improve educational coverage: The government should prioritize efforts to improve access to primary education, empowering individuals to access information through reading.
6) Further research: Additional research is needed to determine the optimal strategies for sun exposure, considering local factors such as ultraviolet (UV) index and cultural practices.

Healthcare professionals, especially nurses and midwives, have a crucial role in educating caregivers about optimal infant sun exposure practices. Providing accurate and timely information can significantly impact caregivers' knowledge and practices regarding infant sun exposure.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The authors thank Arsi University College of Health Sciences, Department of Paediatrics for facilitating to conduct of this research and their colleagues for their unreserved constructive comments and guidance throughout the research work. The data collection of the study was funded by Oromia Health Bureau.

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