Spatial distribution and Determinates of poor consumption of foods rich in vitamin A among children aged 6–23 months in Ethiopia using data from Ethiopia Demographic and Health Survey 2019: Spatial and Multilevel Analysis

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Abstract

Introduction:

Vitamin A is an essential element that supports rapid growth, builds the immune system, and prevents infection. In impoverished countries like Ethiopia, however, consumption of vitamin A-rich foods is a major problem. Thus, this study aimed to investigate the spatial distributions and determinants of poor consumption of foods rich in vitamin A among children aged 6–23 months in Ethiopia.

Methods

Data were obtained from the Ethiopian Demographic and Health Survey (EDHS) 2019. Spatial autocorrelation was done to test whether the poor consumption of foods rich in vitamin A had spatial dependency or not. Spatial SAT scan analysis and Hotspot (Getis Ord Gi*) were used to detect spatial clustering of poor consumption. A multilevel binary logistic regression model was fitted to identify factors associated with poor consumption of vitamin A-rich foods. An adjusted odds ratio with a 95% confidence interval was calculated, and variables with a p-value less than 0.05 were declared to be significant predictors of poor consumption of vitamin A-rich foods.

Result

The analysis looked at 1,605 children aged 6 to 23 months. In Ethiopia, poor consumption of vitamin A-rich foods was found to be prevalent in 61.2% of the population, with significant spatial variation. Spatial clustering of poor consumption of foods rich in vitamin A was observed in the Amhara, Somali, and Afar regions. At the individual level, the odds of poor consumption of foods rich in vitamin A among children aged 12–17 and 18–23 months were 0.57 (95%CI (0.39, 0.84)) and 0.39 (95%CI (0.26, 0.58)) respectively. At the community level, the odds of poor consumption of foods rich in vitamin A in Afar, Amhara and Somali were 6.07 (95%CI (2.59, 14.23)), 2.27 (95% CI (1.16, 4.44)) and 57.39 (95%CI (11.76, 279.90)) respectively.

Conclusion

In Ethiopia, poor consumption of vitamin A-rich foods among children aged 6 to 23 months varied significantly by region, with the highest prevalence found in the Amhara, Somali, and Afar regions. Child age, media exposure, maternal education, and regions were the significant predictors of poor consumption of foods rich in vitamin A. Through improving maternal education and creating awareness through mass media, interventions are targeted to improve the consumption of foods rich in vitamin A.

Introduction

Vitamin A is one of the four fat-soluble vitamins. The two main forms of vitamin A are retinoids, found in animal sources, and carotenoids, which are mostly found in plant sources. Preformed retinol foods rich in vitamin A were exclusively found in animal products, and provitamin A carotenoids were found in green leafy vegetables (1). Animal-source foods are important for infant and early childhood growth and development (2). Vitamin A is essential for vision, reproduction, cell division, and differentiation. According to the United Nation Children's Emergency Fund (UNICEF), vitamin A is important to enhance immune response, healthy growth and development in children, and protect from infection (3). Further, if there is inadequate intake, it can cause illness and increase the risk of death (4). For infants and young children, vitamin A is needed for two reasons. The first reason is that as the child is growing, they need a relatively high intake of vitamin A. The second reason is to increase intake because the child is susceptible to infection, which increases the metabolic rate and therefore increases the use of vitamin A. The consequence of vitamin A deficiency during early childhood is associated with diarrhea, measles, malaria, gastro-intestinal, respiratory, and other infectious disease morbidity and mortality among children (5). Vitamin A supplementation also plays a great role in child health. A randomized controlled trial (RCT) and cluster-RCT evaluating the effect of synthetic high-dose vitamin A supplementation in children aged six months to five years using 47 studies in Asia, India, Africa, Latin America, and Australia with long-term follow-up found a 12% observed reduction in the risk of all-cause mortality for vitamin A supplementation compared to control groups (6).On the other hand, another study shows that high-dose vitamin A supplementation every six months does not reduce the prevalence of vitamin A deficiency itself, as estimated by low serum retinol levels. It requires frequent intake of vitamin A in physiological doses through vitamin A-containing foods, food fortification, and regular low-dose supplementation, which is highly effective in increasing serum retinol levels and reducing vitamin A deficiency(7).

Globally, at least 1 in 2 children under 5 suffers from hidden hunger due to deficiencies in vitamins and other essential nutrients. In 2018, UNICEF estimates that at least 340 million children under 5 suffer from micronutrient deficiencies(3). Therefore, vitamin A deficiency (VAD) is a major public health problem in poor societies, especially in low-income countries. Vitamin A deficiency remains prevalent in South Asia (44%; 13%– 79%) and sub-Saharan Africa (48%; 25% – 75%). In 2013, 94 500 (54 200–146 800) diarrhea-related deaths and 11 200 (4300–20,500) deaths from measles were attributable to vitamin A deficiency in 2013, which accounted for 1·7% (1–2·6) of all deaths in children younger than 5 years in low income and middle-income countries(8). More than 95% of these deaths occurred in sub-Saharan Africa and South Asia. And also high prevalence of vitamin A deficiencies among young children in Vietnam (47.3%)(9). In Ethiopia also vitamin A deficiency is a major public health problem because more than one –third (37.7%) of children had deficiency of serum retinol level, and also the prevalence of clinical vitamin A deficiency, Bitot's spot ranges from 0.8–1.46% and night blindness 1.2%(10–12). Studies in Ethiopia also showed that Consumption of animal source foods among children age 6–23 months were very low(13) and the prevalence of poor consumption of foods rich in vitamin A was high(62.3%)(14).

Poor consumption of vitamin A-rich foods is influenced by a variety of factors, including socio-demographic characteristics, child age, maternal knowledge and media exposure about infant and young child feeding (IYCF), maternal education, region, and wealth index (ten, fifteen, seventeen).Despite the fact that little is known about the spatial distribution and determinants of poor consumption of vitamin A-rich foods, different studies have shown that dietary diversity and undernutration are not random in Ethiopia (18, 19).However, little is known about the spatial distribution and multi-level analysis of poor consumption of foods rich in vitamin A across the regions of Ethiopia. Identifying the determinant factors and spatial distribution of poor consumption of foods rich in vitamin A in the regions of Ethiopia is used for local specific nutrition intervention to reduce vitamin A deficiency-related child morbidity and mortality. Therefore, the objective of this study was to assess the spatial distribution and determine the poor consumption of foods rich in vitamin A among children aged 6–23 months in Ethiopia.

Methods

Study design and setting

Secondary data analysis of EDHS 2019 was done to investigate the spatial distribution and determinants of poor consumption of foods rich in vitamin A among children aged 6–23 months. The study was conducted in Ethiopia, which is located in the horn of Africa and bordered by Sudan and South Sudan in the west, Djibouti and Somalia in the east, Kenya in the south, and Eritrea in the north. Ethiopia is one of the most populous countries in Africa.

EDHS is a national and sub-national household survey, which is conducted regularly every five years. Ethiopia is subdivided into 11 geographical regions, which are further subdivided into zones, districts, and the smallest administrative units called Kebeles. A household survey of EDHS was conducted by dividing each smallest administrative unit (kebeles) into enumeration areas. The enumeration area was used as a sampling frame. The sample for the 2019 EMDHS was designed to provide estimates of key indicators for the country as a whole and for urban and rural areas separately.

Study populations

All children aged 6–23 months in the selected Enumeration Areas (EAs) were included in the study population.

Study variables

Outcome variable

The outcome variable for this study was consumption of foods rich in vitamin A. The responses were dichotomized as "good=0" if the child ate at least one food item among the seven food items (egg, meat, vegetables, green leafy vegetables, fruits, organ meat, and fish), which are rich in vitamin A in the last 24 hours preceding the interview, and "poor=1" if the child failed to eat at least one food item among the seven food items in the 24 hours preceding the interview.

Independent variables

Due to the hierarchical nature of the EDHS data, two levels of independent variables were considered. individual-level factors such as Sociodemographic and economic factors (sex, religion, maternal educational status, ANC follow up, media exposure, child age, maternal age, and wealth index) and community-level factors such as region, residence, level of community poverty, and level of community illiteracy. Community poverty and illiteracy levels were aggregated from the individual-level factors.

Data collection procedures

A stratified, two-stage cluster sampling technique was used to select the study participants. In the first stage, 305 (93 urban and 212 rural) clusters were selected with proportional probability sampling in each region. In the second stage, a fixed number of 30 households per cluster was selected with an equal probability of systematic selection. Women aged 15–48 in the selected households were interviewed and anthropometric data was also taken from children younger than five in the selected households. Finally, a total of 9,150 households were selected for the sample, of which 8,794 were occupied. Of the occupied households, 8,663 were successfully interviewed, yielding a response rate of 99%. In this study, a total of 1,605 children aged 6–23 months were included in the final analysis. We accessed the data from the official DHS program website (https://dhsprogram.com/), through online registration and request. Data on geographic coordinates (longitude and latitude) were collected at the EAs/cluster level. The Kids Records (KR) dataset was used to extract data on poor consumption of vitamin A-rich foods and determinants. The detailed methodology has been published in the 2019 EDHS final report (20).

Data management and analysis

Data management was done by using STATA version 14.1 software and Microsoft Excel. Mapping was done using ArcGIS version 10.8 and SaTScan version 9.6 software.

Spatial autocorrelations

Spatial autocorrelation (Global Moran's I) was done to test whether poor consumption of foods rich in vitamin A was clustered, dispersed, or randomly distributed in Ethiopia. By using Moran's I statistics, it is used to measure whether poor consumption of foods rich in vitamin A in Ethiopia was distributed randomly, clustered, or dispersed by taking the entire dataset and producing a single output value, which ranges from-1 to 1.

Hotspot analysis of poor consumption of foods rich in vitamin A

Hotspot analysis (Getis-Ord Gi*) was used to identify the spatial clustering of poor consumption of foods rich in vitamin A in Ethiopia. Spatial scan statistical analysis (SaTScan) using the Bernoulli model was employed to test for the presence of statistically significant clusters of poor consumption of foods rich in vitamin A. The spatial statistics use a circular scanning window that moves across the study area. Cases, controls, and geographic coordinate data were fitted to the Bernoulli model. For each potential cluster, likelihood ratio (LLR) test statistics and P-values were used to determine whether the number of observed cases within the potential cluster was significantly higher than expected.

Spatial interpolation

Spatial kriging interpolation was used to estimate the distribution of poor consumption of foods rich in vitamin A in the unobserved areas using the observed data.

Factors associated with poor consumption of foods rich in vitamin A

A two-level binary logistic regression analysis was performed to examine the effects of individual and community-level characteristics of poor consumption of foods rich in vitamin A among children aged 6–23 months. In the EDHS data, children aged 6–23 months were nested within a cluster. Children aged 6–23 months within the same cluster were more similar to each other than children aged 6–23 months within different clusters. Therefore, this violates the standard regression model assumptions, which are independence of observation and equal variance across the cluster assumptions. This implies the need to take into account between-cluster variables by using an advanced model. Therefore, a multilevel random intercept logistic regression model was fitted to estimate the association between individual-level and community-level factors and the likelihood of poor consumption of foods rich in vitamin A. Models were compared based on deviance (-2log likelihood). Since the models were nested, the model with the lowest value of deviance was the best fitted model. A log-likelihood and intracellular correlation coefficient (ICC) were computed to measure the variation between clusters. The ICC indicates the degree of heterogeneity of poor consumption of foods rich in vitamin A between clusters.

Research ethics approval

The study is based on the secondary data analysis of EDHS 2019. The authors requested the Measure DHS through briefly stating the objectives of this analysis and were granted permission to use the data on the (http://dhsprogram.com) website.

Result

Sociodemographic characteristics of the study population

A total of 1,605 children aged 6–23 months were included in this study, with a mean age of 14.12± 5.06 months. More than half (51.21%) of the children were males. Of the total children, 283 (17.63%) were aged 6–8 months, and 595 (37.07%) were aged 12–17 months. Of the total mothers, 124 (7.73%) were aged 20 years and the majority, 1,220 (76.01%), were in the age group of 20–34 years. Most of the 1,499 (93.4%) mothers were married. Approximately three-fourths of 1,191 (74.21%) of the participants were residing in rural areas. Regarding educational status, nearly half (781, 48.66%) of mothers had no formal education. Seven hundred fifty (46.73%) of the households had a poor wealth status (Table 1).

Table 1: Sociodemographic and economic characteristics of the study population in Ethiopia, EDHS 2019

Variables	Category	Frequency(n)	Percent (%)
Child Sex	Male	822	51.21
	Female	783	48.79
Religion	Orthodox	501	31.21
ANC Follow up	Muslim	770	47.98
	Other*	334	20.81
	<4	966	60.18
	>4	639	39.82
Residence	Urban	414	25.79
	Rural	1191	74.21
Region	Tigray	130	8.10
	Afar	170	10.59
	Amhara	164	10.22
	Oromia	193	12.02
	Somali	146	9.10
	Benshangul	146	9.10
	SNNPR	183	11.40
	Gambela	124	7.73
	Harari	126	7.85
	Addis Ababa	96	5.98
	Dire Dawa	127	7.91
Maternal education	No education	781	48.66
	Primary	569	35.45
	Secondary and above	255	15.89
Maternal age(years)	< 20	124	7.73
	20-34	1,220	76.01
	35-49	261	16.26
Child age(months)	6-8	283	17.63
	9-11	257	16.01
	12-17	595	37.07

	18-23	470	29.28
Wealth index	Poor	750	46.73
	Middle	236	14.70
	Rich	619	38.57
Media exposed	Not Exposed	988	62.18
	Exposed	601	37.82
Marital status	Married	1,499	93.40
	Not married	106	6.60
Community level of poverty	Low	817	50.90
	High	788	49.10
Community level of Illiteracy	Low	922	57.45
	High	683	42.55

*=Catholic, Protestant, Traditional

Consumption of vitamin A-rich foods among children aged 6–23 months

The overall poor consumption of foods rich in vitamin A among children aged 6–23 months in our study was 61.2% (95% CI: 58.7–63.7). The most consumed animal products were eggs (15.5%) and the least consumed foods were fish or shellfish (2.67%). (Table 2)

Table 2: Consumption of vitamin A-rich foods among children aged 6–23 months in the previous 24 hours before the survey EMDHS, 2019, Ethiopia (n = 1,605)

S. No.	Food groups interviewed in the last 24 hours.	Consumption status	
		Yes (%)	No (%)
1	Have the child took eggs in the last 24 hours?	15.5	84.5
2	Has the child taken meat (beef, pork, lamb, chicken, etc.) in the last 24 hours?	6.01	93.99
3	Has the child taken a pumpkin, carrots, squash (yellow or orange inside) in the last 24 hours?	11.36	88.64
4	Has the child taken any dark green leafy vegetables in the last 24 hours?	10.09	89.91
5	Has the child taken mangoes, papayas, other vitamin A fruits in the last 24 hours?	12.36	87.64
6	Has the child taken liver, heart, other organs in the last 24 hours?	2.74	97.26
7	Has the child taken fish or shellfish in the last 24 hours?	2.67	97.33

Spatial autocorrelation

The Global Moran's index autocorrelation analysis of poor consumption of foods rich in vitamin A showed that there was significant spatial dependence across Ethiopia, with a Global Moran's I value of 0.26 (p-value 0.0000) and a z-score of 5.78 (Figure 1).

Hotspot analysis

Figure 2 shows the hotspot (Getis Ord Gi*) analysis map of poor consumption of foods rich in vitamin A among children aged 6–23 months. A high proportion of poor consumption of foods rich in vitamin A among children aged 6–23 months was clustered in the Afar, Amhara, and Somali regions of Ethiopia. However, the Addis Ababa, Gamebela, and Benshangul regions of Ethiopia were less at risk for poor consumption of foods rich in vitamin A among children aged 6–23 months.

Spatial Scan Statistical Analysis

In spatial scan analysis, a total of 49 significant clusters were identified. As shown in Figure 3 below, among the significant clusters, 19 clusters were most likely primary, and 30 clusters were secondary. The most likely (primary) clusters were located at 5.856584 N and 43.726017 E with a radius of 360.74 km in the Somali National Regional State of Ethiopia. The secondary significant clusters were located at 10.992773 N and 39.299564 E with a radius of 181.96 km in Afar and the Amhara Regional State of Ethiopia. Children aged 6–23 months living in the primary cluster were 1.66 times more vulnerable to poor consumption of foods rich in vitamin A than those living outside the window (RR = 1.66, LLR = 51.20, P 0.001). Children living in the secondary cluster were 1.43 times more likely to be at risk of poor consumption of foods rich in vitamin A than those living outside the window (RR = 1.43, LLR = 23.34, P-value 0.00043)

Table 3. Significant spatial scan statistics clusters of poor consumption of foods rich in vitamin A among children aged 6–23 months, EDHS, 2019.

Cluster	Enumeration areas(cluster) detected	Coordinates/Radius	Population	Cases	RR	LLR	P-value
1	137, 138, 123, 135, 142, 136, 145, 134, 140, 131, 141, 122, 132, 133, 124, 125, 143, 144, 129	(5.856584 N, 43.726017 E) / 360.74 km	115	114	1.66	51.20	<0.0000001
2	63, 66, 51, 65, 64, 67, 68, 60, 61, 48, 47, 62, 49, 44, 50, 58, 71,100, 46, 29, 73, 33, 78, 43, 70, 40, 18, 76, 45, 42	(10.992773 N, 39.299564 E) / 181.96 km	165	141	1.43	23.34	0.000000043
3	39, 35	(14.300432 N, 39.911831 E) / 32.54 km	18	18	1.61	8.47	0.053
4	38	(13.811395 N, 40.034386 E) / 0 km	10	10	1.60	4.69	0.815
5	77, 80, 79, 163	(10.511250 N, 36.855595 E) / 71.16 km	15	14	1.50	3.88	0.955

RR, relative risk; LLR, loglikelihood ratio

Interpolation of poor consumption of foods rich in vitamin A

Ordinary kriging interpolation was used to map the predicted prevalence of poor consumption of foods rich in vitamin A in an observed area. The high predicted prevalence of poor consumption of foods rich in vitamin A was observed in the eastern, southwestern, and north-central parts of Ethiopia. Whereas a low predicted prevalence of poor consumption of foods rich in vitamin A was observed in the western and central parts of the country (Figure 3).

Factors associated with poor consumption of foods rich in vitamin A among children aged 6–23 months in Ethiopia, EDHS 2019.

After LR and ICC tests were checked, the multilevel logistic regression model was the best-fitted model for our data. Thus, the two-level logistic regression model was fitted to obtain an unbiased result and make a valid inference. In this study, deviance was used for model comparison, and the final model was the best-fitted model with the lowest deviance value. The ICC value was 0.30 (95% CI: (0.23, 0.38)) in the null model, which indicates that about 30% of the overall variability of poor consumption of foods rich in vitamin A was due to the inter-cluster variability. A two-level logistic regression model was fitted to identify factors associated with poor consumption of foods rich in vitamin A in Ethiopia. On the other hand, media exposure, child age, maternal education, and wealth index were variables significantly associated with poor consumption of foods rich in vitamin A in Model II. On the other hand, region was an associated variable with poor consumption of foods rich in vitamin A in Model III. Similarly, in Model IV, child age, media exposure, maternal education, and region remain significant in the multivariable multilevel logistic regression model. At the individual level, the odds of poor consumption of foods rich in vitamin A among children aged 12-17 and 18–23 months were 0.57 (95%CI (0.39, 0.84)) and 0.39 (95%CI (0.26, 0.58)) respectively. Those mothers who have no media exposure have 1.41 times higher odds of poor consumption of foods rich in vitamin A compared to media-exposed mothers. 1.41 (95%CI (1.02, 1.95). The odds of poor consumption of foods rich in vitamin A among mothers whose mothers had no education were 1.9 times higher than in secondary and above. At the community level, the odds of poor consumption of foods rich in vitamin A were 6.07 (95%CI (2.59, 14.23)), 2.27 (95% CI (1.16, 4.44)) and 57.39 (95%CI (11.76, 279.90)) times higher among children who resided in Afar, Amhara and Somali regions, respectively, as compared to children who resided in the Tigray region (Table 4).

Table 4: Multivariable multilevel logistic regression analysis results of both individual-level and community-level factors associated with poor consumption of foods rich in vitamin A in Ethiopia, EDHS 2019.

Individual and community-level characteristics		Null model	Model II	Model III	Model IV
			AOR (95%CI)	AOR (95%CI)	AOR (95%CI)
sex	Male		0.98 (0.76, 1.27)		1.02 (0.79, 1.31)
	Female		1		1
Media exposed	Not exposed		**1.55 (1.12, 2.14)**		**1.41 (1.02, 1.95)**
	exposed		1		1
Child age (months)	6-8		1		1
	9-11		0.78 (0 .49, 1.24)		0.78 (0.49, 1.22)
	12-17		**0.56(0.38, 0.83)**		**0.57(0.39, 0.84)**
	18-23		**0.37(0.25, 0.56)**		**0.39(0.26, 0.58)**
Maternal age (years)	<20		1.05 (0.57, 1.93)		0.99 (0.54, 1.82)
	20-34		0.97 (0.68, 1.40)		0.93 (0.64, 1.33)
ANC Follow-up	35-49		1		1
	<4		1		1
	>4				1.11(0.83, 1.47)
			1.21(0.91, 1.60)		
Maternal educational status	no education		**2.04 (1.32, 3.14)**		**1.90 (1.22, 2.95)**
	primary		1.25(0.84, 1.86)		1.34 (0.91, 1.98)
	Secondary and above		1		1
Wealth index	poor		**1.96 (1.33, 2.88)**		1.31 (0.82, 2.09)
	middle		**1.55 (1.00, 2.38)**		1.26 (0.80, 1.97)
	rich		1		1
Religion	Orthodox		1		1
	Muslim		1.30(0.90, 1.86)		0.75(0.49, 1.15)
	Other**		0.64(0.41,0 .97)		0.92(0.57, 1.49)
Region	Tigray			1	1

	Afar			**5.26 (2.47, 11.21)**	**6.07 (2.59, 14.23)**
	Amhara			**2.80 (1.44, 5.44)**	**2.27 (1.16, 4.44)**
	Oromia			1.25 (0.67, 2.34)	1.31 (0.65, 2.64)
	Somali			**52.68 (11.35, 244.55)**	**57.39(11.76, 279.90)**
	Benshangul			0.93 (0.47, 1.83)	0.89 (0.43, 1.82)
	SNNPR*			0.96 (0.51, 1.78)	0.86 (0.42, 1.75)
	Gambela			0.61 (0.30, 1.24)	0.61 (0.28, 1.34)
	Harari			1.24 (0.62, 2.49)	1.58 (0.72, 3.45)
	Addis Ababa			1.16 (0.53, 2.52)	1.42 (0.64, 3.17)
	Dire Dawa			1.40 (0.69, 2.83)	1.79 (0.81, 3.92)
Residence	Urban			1	1
	Rural			1.50 (0.97, 2.31)	1.27 (0.81, 2.02)
Community poverty level	Low			1	1
	High			**1.65 (1.15, 2.37)**	1.28 (0.83, 1.96)
Community illiteracy level	Low			1	1
	High			1.34 (0.93, 1.92)	1.00 (0.67, 1.49)
ICC		0.30(0.23, 0.38)	0.20(0.14,0.29)	0.12 (0.06, 0.20)	0.11 (0.06, 0.20)
Log likelihood		-930.06	-869.79	-849.90	-823.35
Deviance		1860.12	1739.58	1699.8	1646.7

****=** Catholic, Protestant, Traditional

*SNNPR= Southern, Nations, Nationalities and Peoples region

Discussion

Vitamin A is one of the essential micronutrients that the body needs in small amounts but is vital to its function. However, the body cannot synthesize vitamin A. For this reason, the body gets vitamin A through external sources. Vitamin A can be obtained through the consumption of vitamin A-rich foods or by regular supplementation. The preferable one is the intake of vitamin A through foods on a daily basis. However, in developing countries like Ethiopia, VAD is a major public health problem, especially in children. As a result, assessing the prevalence and determinants of poor consumption of foods rich in vitamin A is used to overcome the problem related to vitamin A deficiency among children aged 6–23 months.

This study revealed that 61.2% (95% CI: 58.7, 63.7) of children aged 6–23 months had poor consumption of foods rich in vitamin A in Ethiopia. This finding is in line with a study conducted in Ethiopia using EDHS 2016 (62.30%) and a study conducted in the southern part of Ethiopia (62.2%) (21). This study's findings were greater than those of the Kenya DHS 2014 (28%) (22) and Ghana (48%) studies (23).This disparity could be due to socio-demographic and cultural variances. Consistent with previous studies in Ethiopia (14), Tanzania (22) and China (23), animal source foods were the least consumed foods in the last 24 hours of the survey period. Shellfish intake was the least consumed food in the 24 hours leading up to the survey (2.67%), whereas egg consumption was the most consumed food among the study participants (15.5%). The possible reason might be due to mothers' misconceptions that young children are unable to digest animal-based foods, the high expense of animal-based foods, limited income, and cultural and religious beliefs.

Consistent with previous studies conducted in Ethiopia, poor consumption of foods rich in vitamin A had a significant spatial variation across Ethiopia, with the highest concentrations in Afar, Amhara, and Somali. Another study conducted in Ethiopia that used the EDHS 2011 data found that undernutration was highly clustered in four areas of Ethiopia, including Amhara and Afar (14, 19).The spatial heterogeneity across different regions of Ethiopia might be due to socioeconomic status and demographic factors such as pastoralist regions (Afar and Somali) and the Amhara region (30.8%), low complementary feeding practices, lack of nutritional knowledge, social norms and beliefs, food preferences, and also accessibility and affordability of foods rich in Vitamin A, especially the high cost of animal source foods across these regions of Ethiopia (13).

In the multilevel logistic regression analysis, media exposure, child age, mothers' educational status, and geography were found to be significantly associated with poor consumption of vitamin A-rich foods.

Media Exposure: If respondents have the opportunity to listen to either radio or television, they are considered to have media exposure; if they do not have access to both, they are not considered to have media exposure.

The odds of poor consumption of foods rich in vitamin A was 1.4 times higher among mothers who had not been exposed to mass media, which was supported by studies conducted in Ethiopia, Bangladesh, Mexico, and Indonesia (25–311). The plausible justification is that media exposure is one way for the mother to receive information. Children's feeding practices can be improved by watching TV and listening to the radio. According to a study conducted in Nigeria, informal education employing various approaches can enhance children's nutritional outcomes (34)

In the present study, the age of infants and young children was positively associated with poor consumption of foods rich in vitamin A. In comparison to children aged 6–8 months, children aged 12–17 and 18–23 months were 43% and 61% more likely to consume vitamin A-rich foods. This study is in line with studies conducted in Ethiopia (32–35), Nepal (15), and Malawi (36). Those mothers who have 12–17 and 18–23 month old children were more likely to practice complementary feeding and offer dietary diversity compared to mothers who have children aged 6–11 months old. It indicated that children's minimum dietary diversity intake increases as they grow older, because children stop breastfeeding at the age of two and begin to eat a variety of foods, particularly those high in vitamin A.

The second explanation could be that mothers are unaware of the importance of complementary feeding; mothers believe that animal-source foods such as meat, eggs, and fruits and vegetables, as well as fruit and vegetables, are difficult to digest in the gut of a baby under the age of one year.

Maternal education was significantly associated with poor consumption of foods rich in vitamin A in children. Mothers who have no formal education have a 1.90 times greater risk of poor consumption of foods rich in vitamin A compared to mothers who have an educational status of secondary or above. That means maternal education plays a great role in child nutrition in general. This finding is supported by different studies conducted in Ethiopia (37, 38), Pakistan (39), Korea (40), and a study conducted in the Buchi compound in the Kitwe district of Zambia (41).

It could be because educated mothers are more likely to have access to more information through reading, have a hint of dietary diversity from their school courses, including foods high in vitamin A, and have a greater ability to capture nutritional information through various forms of media. Another possible explanation is that educated mothers are more aware of the necessity of complementary feeding, dietary consumption of vitamin A-rich foods, and the causes of vitamin A deficiency problems for their children. Furthermore, these educated women adhere to scientifically validated feeding practices as well as a good predictor for adequate nutritional feeding for child growth and development.

Furthermore, Ethiopian regions with poor consumption of vitamin A-rich foods were statistically significant. Children aged 6–23 months in Ethiopia's Amhara, Afar, and Somali regional states were less likely to consume vitamin A-rich foods than children in Tigray, although children in Ethiopia's Benishangul Gumuz and central regions were more likely. This finding was in line with spatial heterogeneity in the hot spot areas.

This study has an important implication for policymakers to design effective strategies to improve consumption of foods rich in vitamin A among children aged 6–23 months in Ethiopia. The study's findings, in particular, direct nutritional intervention in hotspot areas. Limitation was that there might be recall bias.

Conclusion

Poor consumption of foods rich in vitamin A among children aged 6–23 months in Ethiopia had significant spatial variations, with the highest prevalence observed in the Amhara, Somali, and Afar regions. Poor consumption of vitamin A-rich foods was significantly associated with child age, media exposure, maternal education, and regions. Through improving maternal education and creating awareness through mass media in the hotspot areas, interventions should be implemented to improve the consumption of foods rich in vitamin A. Besides, complementary feedings rich in Vitamin A should be encouraged, particularly for infants less than one year of age.

Abbreviations

ANC
Antenatal care
AOR
Adjusted odds ratio
CI
Confidence Interval
DHS
Demographic and Health Survey
EDHS
Ethiopia Demography and Health Survey
EAs
Enumeration Areas
ICC
Intra Class correlation Coefficient
RR
Relative Risk
LLR
Loglikelihood Ratio
SD
Standard Deviation
SNNPR
South Nations and Nationality of Peoples Republic UNICEF:United Nation Children's Emergency Fund.

Declarations

Ethical considerations

The data from the 2019 Ethiopia demographic and health survey was used for this study with permission from the Measure DHS program after being registered and submitting a request with the briefly stated objectives of the study. The data has been used only for this registered research and it cannot be passed on to other researchers.

The shape files for Ethiopia's administrative boundaries were obtained from the open AFRICA website [https://africaopendata.org/dataset/ethiopia-shapefiles].

Availability of data and materials

The datasets used and/or analyzed during the current study are **publically available on (http://dhsprogram.com) website.**

All the data were used during the report writing and attached during submitting my paper , if any concern about the data I will be attached any time when you need.

Consent for publication: Not applicable

Competing interests: The author declared that she or he has no competing interests**.**

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Authors' Contributions: Addis Bilal – topic selection, study design, and final manuscript preparation. All other co-authors involved in the analysis part then read the paper, review it, and provide constructive feedback throughout the manuscript preparation process.

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Figures

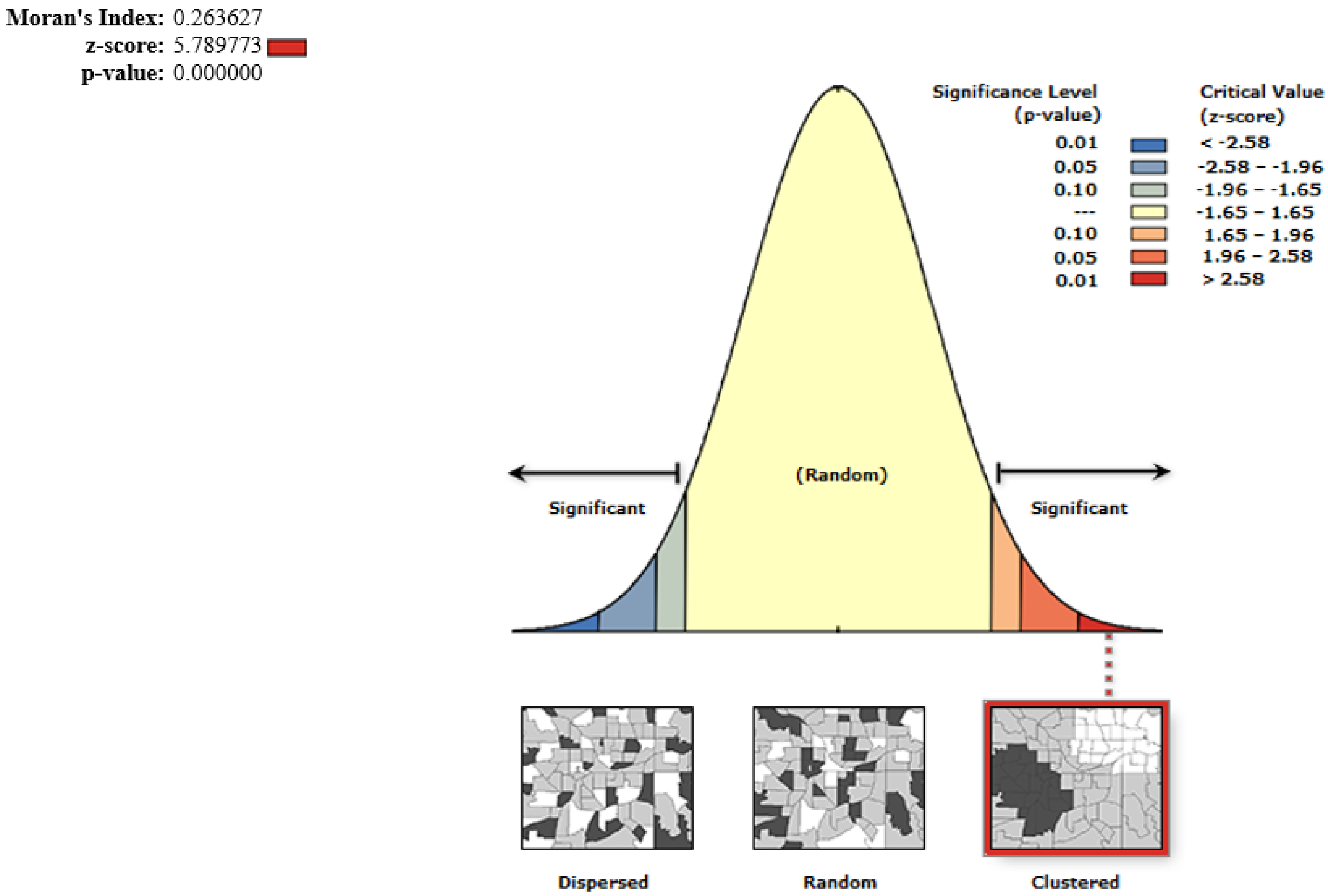

Figure 1

The Global Moran's I autocorrelation analysis of poor consumption of foods rich in vitamin A among children aged 6–23 months in Ethiopia, 2019.

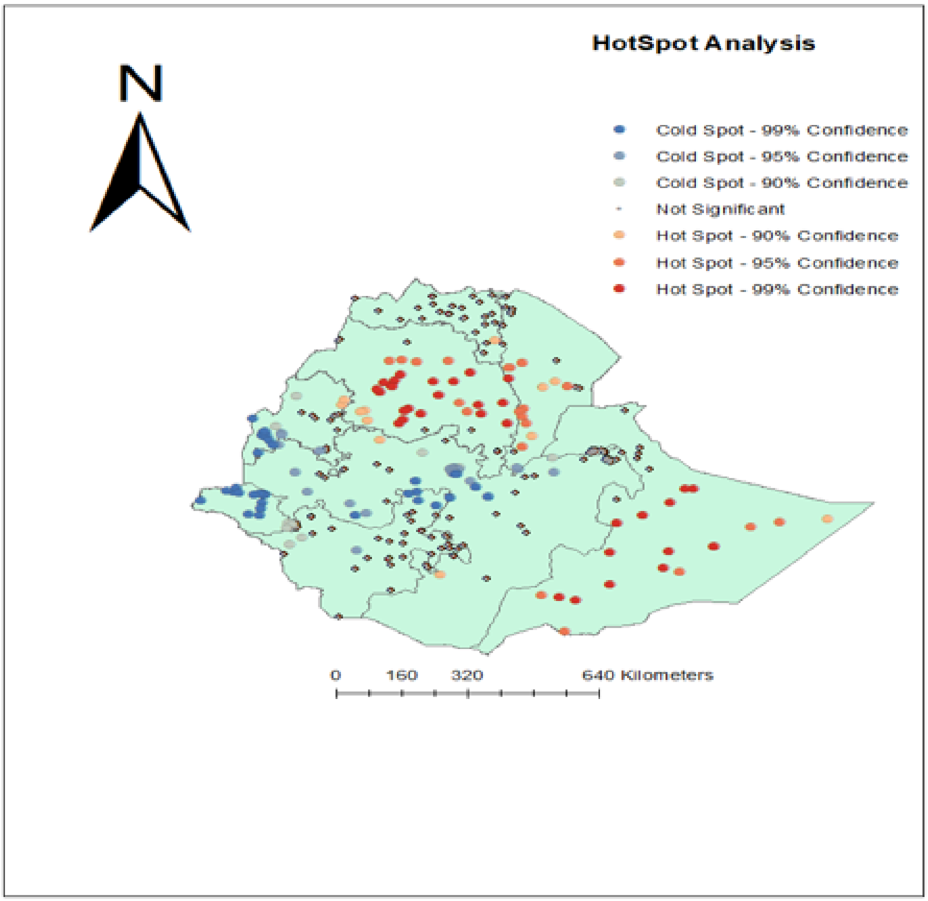

Figure 2

Hot spot analysis of poor consumption of foods rich in vitamin A among children aged 6–23 months in Ethiopia, EDHS 2019.

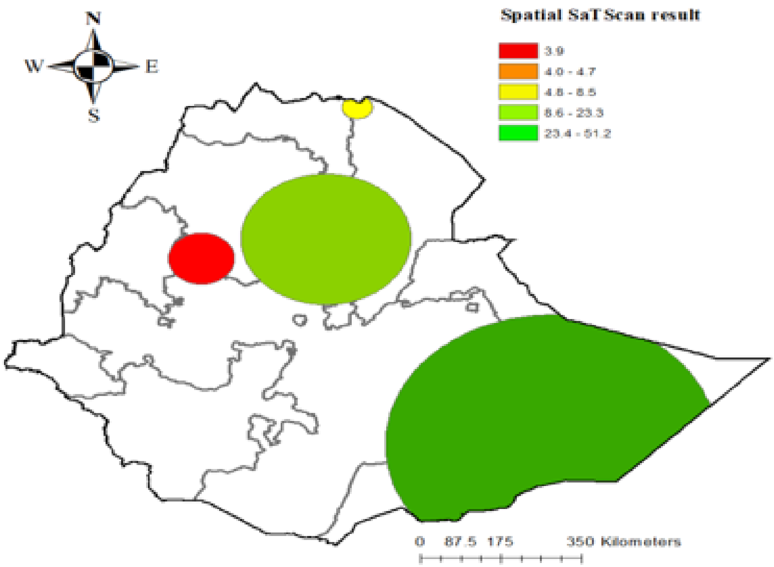

Figure 3

Spatial Scan Statistical Analysis of poor consumption of foods rich in vitamin A in Ethiopia, 2019

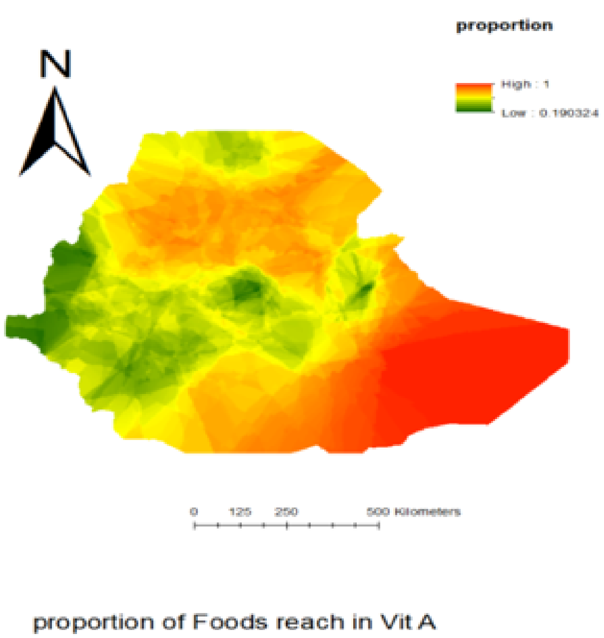

Figure 4

Kriging interpolation of poor consumption of foods rich in vitamin A among children aged 6–23 months, Ethiopia

Supplementary Files

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