The determinant of National Vitamin A supplementation in Ethiopia: A Multilevel Logistic Regression Analysis

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Abstract

Background: Vitamin A deficiency is a public health problem in many low-income countries including Ethiopia. Globally, the prevalence of vitamin A deficiency is estimated to be 190 million among children under-five age causing one up to two million deaths annually.Its periodic supply is a major intervention program to reduce the morbidity, mortality, and blindness among the children in Ethiopia.

Objective: The aim of this study was to determine associated factors of national vitamin A supplementationamong children aged 6-59 monthsusing the 2016 Ethiopian Demographic and Health Survey Data.

Methods: A population based cross-sectional study design wasperformed to determine factors associated with the vitamin A supplyamong children aged between 6 and 59 monthswithin the last six months before the start of the survey. A univariateanalysis, bivariate analysis, binary logistic regression, and generalized linear mixed effect model were appliedto analyze the data.

Results: After adjusting for covariates; the odds of taking vitamin A supply were 1.3 times, 1.7 times, and 1.8 times higher among the women who had two, three, and four and above antenatal care visits, respectively. The mothers' employment status, health cheek up after their delivery,and theirhealth facility delivery were positively influence the uptake of the vitamin A capsule. In addition,women residing in the communities with high proportion of the media exposure[AOR (Adjusted Odds Ratio) = 1.17 (95%CI: 1.00, 1.37)]were positively associated with the receipt of vitamin A capsule.Random effects indicated that the variation on the uptake of vitamin A supplementation between the communities was statistically significant in all stage of the models.

Conclusions: The individual and community level characteristics had a significant influence on the uptake of vitamin A supplementation. Therefore, these factors should be considered in policy formulation and programming in order to improve the coverage of vitamin A supplementation in Ethiopia. Keywords: Vitamin A supply, associated factors, multilevellogistic regression analysis, Ethiopia

Background

Vitamin A is an essential nutrient needed for the usual activity of the visual system, immune function, growth and development, maintenance of epithelial cell integrity, and for reproductive activity [1, 2, 3]. Vitamin A deficiency is the main cause of blindness, morbidity, and mortality among under-five age children in many low-income countries and it has been recognized as a major public health problem in Ethiopia [2, 4-6]. Globally, vitamin A deficiency affects one hundred ninety million under-five age children and causes one up to two million deaths annually [1, 7]. Vitamin A deficiency is considered public health importance if the national prevalence rate reaches an estimated fifteen percent using serum retinol concentration less than 0.7 µmol/L as a cut-off point for vitamin A deficiency [1, 8, 9]. In under-five age children, the worldwide reported prevalence rates of night blindness and vitamin A deficiency are 0.9 % and 33.3 %, respectively [1, 10]. In Africa, the prevalence of night blindness in under-five age children is two percent [10]. According to the World Health Organization (WHO), an estimated forty-two percent of under-five age children are at high risk for vitamin A deficiency in Sub-Saharan Africa countries and is responsible for an approximately six percent of child deaths in the preschool age children [1, 11, 12]. Vitamin A deficiency is a severe public health problem in Nigeria too, an estimated twenty-five percent of Nigerian under five age children are growing up with low immunity (due to vitamin A deficiency) that exposes them for frequent ill health and poor growth [13]. The prevalence of vitamin A deficiency in Nigeria was around twenty-nine percent with significant variations across the agro-ecological zones [13]. In countries where vitamin A deficiency is a public health problem, the provision of the high-dose vitamin A supplementation to the under-five age children (6-59 months) is being implemented as one of the three strategies to improve the health status of the children [14]. A universal vitamin A supplementation is a relatively a low cost, short term, and highly cost effective intervention strategy for child health by improving the vitamin A status of under-five age children [14, 15]. It reduces all causes of mortality by nearly one-quarter in under-five age children [16]. A periodic high dose vitamin A supplementation programs have been established over the last three decades in many developing African countries in order to increase the child survival and decrease the incidence of child blindness [15, 16]. In recent years, over eighty countries in the world have started to implement a universal vitamin A supplementation programs targeted to children age from six to fifty-nine months through semi-annual national campaigns [17]. Vitamin A supplementation programs began in the 1990's in response to evidence demonstrating the association between Vitamin A deficiency and increased childhood mortality [18, 19]. After that, many related studies have concluded that Vitamin A supplementation can considerably reduce the mortality and the morbidity of the children in 6-59 months of age [20].

In Ethiopia, there has been a rise in nutrition interventions for children due to the investment in the health system [21]. In 2004, the enhanced outreach strategy started in four drought prone regions. The mobile teams went from local to local in order to provide vitamin A capsule, deworming, and nutrition screening in twice-yearly campaigns. Malnourished children and lactating mothers were sent into the supplementary feeding programs [21]. Consequently, the whole country was considered for the vitamin A capsule during 2006. In this year, almost ten million children had been received vitamin A capsule. Then after, an important improvement had observed due to support of the UNICEF in all related matters [21, 22]. In 2008, the pilot districts in the original four regions began to transit the package of nutrition interventions from the enhanced outreach strategy to community health days, with the aim of gradually integrating the activities into the routine health services [21, 23]. The communities were mobilized to attend the campaign sites that arranged by each health post on specific days every three months to receive a package of the services, and every six months to receive vitamin A supplementation. The services were provided by outreach sites during the campaigns and through the house to-house visit in the urban areas [21, 23]. In 2013, the community health day's program and the enhanced outreach strategy were fully transitioned into the routine services program.

Ethiopia has maintained the good coverage of supplementation throughout these changes. The national coverage of the vitamin A supplementation was at least eighty percent in each of the two annual rounds (every 6 months in a year) between 2006 and 2011 [24]. The coverage was also 31 %, 70 %, and 80 % in

2012, 2013, and 2014, respectively [24]. According to the 2005 Ethiopian Demographic and Health Survey (EDHS), the overall coverage of vitamin A supplementation in unser-5 children within the last six months was 46.8 % [2]. There was variation in coverage of Vitamin A uptake in subsequent years; in addition, there were a hidden variation at regional levels. For instance, the Tigray region has the highest coverage (65 %), whereas the Benishangul Gumuz region had around 25 %, the lowest coverage [2]. These disparities in the coverage of vitamin A supplementation indicated that there is a factor that determines the coverage of vitamin A supplementation beyond the individual level factors. The regional or community level factors have also an essential role in determining the coverage of vitamin A supplementation [1, 25, 26].

As evidence from previously published studies has shown, the uptake of vitamin A supplementation is influenced by the socio-economic, demographic, and geographical factors [1, 2, 21, 26-29]. Some of these principal factors include the maternal educational status, or the educational status of their husbands, the employment status of the mother, the place of the delivery of the child, the number of antenatal care visits, community poverty level, community media exposure, and community level maternal education [1, 2, 21, 28, 29].

This study has tried to address not only the effects of the individual and socio-economic factors on the uptake of vitamin A supplementation, but also the factors that operate at the community levels. The communities provide a localized context for the social, economic, and political structures relevant to the interplay between macro and individual level determinants of health and health outcomes [27]. The people with similar characteristics who live in different neighborhood may have different health status because the presence of economic, cultural, political or geographical variations. In other words, different people may have almost similar health status because they share a common environment [1, 28]. According to the studies [29], the community level factors have a great influence in the child health and identifying these factors will allow the policy makers and the concerned bodies to prepare the community-level strategies and interventions.

Therefore, the aim of this study was to determine associated factors of national vitamin A supplementation in Ethiopia for the last six months before the 2016 EDHS.

Methods

Data source

This study analysis utilized the data of the 2016 EDHS. The approval letter for the use of this data set was gained from the Measure Demographic and Health Survey (DHS) (the Authorization was granted) and the data set was downloaded from the Measure DHS website: www.measuredhs.com. The DHS is undertaken every five years and the 2016 survey is the fourth DHS in Ethiopia. The first, second, third, and fourth DHS were undertaken in 2000, 2005, 2011, and 2016 in Ethiopia, respectively [30].

Study design and settings

A population based cross-sectional study design was applied. The survey was done from January 18, 2016, to June 27, 2016. The study population of this study was all children aged from six up to fifty-nine months and their families who participated in the 2016 EDHS. The full details of the methods used during data collection for the EDHS have been published [30].

Sample size and sampling technique

A nationally representative sample of 15,683 women age 15-49 and 12,688 men age 15-59 in 16,650 selected households were interviewed using a structured questionnaire. This represents a response rate of 95 % of the women and 86 % of the men [30]. In this study, a weighted sample of 8,361 children aged from six up to fifty-nine months was included in the analysis.

A stratified, two-stage cluster sampling technique was used to identify representative samples. The sampling frame of the 2016 EDHS consists of a complete list of 84,915 enumeration areas. An enumeration area is a geographic area covering on average of 181 households. In the first stage, 645 enumeration areas (202 in urban areas and 443 in rural areas) were selected using probability proportional to each size of enumeration area and with independent selection in each sampling stratum. In the second stage, twenty-eight households per cluster were selected using systematic selection. The mothers either permanent residents of the selected households or visitors who stayed in the household the night before the survey were eligible to be interviewed [30].

Study variables

The dependent variable is vitamin A supplementation. This outcome data were collect from mothers' direct verbal report, whether their children had taken vitamin A capsule [30].

Independent variables include individual level factors: The age of the mother, religion, ethnicity, marital status, the educational status of the mother, the educational status of the husband, the employment status of the mother and their husbands, the working status of the mother, place of the delivery, sex of the child, pregnancy wanted, the mothers health cheek after delivery, current age of the child, birth order, number of children live, and the number of antenatal care visits. And, the community level factors: the region, the place of residence, type of region of residence, community level poverty, community level education, and community media exposure. These variables were selected for the analysis in this study because they have been considered by the previous similar studies in the developing countries [1, 2, 31]. Some of the covariates were re-coded for suitable analysis. The aggregate community level covariates were found by aggregating individual level covariates at cluster level and its categorization was done as high or low based on proportion distribution values [31]. Histogram was used to check the distribution of the proportion values. If the aggregate variable was normally distributed, the mean value was considered, and if not normally distributed, median value was used as cut off point for categorization [31]. Therefore, the community poverty was categorized as high if the proportion of mothers from the two lowest wealth quintiles in a given community was 35-100 % and low if the proportion was 0-34 %. Community media exposure was classified as low if the proportion of the media exposure in the community was from 0-68 %, and as high if the proportion was from 69-100 %. Community education was classified as low if the proportion in the community with primary, secondary and above education was 0 %, and classified as high if the proportion was from 1-100 % [31]. These aggregations were performed because the variables are not directly available in the EDHS data set. This study adopted the classification method because the previous studies have analyzed the community-level variables in this way [1, 31].

Data collection tools, techniques, and procedures

The data were collected through face-to-face interviews using a structured questionnaire. The questionnaire was first prepared in English, translated in to three different local languages. The trained interviewers collected the data under close supervision throughout the data collection process in order to ensure its quality [30].

Data processing and analysis

The data were checked for its completeness. The covariate that needed coding was coded and missing values were dealt before the actual analysis. The data were analyzed by the investigators using Version 14.0 Stata Statistical Software. The dependent variable vitamin A supply was coded as No = 0 and Yes =1. Univariate analysis was done to explain the frequency and percentage of the dependent and independent variables. In a bivariate analysis, cross tabulation was carried out to show the percentage of the vitamin A supply as changes in the categories of the explanatory variables and to describe the relationship between the variables using the crude odd ratio.

Multi-level logistic regression analysis technique was applied in order to consider the hierarchal nature of the data (two-stage cluster-sampling procedure) and the binary response of the dependent variable. Binary multilevel logistic regression analysis was applied to calculate the crude odds ratios at 95 % confidence interval and those covariates that were statistically significant were considered for individual and community level multivariate analysis. Multivariable multilevel logistic regression analysis (multivariate) was applied for individual and community level variables and those variables, which were statistically significant, were considered for the final model of multivariate analysis. Multivariable multilevel logistic regression analysis was done to calculate the adjusted odds ratios and to estimate the extent of the random variations between the communities [31-34]. In multivariate analysis, Variance Inflation Factor (VIF) was calculated to identify the extent of multi-collinearity of explanatory covariates using the average value of VIF, help to identify suitable covariates for multivariate analysis. As a rule of thumb, average VIF value is less than five can be tolerated [35-38].

Model building

Four models were fitted using the xtmelogit command. Model I, empty model, was fitted without independent covariates in order to test random variability of the intercept and to estimate the intra-class correlation coefficient (ICC). Model II fitted in order to see the effects of individual level covariates. Model III fitted to see the effect of community level covariates. Model IV examined the effects of both the individual and community level variables simultaneously. The individuals (the mother and child) were nested within the community was expressed elsewhere [31, 32]. The chi square likelihood-ratio test was used to assess the difference between the models because the models were nested, the P-values were estimated using the wald statistics, tells about the model adequacy.

Parameter estimation methods

In the multilevel models, the fixed effects (measures of association) estimates the association between the likelihood of taking vitamin A capsule and the individual and community level factors. These estimates were expressed as odds ratio with their 95 % confidence intervals. The random effects are the measures of variation in use of vitamin A supply across the communities. It was expressed as ICC and proportional change in variance (PCV). The ICC was calculated to evaluate whether the variation in vitamin A supplementation is primarily within or between communities [39, 40]. The ICC ranges from 0 to 1, with ICC of 1 indicating that mothers in the community have identical use of vitamin A supply for their children, and with ICC of 0 indicating that mothers in the community do not have identical use of vitamin A supply. A multilevel random intercept logistic regression models was used in the analysis. In addition, the mixed-effect logistic regression was used to determine extent of the variation in use of the vitamin A supply attributable to the individual and community-level characteristics. The mixed-effects logistic regression model consists of two parts, namely, the fixed effect and the random effect [37, 38].

The model was specified as:

$$\text{logit}(\pi ij) = \log(\pi ij/1-\pi ij) = \beta_0 + \beta_1 xij + \beta_2 x_2 ij + \dots + \beta_8 x_8 ij + \beta_9 z_1 j + \beta_{10} z_2 j + \dots \beta_{14} z_6 j + \mu_0 j$$

Where: πij is the log of the odds of using vitamin A supply for the mothers i in the cluster j; (1-πij) is the log of no-receiving; x and z are the explanatory variables for the likelihood of taking vitamin A; x_1 to x_8 are the individual-level variables; z_1 to z_6 are the community-level variables; β_0 is the overall intercept; β1-β14 are the regression coefficients for the explanatory variables x1 to x8, and z1 to z6; and u_0j is the community-level random effect (assumed to be normally distributed with mean equal to 0 and variance equal to $\sigma^2\mu_0$). The ZjXij is added as a cross-level interaction term.

The ICC calculated as: $\tau/ \tau+(\pi^2/3)$ where τ is the estimated community-level variance [33]. Since the logistic distribution for the level one residual variance implies a variance of $\pi^2/3$ (σ^2) ~3.29 [37].

Ethical consideration

The researchers had received the survey data and an authorized approval letter from the Measure DHS site (Supplementary file 1).

Results

Socio-demographic characteristics of the respondents

A total of 8,361 (after weighting of the data) children aged between 6 and 59 months were involved in the study analysis, based on the report of their mothers. Among the total mothers whose data were analyzed, 49 % were aged above 30 years, 41 % were Oromo in their ethnicity, and 40 % were Muslim in their religion. Further characteristics analyzed showed that 66.5 % of the respondents were no education, most of the women were married (99 %), and 55 % were unemployed. Among respondent's husband, 92 % were employees in their occupation and 48 % had no education in respect to their educational qualification (Table 1).

Based on the community level factors, more than three-fourths of the respondents were rural residents and about two-thirds of the respondents had low-level community education (Table 2).

Reproductive, maternal, and child health characteristics

Among the total mothers, whose data were analyzed, 37 % were no antenatal care visits, 90 % were their pregnancy wanted, 94 % were no postnatal health cheek ups or postnatal care visits, and 75 % were delivered at their home. About 29 % of children were found from 45-59 age groups (Table 1).

Binary multilevel logistic regression analysis

Bivariate multilevel logistic regression analysis was performed for individual and community level factors to select statistically significant variables for multivariate multi-level logistic regression analysis. Antenatal care visits, employment status of the mothers and their husbands, educational status of the mothers and their husbands, age of the mothers, ethnicity, the current working status of the mothers, place of delivery, and mother's health cheek after delivery were significant at 0.05 of individual level factors. In addition, place of residence, type of region of residence, community media exposure, community level poverty, and community level education were significant at community level variables (Table 3).

Multivariable multilevel logistic regression analysis

The fixed effects (measure of association) and the random intercepts for receiving vitamin A supplementation are presented in Table 4 and 5. The results of the model I depicted that there was a statistically significant variability in the odds of the receipt of vitamin A supplementation between communities (τ = 1.208, P-value <0.0001). Similarly, the ICC in the empty model implied that 26.9 % of the total variance in the receipt of vitamin A supplementation was attributed to differences between communities, or intra cluster or community factors are responsible for 26.9 % of variation in the uptake of vitamin A supplementation.

In model II, only significant individual level variables were added. The results showed that the age of the mothers, employment status of the mothers and their husbands, number of antenatal care visits, mother's health cheek after delivery, and place of delivery were significantly associated with the uptake of vitamin A supplementation. The ICC in Model II indicated that, 16.7 % of the variation in child's vitamin A supplementation uptake was attributable to the differences across the communities. As shown by the PCV, 45.6 % of the variance in the uptake of vitamin A supplementation across communities was explained by the individual level characteristics.

In model III, only significant community level variables were added. The result revealed that those women residing in the communities with low poverty level, residing in the communities with high media exposure, and those women residing in the communities with high education level were significantly associated with the uptake of vitamin A supplementation. The ICC in Model III implied that differences between communities account for about 25.0 % of the variation in the uptake of vitamin A supplementation. In addition, the PCV indicated that 9.2 % of the variation in the uptake of vitamin A supplementation between communities was explained by community level characteristics.

The model IV, the last and full model, included both statistically significant individual and community level variables simultaneously. After controlling for other individual and community level factors, the mothers who had two antenatal care visits were 34 % [AOR = 1.34 (95 % CI: 1.04, 1.73)] more likely to receive vitamin A capsule for their child as compared to that of the mothers who had no antenatal care visits, the mothers who had three antenatal care visits were 1.7 times [AOR = 1.65 (95 % CI: 1.35, 2.02)] more likely to receive vitamin A capsule for their child as compared to that of the mothers who had no antenatal care visits, and the mothers who had four and above antenatal care visits were 1.8 times [AOR = 1.76 (95 % CI: 1.47, 2.12)] more likely to receive vitamin A capsule for their child as compared to that of mothers who had no antenatal care visits.

The employed mothers were 1.4 times [AOR = 1.43 (95 % CI: 1.25, 1.64)] more likely to receive vitamin A capsule for their child as compared to that of un employed mothers. The employment status of their husband were also affected the uptake of vitamin A capsule [AOR = 1.40 (95 % CI: 1.12, 1.75)]. The mothers who got postnatal care after delivery were 1.3 times [AOR = 1.32 (95 % CI: 1.02, 1.71)] more likely to receive vitamin A capsule for their child as compared to that of without postnatal cheek ups. The mothers who delivered at health facility were 1.2 times [AOR = 1.19 (95 % CI: 1.00, 1.40)] more likely to receive vitamin A capsule for their child as compared to the mothers delivered at their home.

After holding other factors constant, the mothers residing in the communities with high proportion of the media exposure were 1.2 times [AOR = 1.17 (95 % CI: 1.00, 1.37)] more likely to receive vitamin A capsule for their child compared to the mothers residing in the communities with low proportion of media exposure.

After the inclusion of both the individual and community level variables in the model IV, the variation in the odds of receiving vitamin A capsule between communities still remained statistically significant (τ = 0.673, P-value <0.0001). As indicated by the estimated ICC, the 17.0 % of the variability in the uptake vitamin A capsule was attributable to the differences between communities. The result of PCV showed that, 44.3 % of the variation in the uptake of vitamin A capsule across communities was explained by both the individual and the community level factors included in model IV (Table 4 and 5).

In multivariate analysis, the fitness of the goodness of test was computed and it showed that the model is good fitted (Pearson χ^2 = 833.6; P value = 0.17). To cheek the presence of multi collinearity between variables, the VIF was computed and it revealed that the mean VIF value was 1.26. It showed that the explanatory variables were not multi-collinear as well as the variables were sufficient for adequate estimation of the regression coefficients. The Wald chi-square (χ^2) confirmed that all the fitted models were statistically significant at P value of less than 0.0001.

Discussion

This population-based study was employed to determine the factors associated with vitamin A supply in children aged 6-59 months based on Ethiopian Demographic and Health Survey data. Accordingly, the number of antenatal care visits, the employment status of the mother and their husbands, mother's health cheek after delivery, health facility delivery, and the community level media exposure were independently and significantly associated with the receipt of vitamin A supply in all stages of the model.

In this study, the mothers who had more than one antenatal care attendance were more likely to receive vitamin A capsule for their child as compared to the mothers who had no-antenatal care attendance. This finding is supported by similar study conducted in the Nigeria [1]. As the previous studies reported, attending antenatal care follow up during the pregnancy increases the chance of receiving vitamin A capsule, even mothers those who had at least one antenatal care visit for their recent birth had higher likelihood of receiving the vitamin A capsule compared to those mothers who had no antenatal care visits [1, 31]. This can be explained with the idea that mothers with antenatal care follow up have a better chance of being familiar with maternal and child health services. As reported by the DHS based studies, the characteristics that predispose the mothers to seek pregnancy care also make them more likely to seek care during and after the delivery [1, 41, 42, 43]. Attending antenatal care visits will make mothers to get information about post-delivery maternal and child health services, informed about pregnancy complications, and to be familiar with healthy maternal and child health practices during and after the delivery (exclusive breastfeeding, immunization, regular growth monitoring, birth preparedness plan which includes identification of health facility for delivery etc., for example). These will increase the likelihood of receiving maternal and child health services, particularly vitamin A supplementation [1, 31, 43, 44]. In addition, attending antenatal care visits create an opportunity for health care workers to provide the relevant health information. This may be due to the health information given to the pregnant women during antenatal care visits is a vital to promote post-delivery health services like vitamin A supplementation. In similar manner, mother's health cheek after the delivery, and health facility delivery were significant predictors of the receipt of vitamin A supplementation. It is a platform where mothers and their children are given necessary health information in order to prevent ill health and adopts healthy practices. Thus, antenatal care attendance, health facility delivery, and postnatal health cheek up increase the likelihood of receiving the vitamin A capsule [1, 43]. The employment status of the mothers and their husbands were independently and positively associated with the receipt of vitamin A supplementation. The working status of the mothers increases the chance of receiving vitamin A capsule for their child [1, 2]. The possible explanation could be due to the information needed to access health care services were easily obtained from their colleagues; the employed parents were mostly educated, and it improves the use health services like vitamin A capsule uptake.

In this study, the mothers residing in the communities with high proportion of the media exposure were more likely to receive vitamin A capsule for their child compared to the women residing in the communities with low proportion of the media exposure. The media exposure affects post-delivery health care services positively; this is consistent with the findings of other studies [31, 45-48]. The studies indicated that the knowledge of the mothers on pregnancy, delivery and post-delivery health care services had a significant influence on utilization of the health care services. Some literature also documented that exposure to the media is an important source for health information and it promotes health related behavior of the mothers [31, 46-49]. The presence of this information (about vitamin A) will influence and make them to utilize it more.

The findings of this study indicated that the community level random intercept, the community level variation, were large and statistically significant that indicating considerable differences between the communities in the odds of taking vitamin A capsule among the children of the mothers. This notion supports the use of multilevel modeling technique for the analysis of this study [31-34, 39]. This study also indicated that the presence of significant unobserved variations between the communities beyond the influence of the measured individual and community level factors on vitamin A supply. This finding is in agreement with the previous African studies [31, 41]. The unobserved effects might represent the differences among communities in terms of social norms and attitude, cultural beliefs, and quality of health services that influences the mothers to use these services.

Strength And Limitations Of The Study

This is a population-based study and based on the most recent Ethiopian Demographic and Health Survey with a nationally representative large sample size. This study has applied a multilevel modeling technique to accommodate the hierarchical nature of the EDHS data.

Despite the above strong sides, the study has the following limitations. The cross-sectional nature of the study does not allow making assumptions surrounding causal effects between the relationships. Due to the presence of a few articles related with vitamin A supplementation that uses a multilevel modeling technique, we were restricted in some extent to compare and contrast deeply in discussion section.

Conclusions

In this study, both the individual and community level factors had significant influence on the uptake of the vitamin A capsule.

The factors like the number of antenatal care visits, employment status of the mother and their husbands, mother’s health cheek after delivery, and health facility delivery were independently and significantly associated with on the uptake of vitamin A capsule at the individual level.

This study also showed that the communities in which the mothers reside play a significant role in shaping a mothers decision to receive vitamin A capsule for their children. Of this, the community level media exposure was positively and significantly associated with the uptake of vitamin A capsule at the community level.

Therefore, the authors recommend that, special awareness creation about maternal and child health services through the means of the media should be given to the population. The government should strive also to expand access to media to remote areas of the country to promote health services. This will help them to develop appropriate knowledge towards vitamin A supplementation.

Further, it is also very important to give special emphasis for those communities who had home delivery, low health cheek up after delivery, and very low antenatal care visit attendance.

Abbreviations

AOR: Adjusted Odds Ratio; COR: Crude Odds Ratio; CI: Confidence Interval; DHS: Demographic and Health Survey; EDHS: Ethiopian Demographic and Health Survey; ICC: Intra-class Correlation Coefficient; PCV: Proportional Change in Variance; USAID: United States Agency for International Development; UNICEF: United Nations Children Fund; VIF: Variance Inflation Factor; WHO: World Health Organization.

Declarations

Ethics approval and consent to participate

“Not applicable”.

Consent for publication

“Not applicable”.

Availability of data and materials

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors contributions

MO, SY, ZM, MM, and AM participated in conceptualization, formal analysis, investigation, methodology, supervision, visualization, writing-original draft, writing-review and editing, and approving the final draft. All authors read and approved the manuscript.

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Tables

Table 1: Bivariate analysis of vitamin A supply by the individual level factors, 2016 EDHS, Ethiopia, 2019

Individual level Characteristics	Received Vitamin A Supplementation		Total (%)
	No (%)	Yes (%)	
Age of the mothers (in years)			
15-19	113 (1.35)	79 (0.95)	192 (2.29)
20-24	860 (10.28)	628 (7.51)	1,487 (17.79)
25-29	1,415 (16.92)	1,180 (14.12)	2,595 (31.03)
30 and above	2,265 (27.08)	1,823 (21.80)	4,087 (48.88)
Ethnicity			
Amhara	929 (11.12)	820 (9.81)	1,749 (20.92)
Oromo	2,113 (25.27)	1327 (15.87)	3,440 (41.14)
Tigray	151 (1.81)	378 (4.53)	530 (6.33)
Others	1,458(17.44)	1,184 (14.17)	2, 643 (31.61)
Religion			
Orthodox	1,423 (17.01)	1,431 (17.12)	2,854 (34.13)
Muslim	2,101 (25.13)	1,266 (15.15)	3,368 (40.28)
Catholic	36(0.43)	37 (0.44)	73 (0.87)
Protestant	1,011 (12.09)	869 (10.40)	1,881 (22.49)
Others	81 (0.96)	106(1.27)	186 (2.23)
Marital status			
Married	4,590 (54.90)	3,690 (44.13)	8,280 (99.03)
Others	61 (0.73)	20 (0.24)	81 (0.97)
Educational status of the mothers			
No education	3,269 (39.10)	2,291 (27.40)	5,560 (66.50)
Primary education	1,168 (13.96)	1,071 (12.80)	2,238 (26.77)
Secondary education	139 (1.67)	217 (2.59)	356 (4.26)
Higher education	75 (0.90)	132 (1.57)	207 (2.47)
Educational status of the husband			
No education	2,376 (28.41)	1,629 (19.49)	4,005 (47.90)
Primary education	1,795 (21.46)	1,552 (18.56)	3,346 (40.02)
Secondary education	318 (3.80)	322 (3.85)	639 (7.65)
Higher education	163 (1.95)	207 (2.48)	370 (4.43)
Employment status of the mothers			
Unemployed	2,779 (33.23)	1,858 (22.22)	4,636 (55.45)
Employed	1,873 (22.40)	1,852 (22.15)	3,725 (44.55)
Employment status of the husband			
Unemployed	428 (5.12)	220 (2.63)	648 (7.75)
Employed	4,223 (50.51)	3,490 (41.74)	7,713 (92.25)
Mother currently working			
No	3, 495 (41.79)	2,563 (30.66)	6,058 (72.55)
Yes	1,157 (13.83)	1,147 (13.71)	2,303 (27.55)
Antenatal care visits			
No visits	1,229 (22.51)	774 (14.18)	2,003 (36.69)

1st visit	126 (2.30)	91 (1.67)	217 (3.98)
2nd visit	229 (4.20)	195(3.58)	424 (7.77)
3rd visit	475 (8.70)	571 (10.45)	1,046 (19.15)
4 and above visits	748 (13.70)	1,021 (18.70)	1,769 (32.40)
Was pregnancy wanted			
No	31 (3.39)	65 (7.05)	96 (10.44)
Yes	425 (46.44)	395 (43.12)	820 (89.56)
Had mothers health cheek after delivery or discharge			
No	2, 680 (49.09)	2, 438 (44.65)	5, 117 (93.74)
Yes	127 (2.33)	215 (3.93)	342 (6.26)
Place of delivery			
Home	3, 683 (44.05)	2, 616 (31.29)	6, 299 (75.34)
Health facility	968 (11.58)	1,094 (13.08)	2, 062 (24.66)
Was delivery twin			
No	4,536 (54.25)	3, 637 (43.50)	8,173 (97.75)
Yes	115 (1.38)	73 (0.87)	188 (2.25)
Sex of the child			
Male	2, 409 (28.81)	1, 913 (22.87)	4, 321 (51.68)
Female	2,242 (26.82)	1, 797(21.50)	4, 040 (48.32)
Current age of the child (in months)			
6-18	1,213 (14.51)	926 (11.07)	2, 139 (25.59)
19-31	1, 025 (12.25)	831 (9.93)	1, 855 (22.19)
32-44	1,073 (12.83)	902 (10.79)	1, 975 (23.62)
45-59	1,340 (16.03)	1,051 (12.57)	2, 391 (28.60)
Birth order			
First	820 (9.80)	616 (7.36)	1,435 (17.17)
2-3	1,398 (16.72)	1, 173 (14.03)	2, 035 (24.34)
4-5	1, 156 (13.83)	879 (10.51)	2, 035 (24.34)
6 and above	1, 277 (15.28)	1, 042 (12.46)	2, 319 (27.74)
Number of living children			
1-3	2, 101 (25.12)	1, 743 (20.85)	3, 844 (45.97)
4-6	1, 765 (21.11)	1, 407 (16.83)	3, 172 (37.94)
7 and above	786 (9.40)	559 (6.69)	1,345.12 (16.09)

Table 2: Bivariate analysis of vitamin A supply by the community level factors, 2016 EDHS, Ethiopia, 2019

Community level characteristics	Received Vitamin A Supplementation		Total (%)
	No (%)	Yes (%)	
Region			
Tigray	147 (1.75)	368 (4.40)	515 (6.15)
Afar	55 (0.66)	29 (0.35)	85 (1.01)
Amhara	813 (9.73)	746 (8.92)	1, 559 (18.65)
Oromia	2, 243 (26.82)	1, 382 (16.53)	3, 625 (43.35)
Somali	241 (2.88)	137 (1.64)	379 (4.53)
Benishangul	33 (0.39)	61 (0.73)	94 (1.12)
SNNPR	998 (11.94)	858 (10.26)	1, 856 (22.20)
Gambela	8 (0.10)	11 (0.14)	19 (0.23)
Harari	12 (0.14)	7 (0.09)	19 (0.23)
Addis Ababa	91 (1.09)	85 (1.02)	176 (2.10)
Dire Dawa	11 (0.13)	25 (0.3)	35 (0.42)
Place of residence			
Urban	385 (4.61)	511 (6.11)	896 (10.72)
Rural	4, 266 (51.02)	3, 199 (38.26)	7, 465 (89.28)
Type of region of residence			
Pastoralist community	337 (4.03)	239 (2.86)	576 (6.89)
Agrarian community	4, 201 (50.24)	3, 354 (40.11)	7, 554 (90.35)
City community	113 (1.36)	117 (1.40)	231 (2.76)
Community media exposure			
Low	3, 327 (39.79)	2, 297 (27.47)	5, 624 (67.26)
High	1, 325 (15.84)	1, 413 (16.90)	2, 737 (32.74)
Community level poverty			
High	1, 184 (14.16)	787 (9.41)	1, 971 (23.57)
Low	3, 467 (41.47)	2, 923 (34.96)	6, 390 (76.43)
Community level education			
Low	3, 269 (39.10)	2, 291 (27.40)	5, 560 (66.50)
High	1, 382 (16.53)	1, 419 (16.97)	2, 801 (33.50)

Table 3: Bivariate multi-level logistic regression analysis on individual and community level factors of vitamin A supply in Ethiopia, 2019

Characteristics	Model I Crude OR (95 % CI)
Fixed effect	
Age of the mothers (in years)	
15-19	0.85 (0.62-1.17)
20-24	0.80 (0.70-0.92)*
25-29	0.92 (0.82-1.04)
30 and above	1.00
Ethnicity	
Amhara	1.00
Oromo	0.83 (0.65-1.05)
Tigray	3.05 (2.18-4.26)*
Others	0.76 (0.61-0.93)*
Religion	
Orthodox	1.00
Muslim	0.58(0.49, 0.74)*
Catholic	0.79 (0.40-1.53)
Protestant	0.86 (0.70-1.07)
Others	1.22 (0.76-1.93)
Marital status	
Married	1.00
Others	0.62 (0.35-1.12)
Educational status of mothers	
No education	1.00
Primary education	1.26 (1.11-1.44)*
Secondary education	1.88 (1.49-2.37)*
Higher education	1.59 (1.17-2.15)*
Educational status of the husband	
No education	1.00
Primary education	1.20 (1.05-1.35)*
Secondary education	1.45 (1.20-1.75)*
Higher education	1.40 (1.12-1.74)*
Employment status of mothers	
Unemployed	1.00
Employed	1.57 (1.40-1.76)*
Employment status of the husband	
Unemployed	1.00
Employed	1.60 (1.33-1.92)*
The mother currently working	
No	1.00
Yes	1.55 (1.38-1.76)*
Antenatal care visits	
No visits	1.00

1^{st} visit	1.35(0.99-1.83)
2^{nd} visit	1.45 (1.13-1.87)*
3^{rd} visit	1.89 (1.56-2.30)*
4 and above visits	2.22 (1.88-2.62)*
Was pregnancy wanted	
No	1.00
Yes	0.60 (0.31-1.20)
Mothers health cheek after delivery	
No	1.00
Yes	1.60 (1.24-2.07*)
Place of delivery	
Home	1.00
Health facility	1.62 (1.42-1.84*)
Was delivery twin	
No	1.00
Yes	0.88 (0.62-1.23)
Sex of the child	
Male	1.00
Female	0.99 (0.90-1.10)
Current age of the child (in months)	
6-18	1.00
19-31	1.02 (0.88-1.18)
32-44	1.04 (0.90-1.20)
45-59	0.88 (0.77-1.01)
Birth order	
First	1.00
2-3	1.17 (1.01-1.36)*
4-5	1.13 (0.96-1.32)
6 and above	1.21(1.03-1.41*)
Number of living children	
1-3	1.00
4-6	1.01 (0.90-1.13)
7 and above	0.93 (0.80-1.09)

Table 3: Bivariate multi-level logistic regression analysis on individual and community level factors of vitamin A supply in Ethiopia, 2019 *(Continued)*

Community level characteristics	Model I Crude OR (95 % CI)
Fixed effect	
Place of residence	
Urban	1.00
Rural	0.64 (0.51-0.81*)
Type of region of residence	
Pastoralist community	1.00
Agrarian community	1.44 (1.14-1.80*)
City community	1.57 (1.17-2.09*)
Community media exposure	
Low	1.00
High	1.44 (1.27-1.63)*
Community level poverty	
High	1.00
Low	1.45 (1.26-1.67)*
Community level education	
Low	1.00
High	1.36 (1.21-1.54)*

Key: * statistically significant at P-value ≤ 0.05 in multivariable logistic regression analysis; OR = Odds Ratio; CI= Confidence Interval.

Table 4: Multilevel logistic regression analysis of individual and community level factors, showing fixed effects on the likelihood of taking vitamin A capsule, 2019

Characteristics	Model I	Model II	Model III	Model IV
Fixed effect		AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Age of the mothers (in years)				
15-19		1.00		1.00
20-24		0.95(0.67-1.34)		0.95(0.67-1.35)
25-29		1.11 (0.79-1.56)		1.09 (0.77-1.53)
30 and above		1.30 (0.92-1.82)		1.27 (0.91-1.79)
Ethnicity				
Amhara		1.00		
Oromo		1.01 (0.79-1.28)		
Tigray		2.40 (1.73-3.32)*		
Others		1.07 (0.85-1.33)		
Educational status of mothers				
No education		1.00		
Primary education		1.14 (0.96-1.35)		
Secondary education		1.44 (1.06-1.95)*		
Higher education		1.04 (0.69-1.56)		
Educational status of the husband				
No education		1.00		
Primary education		1.03 (0.88-1.21)		
Secondary education		1.15 (0.90-1.47)		
Higher education		1.11(0.82-1.52)		
Employment status of mothers				
Unemployed		1.00		1.00
Employed		1.42 (1.15-1.75)*		1.43 (1.25-1.64)*
Employment status of the husband				
Unemployed		1.00		1.00
Employed		1.38 (1.11-1.72)*		1.40 (1.12-1.75)*
The mother currently working				
No		1.00		
Yes		1.01 (0.81-1.76)		
Antenatal care visits				
No visits		1.00		1.00
1st visit		1.26(0.92-1.71)		1.28 (0.94-1.74)
2nd visit		1.32 (1.03-1.70)*		1.34 (1.04-1.73)*
3rd visit		1.67 (1.37-2.04)*		1.65 (1.35-2.02)*
4 and above visits		1.75 (1.46-2.10)*		1.76 (1.47-2.12)*
Mothers health cheek after delivery				
No		1.00		1.00
Yes		1.29 (1.10-1.67)*		1.32 (1.02-1.71)*
Place of delivery				
Home		1.00		1.00

Health facility	1.16 (0.98-1.37)	1.19 (1.00-1.40)*

Table 4: Multilevel logistic regression analysis of individual and community level factors, showing fixed effects on the likelihood of taking vitamin A capsule, 2019 *(Continued)*

Characteristics	**Model I**	**Model II**	**Model III**	**Model IV**
Fixed effect		**AOR (95% CI)**	**AOR (95% CI)**	**AOR (95% CI)**
Community level characteristics				
Place of residence				
Urban			1.00	
Rural			0.83 (0.63-1.09)	
Type of region of residence				
Pastoralist community			1.00	
Agrarian community			1.27 (1.01-1.60)*	
City community			1.04 (0.76-1.43)	
Community media exposure				
Low			1.00	1.00
High			1.27 (1.11-1.45)*	1.17 (1.00-1.37)*
Community level poverty				
High			1.00	1.00
Low			1.24 (1.07-1.44)*	1.10 (0.93-1.30)
Community level education				
Low			1.00	1.00
High			1.22 (1.07-1.38)*	1.15 (0.98-1.35)

Key: * statistically significant at P-value ≤ 0.05 in multi-level multivariable logistic regression analysis. AOR = Adjusted Odds Ratio.

Table 5: Multilevel logistic regression analysis, the random effects showing influence of community characteristics on the receipt of vitamin A supply, 2019

Random effect	Model I	Model II	Model III	Model IV
Community variance (SE)	1.208* (0.111)	0.658* (0.086)	1.097* (0.103)	0.673* (0.087)
ICC (%)	26.9 %	16.7 %	25.0 %	17.0 %
PCV (%)	Reference	45.6 %	9.2 %	44.3 %
Model Fitness				
	Model I	Model II	Model III	Model IV
Log likelihood	-5094.3251	-3303.3813*	-5063.4939*	-3301.291*
AIC	10192.65	6630.763	10140.99	6624.582

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