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Determinants of Vitamin A Uptake in Nigeria: The Role of Contextual Factors

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Authors' contributions

This work was carried out in collaboration between all authors. Author TD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors KHL and SSB wrote the discussion and conclusion. Authors NMS, ZZ, MM, JCI, RO, MBG and UMU contributed in discussion. All authors read and approved the final manuscript.

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ABSTRACT

Vitamin A deficiency (VAD) is a public health problem in many low-income countries including Nigeria. Worldwide, it can be estimated that 190 million preschool-age children are Vitamin A deficient causing 1–2 million deaths annually. In Nigeria the prevalence of VAD is 29.5% with significant variations across the agro-ecological zones; and that only 43% of children aged 6-59months have received Vitamin A supplementation (VAS) in the past six months. We conducted a secondary analysis using the 2013 Nigeria DHS data with the objective of determining factors associated with receipt of VAS using a multi-level technique in which cluster characteristics were regarded as the community-level factors. The analysis involved a weighted sample of 25, 617 children aged between 6 and 59 months whom receipt of vitamin A supplementation was reported by their mothers. A number of individual, household and community level factors were found to be

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significant determinants of receipt of VAS: maternal education, working status of the mother, place of delivery of child, ANC visits, household wealth index and community levels of maternal education. These community-level factors are significant contextual determinants of VAS uptake contributing up to 96% of variation across the communities. Therefore, these factors should be considered in policy-formulation and programming aimed at improving VAS coverage in Nigeria that will lead to improved child health status and survival.

Keywords: Vitamin A; supplementation; state; multi-level.

1. INTRODUCTION

Vitamin A is an essential nutrient needed in a small amount for the normal functioning of the visual system, growth and development and maintenance of epithelial cellular integrity, immune function and reproduction [1]. Vitamin A deficiency (VAD) is a public health problem in many low-income countries. Worldwide, the prevalence of VAD is estimated to be 190 million in preschool-age children [1] causing 1–2 million deaths annually [2]. VAD is defined to be of public health importance if the national prevalence reaches 15% [3] using serum or plasma retinol concentration < 0.7 μmol/L as a cut-off for VAD [1,4]. Globally, reported prevalence rates of subclinical VAD and night blindness among preschool-aged children are 33.3% and 0.9%, respectively [1]. The World Health Organization (WHO) estimated the prevalence of night blindness among preschool-aged children of 2.0% in Africa [1]. It is expected that approximately 42% of children under-five years of age are at risk of VAD in Sub-Saharan Africa [5] and is still responsible alone for almost 6 percent of child deaths under the age of 5 years [6].

In Nigeria, vitamin A deficiency is a severe public health problem [7]. An estimated 25% of Nigerian children are growing up with lower immunity leading to frequent ill health and poor growth due to vitamin A deficiency. According to a study by Maziya-Dixon et al presented at the proceedings of the International Vitamin A Consultative Group Meeting (IVACG) in 2004, the prevalence of vitamin A deficiency in Nigeria was 29.5% with significant variations across the agro-ecological zones: 31.3% in the dry savanna; 24.0% in the moist savanna; and 29.9% in the humid forest ($P< 0.001$) [7]. Based on this study, severe deficiency (serum retinol<0.35 μmol/L) lived in the humid forest (7.1%) than in the dry (3.1%) or moist savanna (2.4%). The distribution of VAD in under-five children was 25.6% in the rural sector, 32.6% in the medium, and 25.9% in the urban area ($P<0.05$). In another study in Ibadan, Nigeria, the prevalence of Xerophthalmia was 1.1% while the national prevalence of vitamin A deficiency was 28.1% [8]. In western Nigeria, a higher incidence of 63% was reported in pre-school age children [9].

In countries where vitamin A deficiency is a public health problem, the provision of high-dose vitamin A supplementation to children aged 6-59 months is being implemented as one of the three strategies to improve vitamin A status in children [10]. Universal vitamin A supplementation is a relatively short-term, low-cost and highly effective strategy for improving the vitamin A situation of children aged 6-59 months [10]. Currently, more than 80 countries worldwide are implementing universal VA supplementation (VAS) programs targeted to children 6–59 months of age through semi-annual national campaigns [11].

VAS programs began in the 1990s in response to evidence demonstrating the association between VAD and increased childhood mortality [12,13]. Between 1990 and 2013, more than 40 efficacy studies of VAS in children 6–59 months of age were conducted, and two systematic reviews and meta-analyses have concluded that VA supplements can considerably reduce mortality and morbidity during childhood [14,15].

In Nigeria, vitamin A supplementation was delivered routinely via the National Immunization Days (NIDs) under the Expanded Program of Immunization (EPI) then later as part of the Polio Eradication Initiative (PEI) in the early 1990s. In this strategy, high-potency vitamin A containing 200 000 IU of vitamin A is periodically delivered to preschool-age children (<5 years), with half this dose given to infants 6–11 months of age [16]. However, from 2010 vitamin A supplementation was delivered (twice annually) as part of MNCH Week programme that included several other PHC interventions. Between 2010 and 2014, ten rounds of the MNCH Week were implemented with an average of over 20million children being reached with vitamin A supplementation. Furthermore, participating in

MNCH Week increases the odds of receiving vitamin A supplementation by 3.24 (95%CI: 2.70, 3.89) [17]. Based on the 2013 Nigeria Demographic and Health Survey, the overall coverage for vitamin A supplementation in Nigeria is at 41% up from 26% in 2008 [18,19]. However, this average hides wide variations both at regional and state levels. For instance, South-South geopolitical region has the highest coverage of 64.8% with North West having the lowest of 26.1%. At a state level, Ekiti and Osun states have the most top coverage of 84.8% while Kano state has the least of 5.4% [18]. These disparities in vitamin A supplementation coverage indicates that beyond the individual and household factors, other factors playing at community, state and regional levels also play essential roles in determining which child gets vitamin A supplementation. These disparities could be attributed to how health policies and programmes are typically implemented in a phased manner in Nigeria; primarily due to the country's massive size and decentralised health system [20-22]. State governments oversee health funding and logistic support, whereas local government areas (LGAs) are the geographic units from which primary health services are provided [20,23] while the Federal government through its various agencies in the Federal Ministry of Health (FMoH) design the policies for the country. This phased implementation of programmes means that different states implement these policies and programmes at different rates resulting in differential outcomes typically seen with vitamin A supplementation coverage.

There appears to be the paucity of studies in documenting factors related to uptake of vitamin A supplementation in Nigeria beyond exploring the individual elements. So far, only one study by Aremu examined the factors operating at individual and socioeconomic levels that influence vitamin A supplementation [24]. To address this paucity, and to further document the significance of the effects of not only the individual and socioeconomic on the uptake of vitamin A supplementation, but we also look examined factors operating at a community level. Communities provide a localised context for the social, economic, and political structures relevant to the interplay between macro-and individual-level determinants of health and health outcomes [25]. People with similar characteristics who live in different neighbourhoods may have different health statuses because of differing cultural, economic, political, historical, or geographical influences. In other words, different people may to some extent share similar health statuses because they share a common environment [26]. The role of community characteristics or place of residence or environment in influencing health outcomes has become increasingly utilized in child health researchers. In a critical review, Pickett and Pearl concluded that there is a presence of the moderate level of evidence of the effects of a neighbourhood (community) on health which is relatively consistent and that this evidence would allow for innovative approaches to community-level interventions [27].

2. METHODS AND DATA ANALYSIS

2.1 Data

We utilized the 2013 Nigeria Demographic and Health Survey (NDHS) dataset [18]. The 2013 NDHS was the sixth survey conducted by the National Population Commission (NPopC) with support from the United States Agency for International Development (USAID), the United Nations Population Fund (UNFPA), the United Kingdom Department for International Development (DFID) (through the Partnership for Transforming Health Systems Phase II [PATHS2]); ICF International provided technical support throughout the duration of the survey.

The 2013 NDHS was based on nationally representative sample that covered the entire population. The survey used as a sampling frame from the list of enumeration areas (EAs) prepared for the 2006 Population Census of the Federal Republic of Nigeria. In this survey, the EAs were used as the primary sampling unit (PSU) or the clusters defined on the basis of EAs from the 2006 EA census frame. The 2013 NDHS sample was selected using a stratified three-stage cluster design consisting of 904 clusters, 372 in urban areas and 532 in rural areas. A representative sample of 40,680 households was selected for the survey, with a minimum target of 943 completed interviews per state. The PSU have previously been used as proxies for neighborhoods or communities in a study by Aremu [24], we are also adopting this approach.

2.2 Measurement Variables

2.2.1 Dependent variable

The dependent/outcome variable is the uptake of vitamin A supplementation by a child between 6 and 59months in the six months before the survey. This is based on the mother's respond to the question during the survey interview.

2.2.2 Independent variables

These variables are grouped into 3: i) individual-level variables consisting of both maternal and child characteristics ii) household- level variables and iii) community-level variables.

i. **Individual-level variables**: these include maternal age, maternal level of education, religion of the mother, birth order and sex of child, age of child, place of delivery of child, number of ANC visits by the mother, ethnicity of mother, working status of mother in the previous one year and marital status of mother.
ii. **Household-level variables**: these include household wealth quintile, type of marriage and sex of household head.
iii. **Community-level variables**: these are place of residence, region of residence and community-level of poverty and community-level of maternal education. Community-level variables were derived by aggregating individual-level or household-level variables. The 2013 NDHS data is hierarchically clustered with primary sampling units (PSU) as the smallest clusters. For the purpose of this study, the PSU were considered to be representative of the community, and contextual factors were assessed at community level, derived from the DHS data by taking the median value of individual-level distribution for each cluster. Two community-level variables were developed as they are not available in the datasets: community-levels of maternal education and poverty in contrast to place of residence and region of residence. For community-level poverty, the level of poverty was categorized into three at 25th percentile, 50th percentile (median) and 75th percentile. Clusters with poverty level at 25th percentile were considered as low poverty levels, those between 25th and 75th percentile considered medium while those above 75th percentile considered high. Similar categorization was performed for community-level maternal education: low at ≤ 25th percentile, medium at 25th - <75th percentile and high at ≥75th percentile. These variables are operationalized using the definitions and categorization provided in Table 1 below.

Table 1. Definitions and operational categorization of variables

Variable	Operational categorization
Maternal age (years)	Categorized into 15-19, 20-29, 30-39 and 40-49
Maternal education	Categorized into none, primary and secondary and above
Maternal religion	Categorized into Christianity, Islam and Traditional/others
Birth order of child	Categorized into 1st , 2nd - 4th , 5th and more
Sex of child	Categorized into male and female
Child age (months)	Categorized into 6-11, 12-23, 24-35, 36-47, 48-59
Place of delivery of child	Categorized into home or hospital/health facility
Number of ANC visits	Categorized into none, 1-3, 4+
Ethnicity of mother	Categorized into Hausa, Igbo, Yoruba, Fulani and others
Working status of mother	Categorized into yes and no
Marital status of mother	Categorized into not in union, currently married and ever married
Household wealth quintile	Categorized into poorest, poorer, middle, rich and richest
Type of marriage/number of co-wives	Categorized into none, 1 – 3, 4+
Sex of household head	Categorized into male or female
Region of residence	Categorized into North East, North Central, North West, South East, South South and South West
Place of residence	Categorized into urban or rural
Community-level of poverty	Less than 25th percentile=low; 25th - <75th percentile=medium; ≥75th percentile=high
Community-level of maternal education	Less than 25th percentile=low; 25th - <75th percentile=medium; ≥75th percentile=high

2.3 Statistical Analysis

The statistical analysis is restricted to a weighted sample of 25, 617 children aged between 6 and 59 months. We performed multi-level logistic regression modelling technique to account for the hierarchical nature of the DHS data [18]. In this strategy, the individuals (mother and child) are nested within households; the households are further nested within communities. We are interested in the contribution of community-level factors in determining which child received or otherwise vitamin A supplementation. We used communities as our contextual or neighbourhood factors since we appreciated the roles played by neighbourhoods or communities in shaping health statuses and health outcomes through their influences on culture, economy, politics, and history of the people [25-27]. These entities would determine community's norms, perception, belief and behaviours regarding health behaviours and by extension receipt or non-receipt of vitamin A supplementation.

2.4 Multi-level Regression

The structure of the 2013 NDHS data allows for the application of multilevel logistic regression, since the respondents (women and/or children) are nested within households that are further nested within clusters (or communities) which are further nested within states. Therefore, to assess the effects of women's individual characteristics and cluster (or community) characteristics on the uptake of vitamin A supplementation, we used one-level mixed logistic regression model. In this model, the first level consists of the women and/or children and the second level is the community. Multilevel mixed effects logistic model has two parts: fixed and random. In a simplified model, the equation is of the form [28]:

$$Log\left[\frac{\pi_{ij}}{1-\pi_{ij}}\right] = \beta_0 + \beta_1 X_{1ij} + ...\beta_n X_{nij} + u_{0j}$$

Where:

πij is the proportion of children who received vitamin A supplementation in the past six months before the survey

(1-πij) is the proportion of children who did received vitamin A supplementation six months before the survey

β0 is the intercept coefficient

β1, … βn are the coefficients of individual and community-level factors

X1ij... Xnij are independent variables of individuals and communities

*u*0j are random errors at cluster levels

The effects of the fixed part of the model were measured by the odds ratio; while the contribution of the random part of the model (u_{0j}) was assessed using intra-cluster (intra-state) correlation coefficient (or ICC). The ICC coefficient describes the proportion of variation that is attributable to the higher level source of variation. The odds ratios were derived by running logistic regression controlling for confounders. To assess the effects of state variability on vitamin A supplementation uptake, we used Stata multilevel analysis command *merqlogit* fitting five models.

2.5 Model Specification

We specified a five-level model as follows: Model 1, the empty model, has no explanatory variable included; Model 2, individual (mother and child characteristic model) controls for a set of individual-level explanatory variables at the level of the mother and child; Model 3, households characteristics; Model 4, community model (geopolitical regions, rural/urban residence, community-levels of maternal education and poverty) and Model 5, full model systematically adjusts for both individual, household and community-level variables. Variance inflation factors were estimated to assess risk of multi-collinearity between variables. All analyses were conducted using Stata version 14 (StataCorp).

3. RESULTS

3.1 Descriptive Statistics

In all, there was a weighted sample of 25, 617 children aged between 6 and 59 months in the analysis whom received vitamin A supplementation as reported by their mothers. Overall, 41% had received vitamin A supplementation six months before the survey. As shown in Table 2, sex of the child was not a significant variable related to vitamin A uptake in Nigeria; all other sociodemographic variables were significant. Specifically, household wealth level is associated with vitamin A uptake; the higher the wealth quintile the greater the percentage of receipt of vitamin A uptake. Similarly, level of maternal education shows a progressive increase with proportion of children receiving vitamin A supplementation as well as paternal education. Belonging to Igbo ethnic group, being the first child, residing in urban area, residing in the three southern geopolitical zones, having a working mother, leaving in household headed by a female, child being delivered in hospital and mother having attended at least four ANC visits all have higher proportions of receipt of vitamin A supplementation.

3.2 Multi-level Models

Table 3 shows the five models fitted for the multi-level logistic regression. Model 1 shows that the ICC for this model is approximately 39% which means that intra-cluster (or community) factors are responsible for 39% of variation in VAS uptake. This proportion, as can be seen from Table 3 decreases gradually as other variables/factors are added to the model. Model 2 adjusts for the individual characteristics and maternal education, current working status of mother, antenatal care visits during pregnancy and hospital delivery emerged as uniform and significant determinants of vitamin A supplementation (VAS) uptake. Maternal education display increasing odds ratio of VAS uptake: primary school (OR=1.36; 95%CI: 1.24-1.50) while secondary school and above has higher odds ratio of 1.66 (95%CI: 1.50-1.84). Contact with formal health care system vis-à-vis ANC visits (1-3 visits; OR=1.41; 96%CI: 1.25-1.58 and 4 or more visits: OR=1.63; 95%CI: 1.51-1.75) and hospital delivery (OR=1.57; 95%CI: 1.45-1.69) are associated with increased odds ratio of VAS. In these model, ICC decreased to around 27% while PCV (proportional change in variation) went up to 42% indicating that individual factors are contributing around 42% to the variation in uptake of vitamin A. Model 3 adjusts for household characteristics in which three household variables were included in the model: wealth, number of co-wives (monogamy versus polygamy) and sex of household head. Expectedly, children from rich households were significantly more likely to utilize VAS compared to those from poor households; the magnitude of these relationship ranged from 1.35 times among the children from poorer households (OR=1.35; 95%CI: 1.21-1.51) to 4.1 times for children from the richest households (OR=4.09; 95%CI: 3.50-4.78). The intra-cluster variation is approximately 31% indicating that household factors (wealth, number of co-wives and sex of household head) within the cluster is responsible for the 31% variation in VAS uptake. Model 4 represents adjustment for the community factors: place of residence, region, community-levels of maternal education and poverty. In this model, only community-levels of maternal education showed a uniform significant relationship with VAS (OR=2.38; 95%CI: 1.72-3.29) and (OR=5.40; 95%CI: 3.71-7.85) respectively for medium and high community-levels of maternal education. Model 5 represents full model adjusting for all other variables operating at individual, household and community levels. In this model, six factors are uniformly and statistically significant determinants of VAS: maternal education, working status of mother, place of delivery of child, ANC visits, household wealth index and community levels of maternal education.

Overall, from Table 3, it is clear that as adjustments are sequentially made with regards to addition of individual, household and community variables in the models, PCV increases from 42% (Model 2) to 96% (Model 5) indicating increasing contribution of community-level factors as determinants of VAS uptake across Nigeria while at the same time showing moderate levels of ICC values across the models (between 25% and 40%) show rather small contributions of individual characteristics within the communities.

Table 2. Percentage of children aged 6-59months given vitamin A supplements in last 6 months by background characteristics, 2013 Nigeria DHS

Variable	Received vitamin A supplementation		χ2	p-value
	No (%)	Yes (%)		
Maternal age (years)				
15-19	783 (69.6)	328 (29.2)	192	<0.000
20-29	7312 (59.5)	4826 (39.3)		
30-39	5274 (53.3)	4463 (45.1)		
40-49	1587 (59.7)	1044 (39.3)		
Maternal education				
None	9246 (74.0)	3108 (24.9)	2900	<0.000
Primary	2593 (51.6)	2360 (47.0)		

Variable	Received vitamin A supplementation		χ2	p-value
	No (%)	Yes (%)		
Secondary and more	3116 (36.9)	5194 (61.5)		
Marital status				
Not in union	157 (40.3)	223 (57.3)	43	<0.000
Currently married	14459 (58.2)	10086 (40.6)		
Ever married	339 (47.4)	353 (49.3)		
Ethnicity				
Hausa	6595 (74.1)	2231 (25.1)	2700	<0.000
Igbo	1113 (37.6)	1813 (61.2)		
Yoruba	872 (29.4)	2030 (68.4)		
Fulani	1626 (77.7)	450 (21.5)		
Others	4750 (52.6)	4138 (45.8)		
Religion				
Christianity	3826 (39.5)	5711 (59.0)	1700	<0.000
Islam	10879 (68.5)	4826 (30.4)		
Traditional/other	250 (64.2)	125 (32.1)		
Mother currently working				
Yes	5089 (65.7)	2583 (33.3)	319	<0.000
No	9798 (54.2)	8024 (44.4)		
Age of child (months)				
6-11	2088 (64.0)	1154 (35.4)	899	<0.000
12-23	3256 (55.2)	2606 (44.2)		
24-35	3083 (56.2)	2332 (42.5)		
36-47	3340 (58.4)	2300 (40.2)		
48-59	3187 (57.1)	2268 (40.6)		
Sex of child				
Female	7494 (57.9)	5281 (40.8)	0.068	0.794
Male	7461 (57.3)	5381 (41.3)		
Birth order				
1^{st}	2748 (54.4)	2234 (44.2)	93	<0.000
2^{nd} – 4^{th}	4693 (55.3)	3679 (43.4)		
5^{th} and more	7515 (60.5)	4749 (38.2)		
Place of delivery				
Home	13804 (59.1)	4826 (29.4)	2600	<0.000
Hospital	3571 (37.5)	5836 (61.3)		
ANC visits attendance				
None	10213 (64.5)	5369 (33.9)	1100	<0.000
1 – 3	1192 (63.9)	655 (35.1)		
4+	3499 (42.9)	4589 (56.2)		
Household wealth quintile				
Poorest	4621 (77.9)	1240 (20.9)	2900	<0.000
Poor	3942 (68.2)	1777 (30.7)		
Middle	2781 (55.9)	2120 (42.6)		
Richer	2167 (46.0)	2476 (52.6)		
Richest	1445 (31.7)	3049 (66.8)		
No. of co-wives				
None	8983 (53.7)	7523 (45.0)	481	<0.000
1-3	5386 (67.9)	2448 (30.9)		
4+	14 (49.4)	15 (50.6)		
Paternal education				
None	9246 (74.0)	3108 (24.9)	2900	<0.000
Primary	2593 (51.6)	2360 (47.0)		
Secondary and more	3116 (36.9)	5194 (61.5)		

Variable	**Received vitamin A supplementation**		**χ2**	**p-value**
	No (%)	**Yes (%)**		
Sex of household head				
Female	1151 (44.5)	1389 (53.7)	178	<0.000
Male	13804 (59.1)	9273 (39.7)		
Place of residence				
Urban	4276 (45.7)	4944 (52.8)	963	<0.000
Rural	10679 (64.3)	5718 (34.4)		
Region				
North Central	1929 (53.8)	1592 (44.4)	2500	<0.000
North East	3028 (67.4)	1391 (31.0)		
North West	6942 (73.5)	2449 (25.9)		
South East	988 (42.8)	1299 (56.2)		
South South	831 (33.8)	1581 (64.3)		
South West	1237 (33.7)	2350 (64.1)		
Total	14955 (57.6)	10662 (41.1)		

4. DISCUSSION

The overall goal of this study was to determine the influence of not only the individual, household and community factors on vitamin A supplementation level, but also to assess the influence of the overall health-related activities at the level of the States, vis-à-vis the programmes directed at improving vitamin A status among children 6-59 months. In this study, the intra-state variation accounted for approximately14% while the inter-state factors accounted for 86% (Table 3) indicating a large contribution of State-level activities in determining VAS uptake. It is important to note that VAS uptake levels in States varied from as low as 6.4% in Kano (in North West) to highest in both Ekiti and Osun State (in South West) further corroborating the strong influence of factors operating at the level of the states [18].

In this study, VAS level was found to be 41.1% which is far less than the optimal target of 70% required for the reduction of childhood mortality [UNICEF]; based on the NDHS 2013, only nine States achieved this 70% threshold. The study further showed that individual and household variables were the major and consistent determinants of VAS uptake: maternal age, maternal education, birth order, place of delivery of child, ANC visits and household wealth quintile.

Maternal education emerged as a strong and major determinant of VAS uptake. Maternal education has been found to be an important factor in the adoption and uptake of child survival strategies including immunization [29] and VAS uptake [30,31]. Our study supports these earlier findings of the strong role played by maternal education in VAS uptake; however, these previous study did not adopt the multi-level approach.

We are not taken aback when we reported that ANC visits as well as place of delivery turned up to have strong and significance influence on VAS uptake in both Models 2 and 5. Antenatal clinic attendance provides a platform where mothers and their babies (children) are given necessary health information for the prevention ill-health and in doing this the mothers adopts healthy practices such as exclusive breastfeeding, immunization, regular growth/weight monitoring, acquisition and use of long-lasting insecticidal nets for the prevention of malaria, use of oral rehydration solution (ORS) as well as birth preparedness and readiness which includes identification of health facility to deliver in presence of skilled medical personnel. Therefore, contact with health facility during pregnancy is expected to increase subsequent use of health services [32] and therefore the results reported here is in line with the expected results. That is, both ANC attendance and health facility delivery increases the odds of VAS uptake. Another significant finding is the relationship between birth order and VAS uptake. The results indicates that the older the child the more odds of VAS uptake, probably because age of child is proportionally related to level exposure to VAS uptake. That is, as the child gets older the odds of VAS uptake also increases. However, Haile reported a contrasting result using Ethiopian Demographic and Health Survey where birth order did not significantly influence VAS uptake. The study by Haile did not use the multi-level technique in their data analysis [33].

Table 3. Multilevel logistic regression of factors associated with vitamin A supplementation uptake among Nigerian children age 6-59 months, Nigeria, 2013 NDHS

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	Empty model	**Individual characteristics**	**Household characteristics**	**Community characteristics**	**Full Model**
Fixed	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**
Fixed effects					
Maternal age (years)					
15-19 (Ref)		1.00			1.00
20-29		1.94 (1.02-1.40)*			1.16 (0.99-1.36)
30-39		1.34 (1.12-1.56)**			1.28 (1.08-1.53)**
40-49		1.19 (0.98-1.45)			1.16 (0.95-1.41)
Maternal education					
None		1.00			1.00
Primary		1.36 (1.24-1.50)***			1.19 (1.08-1.31)***
Secondary and more		1.66 (1.50-1.84)***			1.32 (1.19-1.47)***
Marital status					
Not in union		1.00			1.00
Currently married		1.11 (0.91-1.37)			1.30 (0.88-1.91)
Ever married		0.96 (0.74-1.24)			0.92 (0.71-1.19)
Ethnicity					
Hausa		1.00			1.00
Igbo		1.99 (1.62-2.46)***			1.60 (1.24-2.05)***
Yoruba		2.62 (2.15-3.18)***			1.62 (1.29-2.02)***
Fulani		1.09 (0.91-1.30)			1.01 (0.84-1.22)
Others		1.60 (1.38-1.85)***			1.21 (1.03-1.42)*
Religion					
Christianity		1.00			1.00
Islam		0.81 (0.72-0.91)***			0.98 (0.86-1.03)
Traditional/other		0.84 (0.65-1.10)			0.93 (0.72-1.21)
Mother currently working					
No		1.00			1.00
Yes		1.10 (1.02-1.18)*			1.09 (1.02-1.17)**
Age of child (months)					

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
	Empty model	Individual characteristics	Household characteristics	Community characteristics	Full Model
Fixed	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**
48-59		1.00			1.00
6-11		0.59 (0.53-0.66)***			0.59 (0.53-0.67)***
12-23		1.00 (0.91-1.10)			1.01 (0.92-1.11)
24-35		0.98 (0.89-1.08)			0.99 (0.90-1.08)
36-47		0.98 (0.90-1.08)			0.98 (0.90-1.07)
Sex of child					
Male		1.00			1.00
Female		1.01(0.95-1.07)			1.01 (0.95-1.07)
Birth order					
1^{st}		1.00			1.00
2^{nd} – 4^{th}		1.07 (0.95-1.18)			1.08 (0.99-1.18)
5^{th} and more		1.04 (0.94-1.15)			1.09 (0.98-1.20)
Place of delivery					
Home		1.00			1.00
Hospital		1.57 (1.45-1.69)***			1.46 (1.35-1.57)***
ANC visits attendance					
None		1.00			1.00
1 – 3		1.41 (1.25-1.58)***			1.40 (1.24-1.56)***
4+		1.63 (1.51-1.75)***			1.58 (1.47-1.70)***
Household wealth quintile					
Poorest			1.00		1.00
Poorer			1.35 (1.21-1.51)***		1.14 (1.02-1.28)*
Middle			1.88 (1.65-2.13)***		1.28 (1.12-1.47)***
Richer			2.66 (2.32-3.06)***		1.48 (1.27-1.73)***
Richest			4.09 (3.50-4.78)***		1.92 (1.60-2.31)***
No. of co-wives					
None			1.00		1.00
1-3			0.82 (0.77-0.88)***		0.84 (0.78-0.90)***
4+			1.27 (0.67-2.43)		1.15 (0.58-2.26)
Sex of household head					
Male			1.00		1.00

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
	Empty model	**Individual characteristics**	**Household characteristics**	**Community characteristics**	**Full Model**
Fixed	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**
Female			1.13 (1.03-1.25)**		1.04 (0.94-1.15)
Place of residence					
Urban				1.00	1.00
Rural				1.05 (0.86-1.29)	1.18 (0.96-1.46)
Region					
South South				1.00	1.00
North Central				0.96 (0.74-1.25)	0.86 (0.65-1.13)
North East				0.77 (0.56-1.05)	0.87 (0.63-1.20)
North West				0.59 (0.43-0.81)***	0.73 (0.51-1.03)
South East				0.88 (0.66-1.18)	0.59 (0.42-0.84)**
South West				1.42 (1.09-1.87)**	1.04 (0.77-1.40)
Community poverty level					
Low				1.00	1.00
Medium				1.34 (0.98-1.82)	1.11 (0.81-1.53)
High				2.01 (1.37-2.95)***	1.15 (0.77-1.71)
Community maternal education level					
Low				1.00	1.00
Medium				2.38 (1.72-3.29)***	1.98 (1.43-2.76)***
High				5.40 (3.71-7.85)***	3.20 (2.17-4.71)***
Random effects					
ICC [VPC] (%)	39.3	27.2	30.6	24.8	24.9
PCV (%)	Reference	42.3	55.7	72.5	96.0

*p <0.05 *, P <0.01**, p<0.001****

A major significant determinant of VAS uptake form this is the household wealth status. Our study though has shown that household wealth status is a significant determinant of VAS uptake it is actually in the inverse relationship. That is, odds of VAS uptake are significantly lower as household wealth index increases from poor to richest (using the poorest as the reference class). Our result is similar to that reported in Tanzania where the authors reported lack of any significant association between household socio-economic status and VAS uptake [34]. Previous studies have demonstrated the positive relationship between household wealth index and odds of VAS uptake; children in the richest household have higher odds of VAS uptake compared to children in poor/poorest households [31,35].

Finally, two important factors though found to be insignificantly related to VAS uptake worthy of note are geographical location and place of residence. Specifically, it is clear from Table 2 that there is a gradient in VAS uptake as one move from North West to North East, North Central, South East, South West and South South. Similarly, the rural/urban differential in VAS uptake is huge (34% versus 53%). However, in the full model (Model 5) generated in Table 3, these factors emerged as non-significant determinants of VAS uptake. In a similar study to our own by Aremu [24], geographic region emerged as non-uniform determinants of VAS uptake with only North West, South East and South South being significant determinants of VAS uptake. In this same paper, though urban location has about 21% increased odds of VAS uptake, these odds were not significant. However, Thapa, using the Nepal Demographic and Health Survey has documented the urban advantage as well as residing in certain ecological and development sub-regions in VAS uptake [36]. It is also important to note that majority of papers cited in this section of the paper are not based on multi-level technique as employed in this work except that of Aremu. Therefore, because of methodological differences we were careful in comparing and contrasting our results with those that used multivariate logistic regression models.

5. CONCLUSION

The results showed that apart from the individual factors affecting uptake of VAS in Nigeria, community-level factors are also significant critical factors. Community-level of maternal education emerged as a single active determinant of VAS suggesting the role of maternal education in influencing the health status of children. Improving maternal education will improve child health status and survival of which vitamin A supplementation has been shown to improve.

CONSENT

As per international standard or university standard written patient consent has been collected and preserved by the authors.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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