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URBAN–RURAL FACTORS INFLUENCING VITAMIN A DEFICIENCY IN UNDER-FIVE CHILDREN IN NORTH-WESTERN NIGERIA: EVIDENCE FOR ONE HEALTH–INFORMED NUTRITION INTERVENTIONS

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Abstract

Vitamin A deficiency represents a convergence of nutritional, environmental, and health system challenges. Within a One Health framework, determinants of vitamin A deficiency among under-five children extend beyond dietary intake to include animal-source food availability, environmental sanitation, infection burden, and access to preventive health services, particularly in settings characterized by urban–rural disparities. This study examines urban-rural factors influencing VAD in under-five children.

Methods: A comparative cross-sectional study was conducted among 260 mother-child pair respondents between October 2022 and November 2022. The participants were selected by a multi-stage sampling technique. Children's serum retinol levels were determined by high-performance liquid chromatography. Data were collected using an interviewer-administered questionnaire and a data sheet. Data were processed using IBM® SPSS version 25 and analyzed using descriptive and inferential statistics.

Results: Prevalence of vitamin A was significantly higher in rural than in urban communities (33.8% vs 16.2%, $p=0.002$). In urban communities, a statistically significant association was found between vitamin A deficiency and fathers' occupation ($p < 0.001$) and vitamin A supplementation ($p = 0.017$). However, in rural areas, a statistically significant association was found between Vitamin A deficiency and fathers' occupation ($p<0.001$), vitamin A supplement ($p = 0.017$), birth order ($p = 0.010$), and Family size ($p = 0.008$).

Conclusion: Vitamin A deficiency was prevalent, but a significantly higher proportion of children in the rural areas had vitamin A deficiency as compared to those in the urban areas.

Recommendation: Community health workers should educate parents about the importance of taking advantage of vitamin A supplementation and ensuring children eat foods from all food groups.

Keywords: Vitamin A deficiency, under-five children, urban-rural disparities, One Health

Introduction

Hidden hunger is a term used to describe human deficiencies in essential vitamins and minerals, also known as micronutrients. Micronutrients are vitamins and minerals required in small amounts that are essential to human health, development, and growth (Sarvar & Bant, 2017). As tiny as the amounts are, however, the consequences of their absence are severe (Sarvar & Bant, 2017). Vitamin A is one of the most important micronutrients in global public health terms; its lack represents a major threat to the health and development, particularly children and pregnant women in low and middle-income countries (Shemwell et al., 2017a). Vitamin A is an essential micronutrient that is important for growth, development, immunocompetence and good vision. It is required for the differentiation and restoration of epithelial tissues in the body, as well as the normal functioning of the immune system (Edem, 2009). Vitamin A is one of the micronutrient deficiencies of greatest public health concern globally, due to its high prevalence and associated health and developmental consequences (Hardin et al., 2017). Roughly 34% of children aged 6–59 months in low- and middle-income countries suffer from vitamin A deficiency (Stevens et al., 2015a; Stevens et al., 2013). Vitamin A has been termed an anti-infectious agent, and it plays an important role in the visual system (Shemwell et al., 2017a). Vitamin A deficiency constitutes a major nutritional concern in the poor communities of the developing world. It is a major contributor to the morbidity and mortality of under-five children and can result in impaired resistance to infection as well as increased risk of death (Edem, 2009). Vitamin A deficiency impairs numerous body functions and can lead to many adverse health consequences, including xerophthalmia (dry eyes), blindness, infectious morbidity, mortality, suboptimal physical growth and anemia (Shemwell et al., 2017a). While there is overlap across such deficiencies at both population and individual levels, and the full extent of multiple deficiencies remains poorly documented, hidden hunger remains a global challenge (Hardin et al., 2017). Understanding the epidemiology and determinants of Vitamin A deficiency within these contrasting settings is crucial for designing targeted interventions aimed at reducing the burden of deficiency and its adverse health outcomes in under-five children across Nigeria's diverse communities. This study was carried out to assess factors associated with Vitamin A deficiency among children under five in Sokoto state, Nigeria.

MATERIALS AND METHODS

Study Design, Population, and Area

This was a comparative cross-sectional study design conducted in Sokoto. The study population comprised mothers or caregivers with children under five years old in urban and rural communities of Sokoto State. Mothers or caregivers of children between 6 to 59 months of age who were residents of urban and rural communities for a minimum of twelve months were included. Mothers and caregivers who were seriously ill or having other disease conditions that made it difficult to communicate or cooperate during the interview were excluded.

Sample Size Determination

Sample size estimation was done based on the formula for the study design to compare proportions in 2 independent groups. The minimum sample size was determined using the formula (Karimollah, 2011).

$$n = \frac{(Z_{1-\frac{\alpha}{2}} + Z_{\beta})^2 \times (P_1q_1 + p_2q_2)}{(P_1 - P_2)^2}$$

A minimum sample size of 130 subjects was recruited into the study per group (urban and rural).

Sampling technique

A multistage sampling technique was used to select respondents for the study. In stage 1, Sokoto North LGA (urban) and Wurno LGA (rural) were chosen using a simple random sampling technique by balloting. In stage 2, two wards were selected from each of the selected LGAs by a simple random sampling technique (balloting). In stage 3, one settlement was chosen from each of the four wards by a simple random sampling technique (balloting). Proportionate allocation (PA) of respondents to be enrolled in each of the settlements in each group (urban and rural) was done using the calculated sample size per group, which was 130. In stage 4, a sampling frame was obtained; systematic random sampling was used to enroll households to get respondents for the study.

Data Collection Methods

Estimation of serum Vitamin A was done by the addition of ethanol to break up complexes and permit Vitamin A to partition into the heptane. The nearly colourless retinal was measured spectrophotometrically at 326 nm. The heptane extract was irradiated with UV light for about 1 hour until a steady absorbance was obtained at 326 nm. This allowed for the absorption of unwanted materials. Vitamin A was obtained by subtracting the second absorbance (A2) from the initial absorbance (A1). Since 2 ml of serum were extracted with 5 ml of heptane, the concentration of the standard equals to $37.5 \times 5/2 = 93.75$ mg/dl. Vitamin A in mg/dl equals $(A1 - A2) \times \text{concentration of standard (93.75 mg/dl)}/\text{absorbance of standard}$ (Valley & Bell, 1998).

Data analysis

Completed forms were downloaded from the ODK server in Excel format, data was then exported in IBM Statistical Package for Social Sciences (SPSS) version 25. Quantitative variables were summarized using the mean and standard deviation and categorical variables were summarized using frequencies and percentages. Chi-square test and Fisher's exact were used to compare sociodemographic characteristics and Vitamin A status. Independent t-test was used for comparison of mean age and serum vitamin A. The results were presented in the form of tables and charts. Level of significance (α) was set at 0.05, thus, any statistical test with $p < 0.05$ was considered to be statistically significant.

RESULT

Table 1: Sociodemographic characteristics of the respondents

Variables	Urban (n=130) n (%)	Rural (n=130) n (%)	Test-statistics p-value
Age group of mothers (years)			
15-19	2 (1.5)	10 (7.7)	
20 – 24	13 (10.0)	22 (16.9)	
25 – 29	63 (48.5)	44 (33.8)	

30 – 34	27 (20.8)	28 (21.6)	$\chi^2= 11.059$ p=0.025 t=2.914 p=0.004
≥35	25 (19.2)	26 (20.0)	
Mean ± SD (years)	32.99 ± 7.598	30.11 ± 8.348	
Religion			
Islam	125 (96.2)	130 (100)	Fischer's exact p=0.029
Christianity	5 (3.8)	0	
Tribe			
Hausa	113 (86.9)	108 (83.1)	Fischer's exact p<0.001
Fulani	9 (6.9)	7 (5.4)	
Yoruba	5 (3.8)	1 (0.8)	
Igbo	3 (2.3)	0	
Other	0	14 (10.8)	
Number of children			
1 – 4	65 (50.0)	79 (60.8)	$\chi^2= 3.051$ p= 0.105
≥ 5	65 (50.0)	51 (39.2)	
Mothers' education level			
None	2 (1.5)	3 (2.3)	Fischer's exact P<0.001
Quranic only	58 (44.6)	109 (83.8)	
Primary	9 (6.9)	14 (10.8)	
Secondary	45 (34.6)	3 (2.3)	
Tertiary	16 (12.3)	1 (0.8)	
Fathers' education level			
None	0 (0.0)	0	Fischer's exact P<0.001
Quranic only	16 (12.3)	60 (46.1)	
Primary	2 (1.5)	7 (5.4)	
Secondary	56 (43.1)	46 (35.4)	
Tertiary	56 (43.1)	17 (13.1)	
Occupation of mother			
Unemployed	48 (36.9)	80 (61.5)	Fischer's exact P<0.001
Farming	0 (00.0)	0 (0.0)	
Trade/business	77 (59.2)	48 (36.9)	
Civil servant	5 (3.9)	2 (1.5)	
Occupation of father			
Unemployed	0 (0.0)	0	$\chi^2 =47.070$ p< 0.001
Farming	6 (4.6)	39 (30.0)	
Trade/business	66 (50.8)	74 (56.9)	
Civil servant	58 (44.6)	17 (13.1)	
Social class of the parent			
SC I	2 (1.5)	0	Fischer's exact P<0.001
SC II	14 (10.8)	1 (0.8)	
SC III	41 (31.5)	7 (5.4)	
SC IV	63 (48.5)	58 (44.6)	
SC V	10 (7.7)	64 (49.2)	

χ^2 -Pearson's Chi-square test; *t*- Independent *t* test

The majority of the mothers in both groups were in the age group 25-29 years. The difference in the distribution of the age groups was statistically significant ($p= 0.008$). About one third of mothers in the urban group 45(34.6%), compared to 3 (2.3%) in the rural group, had completed their secondary education. The rural group had a higher proportion of unemployed mothers, 80 (61.5%), compared to the urban group, 48 (36.9%). There was a statistically significant difference in terms of the educational attainment and the occupation of the mothers of the children in both groups ($p< 0.001$). There was a statistically significant difference ($p<0.001$) in the distribution of the respondents by social class, with the majority of the respondents being in social class IV and V in the Urban (48.5%) and rural groups (49.2%), respectively [Table 1].

Table 2 : Demographic characteristics of children, place of delivery and birth order

Variables	Urban (n=130) n (%)	Rural (n=130) n (%)	Test-statistics p-value
Child's age group (months)			
12-23	32 (24.6)	28 (21.5)	$\chi^2= 0.927$ $p=0.467$
24-35	30 (23.1)	30 (23.1)	
36-47	30 (23.1)	30 (23.1)	
48-59	38 (29.2)	42 (32.3)	
Mean \pm SD (months)	34.70 \pm 14.4	35.12 \pm 14.8	
Sex			
Male	57 (43.8)	65 (50.0)	$\chi^2= 0.988$ $p=0.384$
Female	73 (56.2)	65 (50.0)	
Place of delivery			
Home	69 (53.1)	106 (81.5)	Fischer's exact $p<0.001$
Hospital	56 (43.1)	24 (18.5)	
Clinic/dispensary	4 (3.1)	0 (0.0)	
TBAs house	1 (0.8)	0 (0.0)	
Birth order			
1- 2	30 (23.0)	50 (38.5)	$\chi^2= 8.388$ $p=0.016$
3 – 4	37 (28.5)	36 (27.7)	
≥ 5	63 (48.5)	44 (33.8)	

χ^2 -Pearson's Chi-square test, t - Independent t test

The highest proportion of children in both the urban 38 (29.2%) and rural 42 (32.3%) groups was in the age group 48-59months. There was no statistically significant difference in age ($\chi^2 = 0.927$, $p = 0.467$). The mean ages in the urban and rural areas were 34.70 ± 14.4 and 35.12 ± 14.8 months, respectively ($t=0.233p=0.81616$). There was no statistically significant difference in the gender distribution in the groups ($\chi^2 = 0.988$ $p = 0.384$). A higher proportion of children in the rural group, 106 (81.5%), were delivered at home compared to 69 (53.1%) in the urban group; and this was statistically significant (Fisher's exact, $p<0.001$) [Table 2].

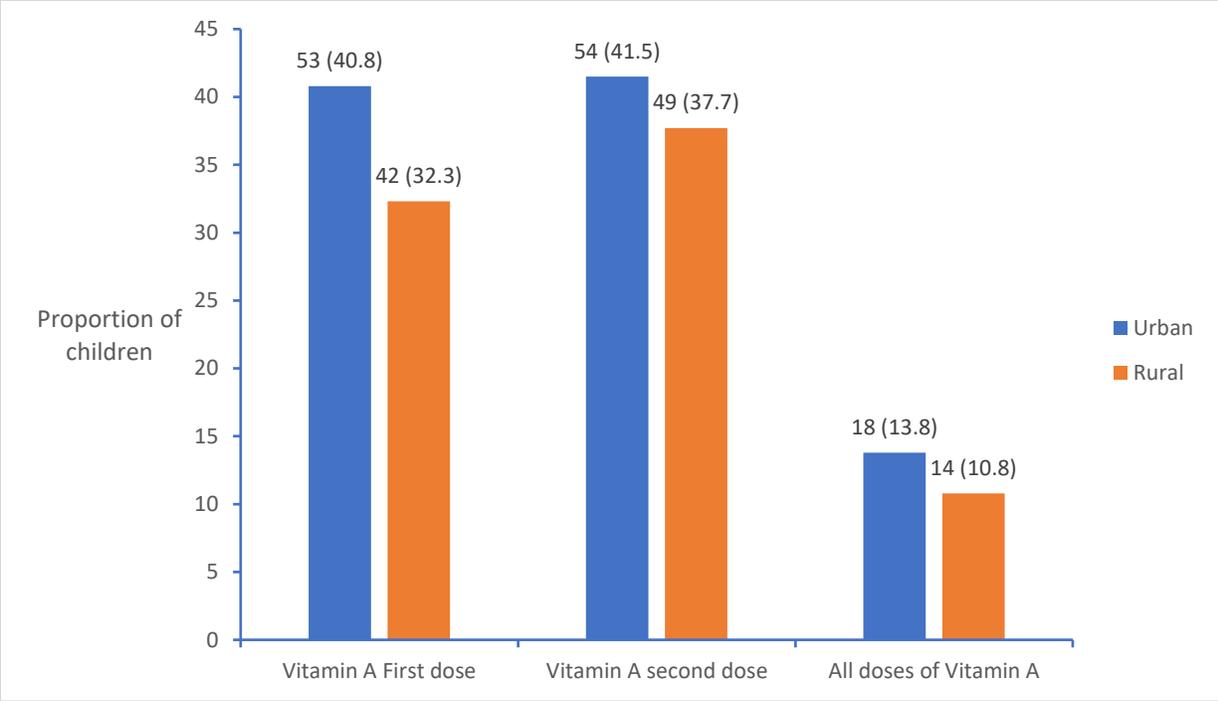


Figure 1: Vitamin A supplement status of the children

Only a smaller proportion of children, 18 (13.8%) in urban and 14 (10.8%) rural, received all ten doses of Vitamin A (p=0.572) [Figure 2].



Figure 2: Exclusive breastfeeding status of children

In the urban areas, 23 (17.7%) of the children were exclusively breastfed compared to 14 (10.8%) of their counterparts in the rural areas. The difference was not statistically significant ($p=0.155$) [Figure 2].

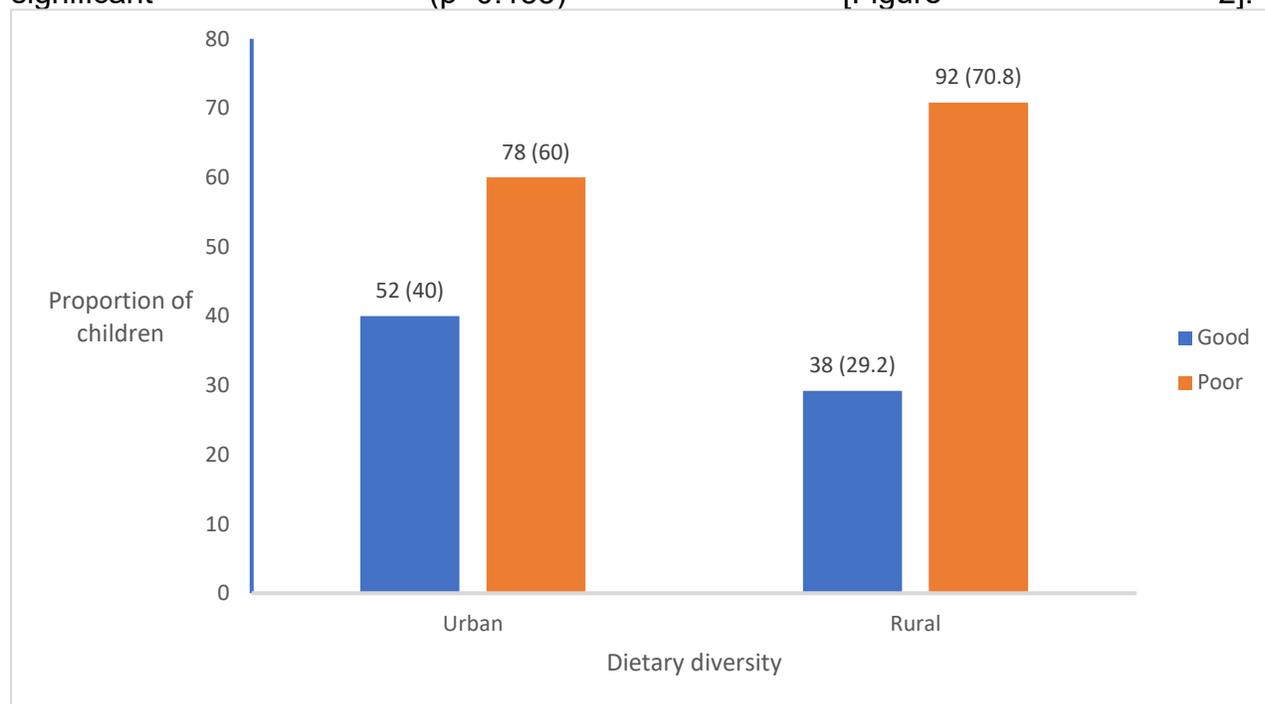


Figure 3: Dietary diversity score of the family

The majority of the children, 92 (70.8%) in the rural areas, compared to 78 (60.0%) in the urban areas, had a poor dietary diversity score. The difference in proportions were not statistically significant ($p=0.090$) [Figure 3].

Table 3: Prevalence of Vitamin A deficiency among the children

Variables	Urban n (%)	Rural n (%)	Test statistics	p- value
Serum Vitamin A	n= 130	n= 130		
Normal	109 (83.8)	86 (66.2)	$\chi^2=10.851$	p=0.002
Deficient	21 (16.2)	44 (33.8)		
Mean \pm SD	35.51 \pm 16.9	28.90\pm17.1	t=3.134	p=0.001

χ^2 = Pearson's chi-square; t-independent t test

A smaller proportion, 21(16.2%) of the children in the urban areas, compared with 44 (33.8%) of those in the rural areas, have vitamin A deficiency, and this was statistically significant. (p = 0.002). The mean serum Vitamin A of children in the urban area (35.51 \pm 16.9) was more than that of the rural areas (28.90 \pm 17.1) (p= 0.001).

Table 4: Relationship between sociodemographic factors of the respondents and serum vitamin A level of the children

Variables	Urban		Test statistics and p-value	Rural		Test statistics and p-value
	Serum Vitamin A n (%)			Serum vitamin A n (%)		
	Normal	Deficient		Normal	Deficient	
Age group (months)						
12-23	26 (81.3)	6 (18.8)	$\chi^2= 0.211$	16 (57.1)	12 (42.9)	$\chi^2= 1.294$
24-59	83 (84.7)	15 (15.3)	$p= 0.782$	70 (68.6)	32 (31.4)	$p= 0.268$
Sex						
Male	49 (86.0)	8 (14.0)	$\chi^2=0.336$	38 (58.5)	27 (41.5)	$\chi^2=3.436$
Female	60 (82.2)	13 (17.8)	$p=0.636$	48 (73.8)	17 (26.2)	$p=0.095$
Tribe						
Hausa	96 (85.0)	17 (15.0)	Fisher's exact $p=0.463$	67 (62.0)	41 (38.0)	Fisher's exact $p=0.022$
Fulani	7 (77.8)	2 (22.2)		6 (85.7)	1 (14.3)	
Yoruba	4 (80.0)	1 (20.0)		1 (100.0)	0 (0.0)	
Igbo	2 (66.7)	1 (33.3)		0	0	
Others (Zabarmawa)	0	0		13 (92.9)	1 (7.1)	
Education of mother						
Nonformal	51 (85.0)	9 (15.0)	$\chi^2= 0.110$	71 (63.4)	41 (36.6)	$\chi^2=2.754$
Formal	58 (82.9)	12 (17.1)	$p=0.814$	15 (83.8)	3 (16.7)	$p= 0.114$
Occupation of mother						
Employed	44 (91.7)	4 (8.3)	$\chi^2= 1.966$	55 (69.6)	24 (30.4)	$\chi^2=1.945$
Unemployed	65 (79.3)	17 (20.7)	$p= 0.176$	31 (60.8)	20 (39.2)	$p=0.231$
Education of father						
Nonformal	15 (93.8)	1 (6.3)		36 (60.0)	24 (40.0)	

Formal	94 (82.5)	20 (17.5)	$\chi^2= 1.811$ $p= 0.467$	50 (71.4)	20 (28.6)	$\chi^2=$ 0.1885 $p= 0.196$
Occupation of father						
Farming	4 (66.7)	2 (33.3)	$\chi^2=13.47$ 1 p= 0.002	13 (33.3)	26 (66.7)	$\chi^2=27.670$ p<0.001
Civil servant	42 (72.4)	16 (27.6)		12 (70.6)	5 (29.4)	
Trade/business	63 (95.5)	3 (4.5)		61 (82.4)	13 (17.6)	
Social class of parent						
Upper (SCI & II)	15 (93.8)	11 (6.2)	$\chi^2= 6.032$ $p=0.051$	1 (100.0)	0	Fisher's exact $p= 0.617$
Middle (SCIII)	36 (87.8)	5 (12.2)		6 (85.7)	1 (14.3)	
Lower (SCIV & V)	58 (79.4)	15 (20.6)		79 (64.8)	43 (35.2)	

$\chi^2=$ Pearson's chi-square

In urban areas, 6 (18.8%) of the children within the age group 12-23months had vitamin A deficiency as compared to those within 24 - 59months of age, 15 (15.3%). In urban areas, 2 (33.3%) of the children whose fathers were farmers were vitamin A deficient as compared to 16 (27.6%) and 3 (4.5%) of those whose fathers' occupations were civil service and business/trade, respectively; this was statistically significant ($p=0.002$). In the rural areas, 26 (66.7%) of children whose fathers were farmers had vitamin A deficiency compared to 5 (29.4%) and 13 (17.6%) of those whose fathers' occupations were civil service and business/trade, respectively. This was statistically significant ($p<0.001$).

Table 5: Relationship between exclusive breastfeeding, dietary diversity score, birth order, number of children, vitamin A supplement and serum vitamin A of the children

Variables	Urban		Test statistics and p-value	Rural		Test statistics and p-value
	Serum vitamin A			Serum vitamin A		
	n (%)			n (%)		
	Normal	Deficient		Normal	Deficient	
Exclusively breastfed						
Yes	18 (78.3)	5 (21.7)	Fisher's exact	9 (64.3)	5 (35.7)	Fisher's exact
No	91 (85.0)	16 (15.0)	p=0.531	77 (66.4)	39 (33.6)	p=1.000
Dietary diversity						
Good	45 (86.5)	7 (13.5)	$\chi^2=0.464$	29 (76.3)	9 (23.7)	$\chi^2=2.476$
Poor	64 (82.1)	14 (17.9)	p=0.628	57 (62.0)	35 (38.0)	p=0.154
Birth order						
1-4	60 (89.6)	7 (10.4)	$\chi^2= 2.295$	50 (58.1)	36 (41.9)	$\chi^2= 7.289$
≥ 5	49 (88.9)	14 (21.1)	p= 0.156	36 (81.8)	8 (18.2)	p= 0.010
Number of children						
1 – 4	58 (89.2)	7 (10.8)	$\chi^2=2.783$	59 (74.7)	20 (25.3)	$\chi^2=7.599$
≥ 5	51 (78.4)	14 (21.6)	p=0.152	27 (53.0)	24 (47.0)	p=0.008
Received at least 2 doses of Vitamin A supplement						
Yes	49 (92.5)	4 (7.5)	$\chi^2= 6.956$	34 (81.0)	8 (19.0)	$\chi^2= 6.069$
No	60 (77.9)	17 (22.1)	p= 0.014	52 (59.1)	36 (40.9)	p= 0.017

χ^2 = Pearson's chi-square

In the urban areas, 7(10.8%) of the children whose parents had one to four children had vitamin A deficiency compared to 14(21.6%) of those with five or more children (p =0.152). Also, 17(22.1%) of children who have not received a vitamin A supplement were vitamin A deficient as compared with 4(7.5%) of those who have received (p = 0.014). In the rural

areas, 20(25.3%) of children whose parents had one to four children were vitamin A deficient as compared to 24(47.0%) of those whose parents had five or more children ($p = 0.017$). Similarly, 8(19.0%) of children who received vitamin A were vitamin A deficient compared with 36(40.9%) of those who had not received. The differences in proportions were statistically significant, $p = 0.017$ [Table 5].

Discussion

In this study, children between 48-59 months of age formed the highest proportion in both urban and rural areas, and this is similar to the findings from studies done in Imo and Bangladesh (Duru et al., 2016; Sarker et al., 2019). A different trend was seen in a study done in Benin, Oyo and Ghana (Adebayo et al., 2012; Adeleye & Mokogwu, 2016; Sally & Kenu, 2017). The reason for this difference could be that the latter studies focused only on children aged 12 to 23 months compared to this study, which included children aged 12 to 59 months.

The majority of the mothers in both groups were in the age group of 25-29 years, which was similar to findings of studies carried out in Nasarawa, Oyo, Imo, Ethiopia and Iran (Adenike et al., ; Duru et al., 2016; Mekonnen et al., 2019; Phadnis et al., 2015; Tabatabaei et al., 2015), in which most of the respondents fell within this age group. However, this is in contrast to a study in Ondo State of Nigeria and also in Mozambique and India (Akanbiemu et al., 2016; Shemwell et al., 2017b; Shemwell et al., 2017a) where the majority of mothers were in the age group of 20 to 24 years. The difference obtained could be due to differences in study settings.

The prevalence of vitamin A deficiency in the present study was higher in rural than in urban areas. This finding is consistent with the results of the Ghana micronutrient survey, in which vitamin A deficiency was higher in children living in rural areas compared to those in urban areas (University of Ghana et al., 2017). The findings in urban areas are similar to the findings in studies conducted in Osun and Saudi Arabia (Abolurin et al., 2018; Alquaiz et al., 2013) Similarly, the findings in the rural areas are similar to the findings in a study conducted in Sri Lanka and another study on the micronutrient deficiency indicators in Nigeria. (Marasinghe et al., 2015). However, the findings of a study done in southwestern Nigeria, Egypt and the Middle East contrast these findings (Abolurin et al., 2016; Tawfik et al., 2010). The prevalence of vitamin A deficiency observed in this study among children in both urban and rural areas was greater than 15%, which is of public health significance (Stevens et al., 2015a). Thus, the importance of identifying those at risk among children and giving them Vitamin A supplements cannot be overemphasized.

A higher prevalence of vitamin A deficiency was observed among children who had not received vitamin A supplements compared to those who had received at least two doses in urban and rural areas, and the difference was statistically significant. The administration of vitamin A supplements during routine childhood immunization and Immunization Plus days might have contributed to the reduction in the prevalence of vitamin A deficiency among children who have received at least two doses of vitamin A supplementation. It was observed in this study that a small proportion of children in urban areas and in rural areas received all ten doses of Vitamin A supplementation. The Vitamin A supplementation programmes should continue and be further strengthened so as to reach all children, thereby preventing the effects of vitamin A deficiency, which are

xerophthalmia (dry eyes), blindness, infectious morbidity, mortality, and suboptimal physical growth and anaemia.

The factors that were found to be significantly associated with the serum Vitamin A deficiency among the children in both groups were the occupation of the father and vitamin A supplements. In addition to the above factors, family size, birth order and tribe were found to be significantly associated with serum Vitamin A deficiency among the children in the urban group. Several studies have found some of the above factors to be significantly associated with serum Vitamin A deficiency in children (Ehwarieme et al., 2018; Endris et al., 2017).

Conclusion

Vitamin A deficiency remains prevalent in both urban and rural areas, with a significantly higher proportion of children in rural communities affected. From a One Health perspective, addressing VAD requires integrated strategies that link child nutrition, food systems, maternal education, and public health interventions. Community health workers should educate parents on the importance of utilizing childhood immunization services, including vitamin A supplementation, and promoting diets that include all essential food groups. Strengthening these integrated approaches will contribute to improved child health outcomes, reduced morbidity, and sustainable population-level nutrition, consistent with One Health objectives.

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Conflicts of interest

There are no conflicts of interest

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