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Abdullahi SM
Yakubu AM
Bugaje MA
Akuyam SM

Serum vitamin A levels among malnourished children aged 6 - 59 months in Zaria

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Abdullahi SM (✉)
Yakubu AM, Bugaje MA
Department of Paediatrics,
Ahmadu Bello University Teaching Hospital, Shika Zaria,
Kaduna State, Nigeria.
Email:
sakinaabdullahi2013@mail.com

Akuyam SM
Department of Chemical Pathology
Ahmadu Bello University Teaching Hospital, Shika Zaria,
Kaduna State, Nigeria.

Abstract*:* *Background:* Vitamin A deficiency (VAD) affects an estimated 6 million pre-school children in Nigeria and 20 million in Africa. When associated with severe malnutrition, it significantly increases morbidity and mortality.
Objectives: To determine serum vitamin A levels in children with Protein Energy Malnutrition and age and sex prevalence of vitamin A deficiency among children with Protein Energy Malnutrition and controls at the institute of Child Health ABUTH Zaria.
Method: This was a case-control hospital-based descriptive study carried out at the Institute of Child Health (ICH) Banzazzau, Zaria. Systematic sampling method was adopted to select undernourished children aged 6-59 months for the study. Serum vitamin A level was analysed by High Performance Liquid Chromatography. The frequency of values below a cut off, usually taken as 0.70 µmol/L (20 µg/ dl) for low and 0.35 µmol/L (10 µg/dl) for deficiency. Data was analysed using the Statistical Programme for Social Sciences version 15.4.
Results: In this study, 132 children (66 cases and 66 controls) aged 6-59 months were studied. Among the cases, all were wasted, out of which 13 (19.7%), 9 (13.6%) and 44 (66.7%) had mild, moderate and severe wasting. Similarly, all the cases were stunted with the severity ranging from mild, 11 (16.7%), moderate, 19 (28.8%) and severe, 36 (54.5%). All the controls were nutritionally normal.
Twenty six (39.4%) and 30 (45.5%) were males while 40 (60.6%), 36(54.2%) were females (M:F= 1:1.5 and 1:1.2) among cases and controls respectively. Low serum vitamin A levels among the cases was 16.7%. VAD was seen only in those with severe wasting (5%). Malnourished females aged 13-24 months and males aged 49-59 months for the controls were more at risk of low vitamin A levels. Children who had measles, persistent diarrhoea, low maternal educational levels and low social class were at a higher risk of having low serum vitamin A levels
Conclusion: This study has been able to establish low vitamin A levels among both undernourished and controls in Zaria. This is of public health significance.

Introduction

Malnutrition (Under-nutrition) is defined as an imbalance between nutrient requirements and intake resulting in cumulative deficits of energy, protein or micronutrients that may negatively affect growth, development and other relevant outcomes.[1]Stunting , underweight and wasting are indices of malnutrition,[2]These are defined respectively as anthropometric measurements that fall below minus two standard deviation (<-2SD) of normal height/length-for-age, weight-for-age, weight-for-height/ length of the median World Health Organization (WHO) child growth standards.[2,3] Severe acute malnutrition (SAM) is defined by a weight-for-height/length below -3z-scores of the median WHO growth standard, (<-3SD) by visible severe wasting or by the presence of nutritional oedema.[4]Severe acute malnutrition remains a major cause of mortality in children under five years of age.[4]
It has been estimated that more than 20 million children of the world mostly developing nations suffer from severe malnutrition and 150 million children are underweight.[3,4.5]

Globally, in 2012, 51 million children under five years were wasted, 17 million had severe wasting and twenty-eight per cent of all severely wasted children are living in Africa.[6]In Nigeria, 24% of children under five years of age are underweight (9% severely), 36% are stunted (19% severely) and 10% are wasted (3% severely).[7] Malnutrition rates in the North Western and North Eastern regions of Nigeria are higher than in the Southern parts of the country.[7,8]

Micronutrients are essential trace elements which play vital roles in metabolism and production of enzymes. Hormones and enzyme help to regulate growth, development, the functioning of immune and reproductive systems.[9]

Malnutrition is associated with vitamin A deficiency (VAD) and is one of the risk factors of VAD.

Vitamin A is a generic term referring to all compound other than carotenoids that exhibits the activity of retinol.[10] Vitamin A is said to be deficient when the serum vitamin A level is <0.7µmol/l or 200µg/l and it is of public health problem when >5 % of population is affected in developing countries of the world.[10]

It is estimated that over 124 million children are vitamin A deficient worldwide. In Africa, approximately 20 million preschool children are at risk of VAD. In Nigeria, 6 million preschool children may be at risk of VAD.[10,11]

The blinding form of severe VAD afflicts 350,000 – 500,000 young children annually, most of them residing among the poor in the developing countries.[11]

This study was carried out to assess the vitamin A status of malnourished children and to determine age and sex prevalence of vitamin A deficiency among children with Protein Energy Malnutrition and controls.

Materials and methods

This was a case-control hospital-based descriptive study conducted over a period of 10 months between June, 2010 and March, 2011.

The study was carried out at the Institute of Child Health (ICH) Banzazzau, Zaria. The Institute of Child Health serves the community/ children mainly from Zaria and its environs and is the Primary Health Care outlet of Ahmadu Bello University Teaching Hospital (ABUTH), Zaria. The ICH offers out-patient service and receives an average of 100 patients in a day. ICH is located in Banzazzau area within the walled city of Zaria. Systematic sampling method was adopted to select 132 children between 6 and 59 months of age in Zaria. The study population consisted of consecutive malnourished children between the age of 6-59 months who presented to ICH.WHO Z-score classification was used in the classification of malnutrition in this study into mild, moderate and severe malnutrition using weight, height/length, MUAC and presence or absence of oedema. Vitamin A was classified based on the frequency of values below a cut-off, usually taken as 0.70 µmol/L (20 ug/ dl) for low and 0.35 µmol/L (10 µg/dl) for deficiency. Age matched non malnourished children who presented to the ICH with clinical features of malaria, ARIs, acute diarrhoeal diseases among others were enrolled as controls. Informed consent was duly obtained from each child's parents or care givers before recruitment in the study.

The sample size was determined using the following formular:[12]

$$S = \frac{[Z_{1-\frac{\alpha}{2}}\sqrt{2P_2(1-P_2)} + Z_{1-\beta}\sqrt{P_1(1-P_1) + P_2(1-}}{(P_1 - P_2)}$$

Relevant data using a proforma which included patient's name, age, sex, parental occupation and educational status, dietary history with particular emphasis on frequency of ingestion of vitamin A – rich foods were collected from all children enrolled for the study. The socio-economic scores as well as social class (1-5) were given to each child based on the scores awarded to the occupation and educational qualification of each parent of a child as described by Ogunlesi et al[13].

History of preceding illnesses within two weeks such as measles, diarrhoeal diseases and acute respiratory infections were recorded. Physical examination looking for eye changes of vitamin A deficiency,[10] skin changes, hair changes and oedema was carried out and also the anthropometric measurements.[8,9,10]

Approval for the study was obtained from ethical committee of Ahmadu Bello University Teaching hospital Zaria.

Four millilitres of venous blood were collected into a plain bottle from the patients and was wrapped in a black polythene wrap so that retinol will not be denatured by light and the sera were separated by centrifugation. The specimens were then frozen at – 20^{O}C until analysis. The pooled samples were analysed for serum vitamin A levels by High Performance Liquid Chromatography using Bieri method[14] at chemical pathology laboratory, University, College, Hospital, Ibadan. Obtained data was compiled and analysed using statistical package for social sciences (SPSS) version 15.4. Comparison of mean values was done using Student t-test and level of significance was set at $p<0.05$.

Results

A total of 66 each for the cases and age-matched controls were sampled for the study. The socio-demographic variables for both groups are as shown in table 1. Twenty six (39.4%) were males and 40 (60.6%) were females with a male: female ratio of 1:1.5 among cases while for the controls, 30 (45.5%) were males and 36 (54.5%) were females.

Among the cases, all were wasted, out of which 13 (19.7%), 9 (13.6%) and 44(66.7%) had mild, moderate and severe wasting. Similarly, all the cases were stunted with the severity ranging from mild, 11 (16.7%) moderate, 19 (28.8%) and severe, 36 (54.5%). All the controls had normal anthropometry.

From table 2, it can be seen that, the cases had a statistically significant higher vitamin A levels compared to their controls in the 6- 12months age group. Whereas the controls had significantly higher vitamin A levels compared to the cases in the 13- 24months age group ($p<0.05$). In the remaining age groups, the controls had higher vitamin A levels, although none of the differences were statistically significant.

The distribution of serum vitamin A levels is as shown in Table 3. Three (4.5%) and 11 (16.7%) cases with wasting had deficient and low serum vitamin A levels as compared to 11 (16.7%) of controls with low serum vitamin A levels and none was deficient in serum vitamin A levels. Similarly, 3 (4.5%) and 11 (16.7%) of cases with wasting had deficient and low serum vitamin A levels as compared to 11 (16.7%) of controls with low serum vitamin A levels. The statistical analysis did not show significant difference ($p=0.492$) between wasting and controls, and stunting and controls.

In the distribution of serum vitamin A levels by age groups and sex among the cases and controls. Eleven cases had low serum vitamin A levels with the highest sub-prevalence among females as compared to males within the age group of 13-24 months. Similarly, 11 controls had low serum vitamin A levels with the highest sub-prevalence among males as compared to female within the age range of 6-12 months. The only 3 cases of deficient serum vitamin A levels were seen among the cases, out of which 2 (66.7%) were in males and 1 (33.3%) was in females within the age range of 13-24 months. Among the cases, 29% had persistent diarrhoea and 15.2% had measles.

Table 1: Socio- demographics of the population, age, social class and educational levels distribution

Variables	Cases n (%)	Control n (%)	X^2	P value
Gender				
Males	26 (39.4)	30 (45.5)	0.49	0.48
Females	40 (60.6)	36 (54.5)		
Tribe				
Hausa	50 (75.6)	52 (78.8)		0.82*
Fulani	12 (18.2)	10 (15.2)		
Yoruba	2 (3.0)	3 (4.5)		
Others	2 (3.0)	1(1.5)		
Social class				
	1 (1.5)	3 (4.5)		0.09*
II	8 (12.1)	19 (28.7)		
III	19 (28.8)	12 (18.2)		
VI	28 (42.4)	22 (33.3)		
V	10 (15.1)	10 (15.3)		
Educational levels				
None	1 (1.5)	0 (0.0)		
Islamic	28 (42.4)	7 (10.6)	18.47	0.0009
Primary	10 (15.1)	13 (19.7)		
Secondary	25(37.9)	34 (51.6)		
Tertiary	2 (3.1)	12 (18.1)		

Others = Nupe, Igala, Southern Kaduna. * = fishers exact

Table 2: Mean serum vitamin A levels by age group in cases and controls

	Mean serum vitamin A level (µg/dl)			
	Cases	Controls, n=66		
Age (months)	Mean, n=66	Mean	T	P value
6 – 12	65.69±9.51	58.36±13.21	3.659	0.0004
13 – 24	56.08±13.78	62.11±17.98	2.163	0.032
25 – 36	59.96±1.31	59.80±11.67	0.111	0.912
37 – 48	59.40±8.94	63.15±14.09	1.826	0.070
49 – 59	57.23±2.45	58.20±13.58	0.571	0.569
Total	59.44±12.93	59.90±14.06	0.196	0.845

Table 3: Distribution of vitamin A levels (mild, moderate and normal) levels in cases and controls

	Serum vitamin A levels					
	Deficient*	Low#	Normal^	Total		
Nutritional status	n (%)	n (%)	n (%)	n (%)	X^2	p value
Wasting	3 (4.5)	11 (16.7)	52 (78.8)	66 (100.0)	1.416	0.492
Stunting	3 (4.5)	11 (16.7)	52 (78.8)	66 (100.0)	1.416	0.492
Controls	0 (0.0)	11 (16.7)	55 (83.3)	66 (100.0)		

*Deficient vitamin A = < 10µg/dl #Low vitamin A= 10 - < 20µg/dl
^Normal vitamin A = ≥20µg/dl

Discussion

This study showed the prevalence of low serum vitamin A levels is 16.7% in both cases and controls while, the prevalence of vitamin A deficiency among the cases is 4.5% and none of the controls had vitamin A deficiency. This showed that VAD is a public health problem among malnourished children in Zaria. The reasons for this same prevalence among cases and controls could be that there was no marked difference in the type of vitamin A containing foods taken by cases and controls that had low serum vitamin A levels. The general availability and intake of vitamin A-rich foods do not preclude the presence of VAD in this region.

The findings from this study was comparable to that of Obukpa in Enugu [15] where 16.4% had low level of vitamin A, however deficiency level occurred in 9.2% of the population studied unlike in the present study where vitamin A deficiency was found in 4.5% of the cases. In Ijaiye-Orile in Ibadan[16],52% (23.2% wasted and 29.2% stunted) of malnourished children were deficient in serum vitamin A levels while 26.8% of the targeted population had deficient serum vitamin A levels and 47.9% had low levels. The reason for this high values may be as a result of non availability of vitamin A rich foods or loss of vitamin A from overcooking of vegetables and palm oil. Other factors such as diarrhoeal disease, measles and acute respiratory tract infections may be contributory to the deficiency state of vitamin A as was seen in their patients.

The present study had shown that there were no statistically significant difference in the mean serum vitamin A levels between cases and controls. This is comparable to findings at Ijaiye-Orile[16] in Ibadan in which they found no difference in the nutritional status of children with and without vitamin A deficiency.
Another finding of this study was the higher prevalence of VAD which occurred in males compared to females among the control group and the other way round for the cases. The reason for this higher prevalence in males among the controls is not clear. No cultural factor could be discovered that may be responsible for this. There was no obvious difference in prohibited foods fed to boys and girls. Similar observation was reported from Sri Lanka[17] and Philippines.[18] In Philippines, it was discovered that males consumed less vitamin A foods than females. However, the sample size in the present study were too insignificant to make a meaningful comparison with the sample sizes of Sri lanka and Philippines which were large.

The lowest mean serum vitamin A level was found in the fifth year of life, the mean retinol was highest in the fourth year followed by second, third and first year of life for the controls, while among the study group, lowest level was obtained in the second year of life and the highest in the first year of life. The explanation for the low mean serum retinol levels in the 5th year of life might be due to increased demand for vitamin A as the child grows older which may be met by dietary intake and stores in the liver. The trend in the distribution of serum vitamin A in this study is not comparable to the findings in Ijaye-orile in Ibadan, [16]Szymanski and Long well [19] in USA who showed lowest mean in the first year and highest in the second year and then decreased until fifth year of life. This could be as a result of deficiency of vitamin A in the mother and also deficiency in breast milk at late infancy.

Some of the limitations encountered in the study included the difficulty in obtaining accurately vitamin A food intake of children. Serum carotene was not estimated because of the limitation of obtaining the commercial standard preparations and estimation of prealbumin and retinol binding protein could have provided valuable information as both are indicators of vitamin A and nutritional status.

Conclusion

In conclusion, low serum vitamin A as defined by WHO is a major public health problem in the population studied in Zaria affecting both malnourished and normal children. The lowest mean serum vitamin A levels for cases were recorded between ages of 13-24 months, while for the controls it was between 49 and 59 months. This might be due to increased demand for vitamin A as the child grows older which may be met by dietary intake and stores in the liver. Male cases had higher mean serum vitamin A than their female counterparts, while the reverse was the case among controls.
It is thus recommended as line of future study to study a larger community in order to find the true prevalence of serum retinol and prevalence of pre-albumin and retinol-binding protein could provide information as both are indicators of vitamin A and nutritional status. Current vitamin A supplementation programmes should be strengthened.

Authors contributions
Abdullahi S M: Planning, literature search, data collection, analysis and writing of manuscript
Yakubu A M: Revised the manuscript and supervised the conduct of the study
Akuyam S M: Review of drafts of manuscript and supervision.
Bugaje M A: Review drafts of manuscript and supervision.
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