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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Prevalence of Vitamin A Deficiency among Malnourished Children in Usmanu Danfodiyo University Teaching Hospital, Sokoto, Northwestern Nigeria

A. Adamu, N.M. Jiya, H. Ahmed, P.K. Ibitoye, M.O. Ugege, U.M. Sani, T. Yusuf, F.B. Jiya and K.O. Isezuo
Department of Paediatrics, Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria

Abstract: Malnutrition refers to a group of pathological disorders resulting from imbalance between intake of essential nutrients and body requirement for these nutrients. It is classified broadly into macronutrient and micronutrient malnutrition. The former comprises Protein energy malnutrition (PEM) and over nutrition/obesity, while the latter encompasses specific micronutrient deficiencies such as vitamin A, zinc (Zn), iodine etc. Micronutrient deficiencies are less dramatic in manifestation and frequently not recognised. Vitamin A deficiency (VAD) is a public health problem affecting 5% of population in developing countries of the world. The study is relevant as it seeks to provide local data on this subject. This study was conducted to determine the prevalence of vitamin A deficiency among children with malnutrition and to compare serum vitamin A levels between children with malnutrition and age matched well-nourished children. A total of 550 children, 275 with malnutrition and 275 controls, aged 6 months to 60 months that satisfied the inclusion criteria were recruited at various Paediatric units of Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto after parents and caregivers consented in writing. Serum vitamin A was analysed using colorimetric method of Bassey. The mean serum level of vitamin A in malnourished children was 23.4±13.2 μg/dl which was significantly lower when compared to that of the controls 54.1±22.8 μg/dl, respectively ($p = <0.05$). The prevalence of VAD was 8.4% among children with malnutrition and 4.0% among the control cohorts, respectively. It was concluded that children with malnutrition had significantly lower serum vitamin A level compared to the controls.

Key words: Vitamin A deficiency, malnourished children, northwestern Nigeria

INTRODUCTION

Malnutrition refers to a group of pathological disorders resulting from imbalance between intake of essential nutrients and body requirement for these nutrients (Ulasi and Ebenebe, 2007). It is classified broadly into macronutrient and micronutrient malnutrition. The former comprises Protein energy malnutrition (PEM) and over nutrition/obesity, while the latter encompasses specific micronutrient deficiencies such as zinc (Zn), iodine, vitamin A, iron and magnesium (Federal Ministry of Health, 2005; Mushi *et al*., 2008).

PEM is globally the most important risk factor for childhood morbidity and mortality, contributing to more than half of deaths in children under the age of five years worldwide (Lawoyin *et al*., 2000; Lawoyin *et al*., 2003; Ulrich and Kaufmann, 2007). PEM occurs worldwide and still constitutes a major public health problem in the tropical and subtropical regions of the world (Federal Ministry of Health, 2005; United Nations Fund, 1985). PEM remains a public health burden in most developing countries due to high level of poverty, adverse socioeconomic conditions and endemic childhood infections (Federal Ministry of Health, 2005; United Nations Fund, 1985; UNICEF, 2005). Studies in rural communities in Nigeria have shown variable prevalence rates of PEM ranging from 20.5 to 41.6% (Oyedeji, 1984, 2000).

Unlike PEM, micronutrient deficiencies are less dramatic in manifestation and frequently not recognised. This is because their clinical manifestations are not always specific and laboratory methods for diagnosis are either not sensitive or too complex for routine use. Hence, this condition has been referred to as "hidden hunger" (Ohiokpehal *et al*., 2012). Micronutrient deficiencies constitute a devastating form of malnutrition whose consequences can be crippling or fatal (Ohiokpehal *et al*., 2012).

In developing countries where PEM is prevalent, children usually have multiple micronutrient deficiencies (Mohammed *et al*., 2002). These deficiencies are common in those with severe forms of malnutrition (Federal Ministry of Health, 2005; Mushi *et al*., 2008). Factors contributing to micronutrient deficiencies in malnourished children include low dietary intake, poor bioavailability, malabsorption, lack of breastfeeding and increase losses due to diarrhoea.

Vitamin A deficiency (VAD) is a public health problem affecting 5% of population in developing countries of the world (West and McLaren, 2003). In Africa about 20 million preschool children are at risk of VAD; seven million of these children are in Nigeria (Abidoye and Soroh, 1999). Hence, Nigeria is listed by the WHO as one of the category one countries with the highest risk of VAD (WHO,

Corresponding Author: A. Adamu, Department of Paediatrics, Usmanu Danfodiyo University Teaching Hospital, PMB 2370, Sokoto, Nigeria

2002). The problem is worst in the northern areas of the country where red palm oil, a very good source of vitamin A, is not consumed as much as in the south (Childhood nutrition and malnutrition in Nigeria, 2001).

Studies on serum retinol by Ikekpeazu and Neboh (2010) in Enugu state, South Eastern Nigeria and Oso *et al*. (2003) in Ijaye-Orile community in Western Nigeria have both shown that malnourished children had lower serum levels of vitamin A than well-nourished children. Similarly, (Airede and Rabasa, 2006) in Maiduguri, North Eastern Nigeria evaluated serum vitamin A levels of PEM children matched with controls. The authors observed 100% inadequate serum retinol levels in children with kwashiorkor and in only 6% of those with marasmus on the first day of admission.

Though, studies of 0Ikekpeazu and Neboh, 2010; Oso *et al*., 2003; Airede and Rabasa, 2006) have evaluated the status of vitamin A in malnourished Nigerian children, there is limited data on vitamin A status in our region. This study therefore aimed to determine the serum levels of vitamin A (retinol) among children with malnutrition aged 6-60 months, at the Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, Nigeria. The specific objectives were to determine the prevalence of VAD among children with malnutrition and compare serum levels of vitamin A between children with malnutrition and age matched well-nourished children.

The study is relevant as it seeks to provide local data on this subject, which will enable comparison with other studies.

MATERIALS AND METHODS

The study was a descriptive and cross-sectional in nature, carried out at the paediatric department of the Usmanu Danfodiyo University Teaching Hospital (UDUTH), a tertiary health facility located in Sokoto, the Sokoto State capital, Northwestern Nigeria. It serves as a referral centre for people from Sokoto, Zamfara, Niger, Katsina and Kebbi states of Nigeria as well as neighbouring Niger and Benin Republics.

The study was conducted among children aged between 6 months to 6 months who presented to the Paediatric units [Emergency paediatric unit (EPU), paediatric outpatient clinic (POPD) and paediatric medical ward (PMW)] of UDUTH, Sokoto with malnutrition. Controls were well-nourished apparently healthy children that attended POPD for follow up after discharge from the hospital. Subjects and controls were recruited consecutively until the required sample size was obtained. Inclusion criteria for recruited subjects were age 6 months to 5 years, presence of malnutrition according to the WHO classification of malnutrition; <-1 to <-3 Zscores of WHO reference growth charts, 20 obtained written consent from parent or caregiver. Greater than -1Z score of the WHO child growth standard reference values for Weight for length/height and length/height for age 20 as well as age 6 to 60 months and obtained informed written consent were inclusion criteria for controls.

Children with normal weight that were >-1Z score of the WHO child growth standard reference values for weight for length/ height and length/height for age, 20 but presented with acute diarrhoea, features of respiratory tract infection and sickle cell anaemia (SCA), preceding history of measles 3 months before the study and those that were stunted were excluded from the study as well as those who received vitamin A supplement in the preceding 3 months before the study.

The minimum sample size was determined using a standard formula (Araoye, 2003). In this study, prevalence of vitamin A deficiency in PEM children was calculated using a p-value of 7.8%, based on previous study by Akinyinka *et al*. (2001). Two hundred and seventy five subjects each were selected for the study and control groups with a total of 550 participants for the study.

All consecutive admissions into the EPU, PMW and children that attended POPD of UDUTH, Sokoto during the study period with diagnosis of malnutrition based on the WHO classification of malnutrition that fulfilled the inclusion criteria were enrolled for the study. Controls were well-nourished non-stunted, apparently healthy children that attended the POPD clinic without haematologic or infectious conditions.

A structured pretested questionnaire using interview method was used to obtain information from recruited subjects and controls on socio-demographic characteristics, such as age, gender and socio-economic class (SEC) of both parents using Oyedeji's (1985) classification (Oyedeji, 1985). Other information included dietary history, preceding illnesses e.g Measles. SEC I and II are the upper class, class III is the middle class, while SEC IV and V form the lower class (Oyedeji, 1985).

All the children recruited for the study had detailed clinical examination. Relevant information was recorded using the study proforma. Anthropometric indices such as the weight and length were measured for all recruited children. Nutritional status of the recruited children was assessed using the WHO classification of malnutrition (Ulasi and Ebenebe, 2007). The subjects were classified as mild wasting (weight-for-height ratio between <-1 to >-2SD), moderate wasting(weight-for height- ratio between <-2 to >-3 SD) and severe wasting (weight-for- height ratio <-3 SD), children that presented with bilateral oedema of the feet were categorised as oedematous malnutrition (Ulasi and Ebenebe, 2007). Controls were well nourished children whose weight-for-height ratio were > -1SD1 and whose height-for-age ratio were +2SD to >-1SD of the WHO child growth standards reference values (WHO, 2006).

Five millilitres of blood was collected from each child by venopuncture after taking aseptic measures and immediately placed into a well-labelled specimen bottle without anticoagulant. The blood samples were immediately transferred to the chemical pathology laboratory for centrifugation at 200 revolutions per minute for 5 min. Serum was relabelled and then frozen at -20°C until time for the analysis. The samples were subsequently analysed for serum retinol using Colorimetric method as described by Valley and Bell (1998).

Ethical approval for the study was obtained from the ethics committee of UDUTH, Sokoto. Informed written or thumb print consent was duly obtained from each child's parent or caregiver before recruitment into the study using the consent form.

Data analysis was done using the statistical package for social sciences (SPSS) version 20.0 software. The results were illustrated using frequency tables, appropriate charts and figures. Comparison of mean values of subjects and controls was done using Student's t test, while comparison of proportions was done using Chi-square test. A p-value of 0.05 or less was regarded as statistically significant.

RESULTS

Demographic characteristics of the subjects and controls: A total of 275 children with malnutrition were studied while 275 well nourished apparently healthy children served as controls. The mean age of the children with malnutrition was 26.2±14.6 months (range of 6-60 months) compared to 28.2±17.0 months (range 6-60 months) in the controls. The difference was not significant (p = 0.157) (Fig. 1) two hundred and twenty five (81.8%) of the children with malnutrition were between the ages of 6 and 36 months. Of the 275 children with malnutrition, 137 (49.8%) were males and 138 (50.2%) were females, with a male to female ratio of 1:1.

Mean weight for age of the subjects compared with controls: The mean weight for age was significantly lower in the subjects compared to that of the controls. Figure 2 shows the mean weight for age centile curves for the subjects and controls compared with the median values of WHO weight for age growth chart. The centile curve for the subjects falls significantly below the median values of WHO weight for age growth chart whereas, that of the controls was comparable to it.

Clinical types of malnutrition according to age groups distribution: Ninety-three (33.8%) of the children with malnutrition had oedematous malnutrition, 82 (29.8%) had severe wasting, while 30 (10.9%) and 70 (25.4%) of the children had mild and moderate wasting respectively. One hundred and sixty eight (61.1%) of the children with malnutrition were between the ages of 12 and 36 months. Oedematous malnutrition and severe wasting were more common among children aged 12 to 24 months.

Mean serum vitamin A levels of the subjects and controls: The mean serum vitamin A levels for the subjects and controls were 23.4±13.2 and 54.0±22.8 µg/dl, respectively. There was significant difference between the mean serum vitamin A levels of the subjects and controls (t = 19.50, df = 548, p = 0.0001).

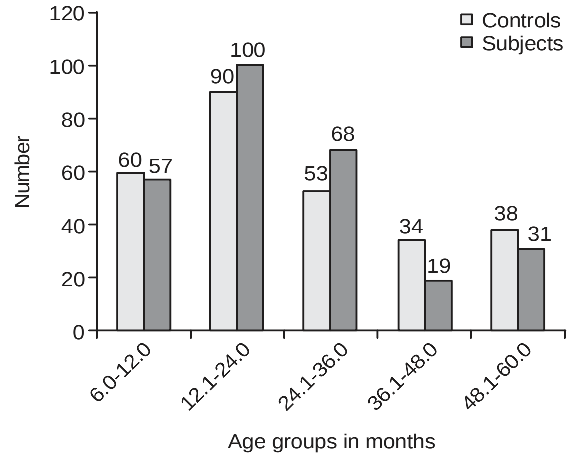

Fig. 1: A bar chart showing the age distribution of the subjects and controls

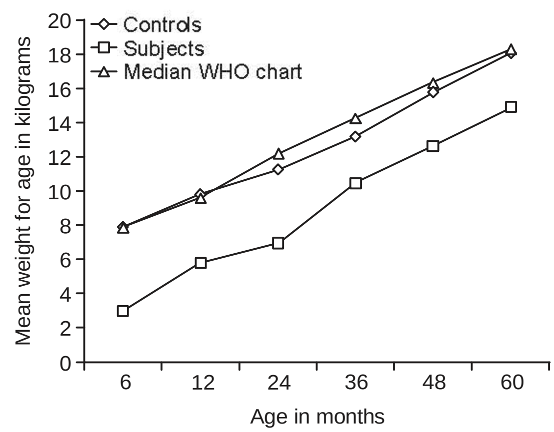

Fig. 2: A graph illustrating the mean weight for age of the subjects compared with that of the controls and the median values of WHO weight for age growth chart

Table 1: Prevalence of vitamin A deficiency among children with malnutrition

	--- Vitamin A level (µg/dl) ---	
Clinical types of malnutrition	<10 n (%)	10-19.9 n (%)
Oedematous malnutrition n = 93	5 (1.8)	30 (10.9)
Mild wasting n = 30	2 (0.7)	7 (2.5)
Moderate wasting n = 70	4 (1.5)	8 (2.9)
Severe wasting n = 82	12 (4.4)	35 (12.7)
Total	23 (8.4)	80 (29.0)

x^2 = 29.2, df = 6, p = 0.0001

Prevalence of vitamin A deficiency among malnourished children: The prevalence of low vitamin A status (10-19.9 µg/dl) and VAD state (<10 µg/dl) were 29.0 and 8.4%, respectively among children with malnutrition

Table 2: Mean serum vitamin A levels of children with malnutrition and controls according to age

Age group (months)		Mean serum vitamin A levels (µg/dl) Subjects (n = 275)	Controls (n = 275)	t	p
6.1-12.0		25.2±14.7	64.9±19.4	12.3	0.0001
	n	57	60		
12.1-24.0		21.4±10.6	52.7±24.3	11.6	0.0001
	n	100	90		
24.1-36.0		21.0±11.2	47.8±22.6	6.6	0.0001
	n	68	53		
36.1-48.0		25.4±14.5	51.1±24.2	3.8	0.001
	n	19	34		
48.1-60.0		26.0±17.5	54.4±17.3	9.4	0.0001
	n	31	38		
Total		23.4±13.2	54.0±22.8	19.5	0.0001

Table 3: Mean serum vitamin A levels (µg/dl) of children with malnutrition and controls according to age and gender

	Males				Females			
Age (months)	Subjects	Controls	t	p	Subjects	Controls	t	p
6.0-12.0	24.5±15.2	26.1±14.2	9.3	0.241	26.1±12.6	27.3±13.0	-1.07	0.350
12.1-24.0	20.5±9.7	22.1±14.8	8.48	0.155	22.3±11.6	23.1±12.0	-1.01	0.233
24.1-36.0	27.7±17.8	27.2±16.3	1.46	0.113	22.1±8.7	24.2±15.0	-7.11	0.325
36.1-48.0	28.6±19.6	30.8±23.1	1.36	0.145	23.7±18.5	23.0±17.3	5.60	0.112
48.1-60.0	20.5±10.1	21.8±16.5	1.34	0.174	21.2±12.0	24.3±8.3	0.36	0.675
Total	23.7±14.1	54.5±23.8	12.9	0.0001	23.1±12.1	51.7±24.3	13.0	0.0001

Table 4: Mean serum vitamin A levels (µg/dl) of children with malnutrition according to age and gender

		Gender			
Age (months)		Males (n = 137)	Females (n = 138)	t	p
6.0-12.0	Mean±SD	24.5±15.2	26.1±12.6	0.39	0.69
	n	34	23		
12.1-24.0	Mean±SD	20.5±9.7	22.3±11.6	0.88	0.38
	n	49	51		
24.1-36.0	Mean±SD	27.7±17.8	22.1±8.7	1.41	0.16
	n	36	32		
36.1-48.0	Mean±SD	28.6±19.6	23.7±18.5	0.63	0.54
	n	8	11		
48.1-60.0	Mean±SD	20.5±10.1	21.2±12.0	0.15	0.88
	n	10	21		
Total	Mean±SD	23.7±14.1	23.1±12.1	0.57	0.195

(x = 29.2, df = 6, p = 0.0001), while the prevalence of low vitamin A status (10.9%) and that of VAD (4.0%) in the controls were lower than that observed in the subjects. Within the subtypes of PEM, the prevalence of low vitamin A status was highest (12.7%) in children with severe wasting and lowest among those with mild wasting (2.5%). The highest prevalence (4.4%) of VAD was observed in children with severe wasting, followed by oedematous malnutrition (1.8%). The least prevalence of VAD (0.7%) was observed among children with mild wasting (Table 1).

Mean serum vitamin A levels comparison between malnourished children and controls according to age: When children with malnutrition were segregated into age groups, the mean serum vitamin A levels were observed to be low among all the age groups compared with age matched controls. The differences were significant (p = <0.05 each). Malnourished children in the age range 24.1-36.0 months have the lowest mean serum vitamin A levels (21.0±11.2 µg/dl) compared with age matched controls (47.8±22.6 µg/dl), the difference was significant (p = 0.0001). Children with malnutrition in the age group 48.1-60.0 months have the highest mean serum vitamin A levels (26.0±17.5 µg/dl), as shown in Table 2.

Relationship between serum vitamin A levels and gender: The mean serum vitamin A levels of male controls (54.5±23.8 µg/dl) was higher than that observed among the male subjects (23.7±14.1 µg/dl). The difference was significant (p = 0.0001). There was also significant difference between the mean serum vitamin A levels of female controls (51.7±24.3 µg/dl) and that of the female subjects (23.1±12.1 µg/dl) (p = 0.0001). However, no significant gender difference was observed in the mean serum vitamin A levels across all age groups between malnourished males and controls males as well as in malnourished females and controls females (p>0.05), as shown in Table 3.

Table 5: Categorisations of vitamin A status among controls according to gender

	Serum vitamin A levels (µg/dl)		
Gender	<10 n (%)	10-19.9 n (%)	>20 n (%)
Male	6 (2.2)	16 (5.8)	130 (47.3)
Female	5 (1.8)	14 (5.1)	104 (38.8)
Total	11 (4.0)	30 (10.9)	234 (85.1)

X^2 = 276.1, df = 2, p = 0.37

Table 6: Categorisations of vitamin A status among children with malnutrition according to gender

	Serum vitamin A Levels (µg/dl)		
Gender	<10 n (%)	10-19.9 n (%)	>20 n (%)
Male	18 (6.6)	31 (11.3)	88 (32.0)
Female	5 (1.8)	49 (17.8)	84 (30.5)
Total	23 (8.4)	80 (29.0)	172 (62.5)

x = 11.5, df = 2, p = 0.003

Table 7: Levels of mean serum vitamin A according to the types of Malnutrition

Clinical types of malnutrition	No. of children n (%)	Mean serum vitamin A levels (µg/dl)
Controls	275.0 (100.0)	54.0±22.8
†Oedematous malnutrition	93.0 (33.8)	22.1±11.7
Mild wasting	30.0 (10.9)	28.8±19.4
Moderate wasting	70.0(25.4)	28.2±12.9
‡Severe wasting	82.0(29.8)	18.6±10.2

F = 101.5, (p = 0.0001), † = t = 13.0, (p = 0.0001), ‡ = t = 13.9, (p = 0.001), F = one way analysis of Variance (ANOVA)

Mean serum vitamin A levels of malnourished children according to age and gender. The mean serum vitamin A levels of malnourish males (23.7±14.1 µg/dl) were similar to that of malnourished females (23.1±12.1 µg/dl), the difference was not significant (p = 0.195). Similarly, no significant gender difference was observed in the mean serum vitamin A level across all age groups (p>0.05), as shown in Table 4.

Categorisations of vitamin A status among controls according to gender: There were more cases of low vitamin A status (10-19.9 µg/dl) and vitamin A deficiency (<10 µg/dl) among the male controls 16.0 (5.8%) and 6 (2.2%), respectively, than in the female controls 14 (5.1%) and 5 (1.8%), respectively. There was no significant relationship between the different categories of vitamin A status and gender among the controls (x^2 = 276.1, df = 2, p = 0.37), as shown in Table 5.

Categorisations of vitamin A status among malnourished children according to gender: There were more cases of low vitamin A status among the female subjects 49 (17.8%) than in the male subjects 31 (11.3%), while for vitamin A deficiency, the male subjects 18 (6.6%)were more affected than the female subjects 5(1.8%). There was significant relationship between gender and the various vitamins A categories among the malnourished children (x^2 = 11.5, df = 2, p = 0.003) (Table 6).

Relationship between serum vitamin A levels with types of malnutrition: The mean serum vitamin A levels were significantly low among all clinical types of malnutrition compared with controls (p = 0.0001). Children with severe wasting had the lowest mean serum vitamin A levels (18.6±10.2 µg/dl), when compared with that of the controls (54.0±22.8 µg/dl) the difference was significant (p = 0.0001). Children with oedematous malnutrition had the second lowest serum vitamin A levels (22.1±11.7 µg/dl) while children with mild wasting had the highest value (28.8±19.4 µg/dl), as shown in Table 7.

Socio-economic class of the parents of the subjects and the controls: Two hundred and thirty three (85%) of the children with PEM were from lower SEC, 34 (12.0%) in the middle SEC and only 8(3.0%) were from upper SEC, while for the controls fifty three (19.0%) of the children were from the lower SEC, 151 (55.0%) from the middle SEC and seventy one (26.0%) were from the upper SEC.

DISCUSSION

This study confirmed the previous findings (Carmel *et al*., 2005 and Agozie *et al*., 2014) that there is no difference in the prevalence of undernutrition in relation to gender, but it is in contrast to the findings of Olwedo *et al*. (2008) in Uganda and (Emina *et al*., 2011) in republic of Congo which suggested that undernutrition is more prevalent among boys than girls.

The predisposition of male children to undernutrition may be due to the fact that female children receives more attention from the parents than the male counterpart, (Babatunde Omilola, 2010) boys rarely stay at home; they tend to be active, running around the neighborhood compared to female children who eat whatever small feeds their mother gave them since they are always with them at home (Olwedo *et al*., 2008). There are inconsistent findings in relation to the prevalence of undernutrition in relation to gender, some studies showed that female children are more at risk of undernutrition than male children; (Kriti *et al*., 2013) inequality between girls and boys can take many different forms, one of which could be neglect of health, nutrition and other needs of girls that influence survival of the girl child (Kriti *et al*., 2013). Oedematous malnutrition was encountered in 33.8% of the recruited subjects, which was the most prevalent form of malnutrition found in this study. This finding was in accordance with that of (Madondo *et al*., 2012) in South Africa who found severe wasting in 29.8% of his subjects. The findings of this study were similar to several reports on children with malnutrition and low mean serum vitamin

A levels (Ikekpeazu and Neboh, 2010; Oso *et al*., 2003; Airede and Rabasa, 2006) when compared to well-nourished children. A high prevalence of VAD (serum retinol <10 µg/dl) and low vitamin A status (serum retinol 10 to <20 µg/dl) of 8.4 and 29.0%, respectively among children with malnutrition found in this study was in consonance with a previous study in North-Eastern Nigeria that reported prevalence of 5.0% for VAD and 40.0% for low vitamin A status (Airede and Rabasa, 2006). Akinyinka *et al*. (2001) reported prevalence of 7.8% for VAD among children with malnutrition in Ibadan. The high prevalence of VAD found in this study could be attributed to interplay of several factors such as parental poverty and low level of education (Ulasi and Ebenebe 2007; Airede and Rabasa, 2006) as 85% of the children in this study were from low SEC. This has been shown to be a significant contributor to the evolution of infectious diseases and ultimate depletion of retinol stores (Ulasi and Ebenebe 2007; Airede and Rabasa, 2006; Akinyinka *et al*., 2001).

The difference in the prevalence rates could be attributed to the large sample size in this study compared to most of the above-mentioned studies. The prevalence of VAD (8.4%) found in this study may be a significant public health problem in malnourished children in the study area. Even though this study was a hospital-based survey, the catchment population was basically indigenous. The WHO classify vitamin A status of a community as a public health problem when the prevalence of VAD defined by serum retinol concentration <10 µg/dl is over 5% of the population (WHO, 2009).

The present study demonstrated that malnourished children aged 2 to 3 years had both lowest mean serum vitamin A level. This is similar to previous finding in which greatest impact of VAD was said to occur among children less than 3 years of age Akinyinka *et al*. (2001). This is because this age coincides with age of weaning and peak age of occurrence of malnutrition Ulasi and Ebenebe (2007) After weaning, children derive nutrition from a monotonous habitual diet, depending heavily on cereals with little nutritious accompaniment (Lawoyin *et al*., 2003; Mary, 2008; Ugwuja *et al*., 2007). VAD can occur at any age but it is a disabling and fatal public health problem for children under five years of age. This period is characterised by high requirements for vitamin A to support early rapid growth, transition from breastfeeding to dependence on other dietary sources of vitamin A (FAO, 2002).

In this study, the mean serum vitamin A levels were comparable in both males and females among the subjects and in the controls. However, significant relationship was observed between the various categories of vitamin status and gender among the subjects but not in the controls, with the male subjects having more cases of VAD. This finding was contrary to what was reported in a previous study, which showed no relationship between VAD and gender (Muzamil, 2010). There is no consistent, clear indication in humans of a gender differential in vitamin A requirements during childhood (Abeer *et al*., 2013).

Growth rates and presumably the need for vitamin A from birth to 10 years for boys are higher than for girls (Reyes *et al*., 2002).

It was also shown in this study that mean serum vitamin A level was significantly low among the different clinical types of malnutrition when compared to the controls. Lowest mean serum vitamin A levels was observed among children with severe wasting, which is similar to what has been reported previously (Akinyinka *et al*., 2001; Reddy and Mohan, 1997; Amal *et al*., 1998; Sarita and Manorama, 1997). The serum retinol in this study is depressed more in those with severe malnutrition than those with mild and moderate malnutrition. Akinyinka *et al*. (2001) reported an association between VAD and wasting, but other studies did not show any association between serum retinol and wasting (Esther and Duncan, 2004; Wolde-Gebriel *et al*., 1991). The relationship between serum retinol concentration and wasting is not entirely understood Amal *et al*. (1998). Previous research confirm the link between poor vitamin A status and wasting (Esther and Duncan, 2004). Diarrhoeal morbidities appeared to mediate this relationship Amal *et al*. (1998).

Eighty five per cent of the children with malnutrition in this study were from lower socio- economic background. This is similar to findings reported in the literature (Lawoyin *et al*., 2000; Oyedeji, 1984). Poverty has been identified as one of the leading cause of micronutrient deficiency in children in developing world (Ivan *et al*., 2007).

Animal food products are the best and richest sources of vitamin A but are unaffordable to many in developing countries (Airede and Rabasa, 2006; Hadi *et al*., 1999; Samba *et al*., 1993). Poor households may lack the resources to diversify their diets leading to micronutrients deficiency (Ohiokpehal *et al*., 2012). VAD could result from habitually low intake as well as economic, social and environmental factors which limit access to vitamin A containing foods (Ikekpeazu and Neboh, 2010).

Although routine immunisation and oral doses of vitamin A are offered free of charge in the state where the study was conducted, it is remarkable that neither all the controls nor all the subjects had complete immunisation and complete doses of vitamin A supplementation for age. This was in fact worse among the subjects. Similar findings were reported by Lawoyin *et al*. (2003) in under five year old children in the inner city of Ibadan. Adequate vitamin A supplementation has been shown to be an inexpensive, quick and effective way to improve vitamin A status and to save children's lives (WHO/UNICEF/IVACG, 1997). Lack of routine immunisation which prevents a child from vaccine preventable diseases such as measles and diarrhoeal disease will lead to a vicious circle of infection and malnutrition (Peter and Judith, 2008). Infection make malnutrition worse while malnutrition increases the risks and severity of infectious diseases (Ulasi and Ebenebe 2007). In developing countries, VAD typically begins during infancy, when infants do not receive adequate supplies of colostrum or breast milk (Akinyinka *et al*., 2001; WHO, 2009).

It is concluded from this study that malnourished children had lower mean serum vitamin A level than the controls. The prevalence of low vitamin A status is 29.0% while that of VAD is 8.4% among children with malnutrition seen at UDUTH, Sokoto, hence VAD is a significant public health problem in malnourished children in the study area. The mean serum vitamin A was significantly low across all age categories in malnourished children when compared to age matched controls. It is recommended therefore that prophylactic doses of vitamin A should be commenced in all malnourished children who do not manifest clinical signs of deficiency. Also food fortification as well as supplementation of vitamin A should be enhanced.

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