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Research Article

Vitamin A Status for Sustainable Development

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Abstract: Vitamin A deficiency is a serious nutritional and health problem affecting most developing countries. The objectives of this work are to assess the dietary intakes and biochemical status of vitamin A among adolescents population in Kano Nigeria. Dietary assessment was conducted using 24 hour dietary recall and biochemical assay of vitamin A was performed using a High Performance Liquid Chromatography (HPLC). Findings from this study revealed the overall energy intake (EI) to be higher ($p<0.05$) among male (2014.4±194.6kcal) than their female (1441.1±169.3kcal) counterparts. Intakes of vitamin A represent only 14% of the total energy intakes in females and 15% in male respectively. Mean vitamin A concentration from this study (female: 15.55±6.14µg/dL and male: 15.74±6.33µg/dL) indicated a moderate deficiency among our study population irrespective of their age groups. This deficiency is of public health importance; if not arrested progresses into the adulthood and will ultimately affect negatively all facets of development in the community. Therefore, there is urgent need for public enlightenment and provision of supplements to avert the scourge of VAD.
Keywords: Vitamin A status, Sustainable development, Adolescents, Deficiency, Dietary intakes

INTRODUCTION

Vitamin A deficiency is a serious nutritional and health problem affecting most developing countries including the sub-Saharan Africa (SSA) [1]. Up to 3 million children in SSA under the age of 5 suffer from partial or total blindness caused by vitamin A deficiency (VAD) [2] and as many as 140 million children in Africa and Southeast Asia [2]. The total prevalence of people with VAD in SSA is estimated at 36 million [3]. The deficiency increases children's risk to common illnesses, and impairs children's growth, development, vision, and immune systems; and in severe cases results in blindness and death from diseases such as malaria and measles [4]. Each year, it is estimated that 670,000 children will die from vitamin A deficiency (VAD), and 350,000 will go blind [38].

Vitamin A deficiency also remains a public health problem among women [5], affecting an estimated 19 million pregnant women [6], with the highest burden found in the WHO regions of Africa and South-East Asia. In women, VAD increases the risk of death during pregnancy [5] and approximately 1000 women die every day from complications related to pregnancy or childbirth [7] as well as giving birth to low weight children [1]. It may also increase the spread of HIV/AIDs [1] and other viral infections [8]. New research findings suggest that vitamin A can profoundly obviate maternal mortality and protect infants against the effect of maternal to child transmission of HIV/AIDs virus infection [1, 5].

Vitamins A is specifically involved in multiple cellular and tissue processes [9-12] and there is increasing evidence that links deficiencies with chronic diseases in adulthood [12], though data are scarce for younger ages. But deficiency stages at these early ages could contribute to risk factors [12-14] which will seriously undermine the productivity and sustainable development of any Nation state. Limited studies have been conducted in Nigeria to determine the prevalence of VAD deficiencies. Available data from smaller scale studies indicated that VAD was evident in many subpopulations in Nigeria [15]. Therefore, the objectives of this work are to assess the dietary intakes and biochemical status of vitamin A among adolescents population in Kano Nigeria.

METHODOLOGY

Study design, sampling and biochemical analysis

Kano State occupies part of Northern Nigeria. The global location of the state is between latitude 11^0 30´ north of the equator and also between longitudes 08^0 30´ east of the Greenwich Meridian [16]. The state occupies an area approximately 60, 473.2 square kilometer and has a projected population of 9, 401, 288 [17]. Kano State consists of forty four local government area councils.

The study design targeted the entire State. The State was stratified according to the four major geopolitical zones and the urban area. A total of thirty seven (37) boarding secondary schools were identified within the study area; 18 female and 19 male schools respectively. Nine (9) boarding schools were therefore randomly selected as sample representative; out of which four (4) were male and five (5) female schools respectively. Thirty (30) study participants were randomly recruited from each school across the study areas to make a total 270 participants.

The sample was stratified by sex and age group. Males and females were 120 and 150 and between 12 and 19 years respectively (n = 270). The study participants were recruited after a Written Consent is obtained from them. Also, Ethical Approval was obtained from the State Ministry of Health's ethical committee. Food and nutrient intake were assessed using a 24-hour dietary recall by trained interviewers for three (3) consecutive days. Mean daily nutrient intakes were calculated using the [18].

Ten (10) milliliters of intravenous blood were collected from all participants. Subjects were asked to eat only lightly beforehand, although, for ethical reasons, they were not asked to fast. Whole blood was collected in a lithium heparin container and centrifuge at 3000 rpm for 5 minutes and separated; plasma were aspirated into tubes and analyzed according to [19]. The samples were protected from light during preparation and storage at -20 ^{0}C. Plasma vitamin A was determined using the Reverse-phase technique described by [20]. We defined low biochemical nutrient status using cutoffs approximating marginal deficiency; Cutoff value was ≤20 µg/dL for vitamin A.

Statistical Analysis

Statistical Software for Social Sciences (SPSS version 20.0 for Windows 2003) was used to calculate percentage distributions dietary intakes. Chi square (X^2) test was used to compare between genders. Associations between nutrients intakes and status data were determined by Spearman's correlation. Variations among energy intakes, vitamin A, and age were ascertained by analysis of variance (ANOVA) using Instat.exe statistical software.

RESULTS AND DISCUSSION

The measurement of dietary intake in children and adolescents is an integral component for monitoring the nutritional status of these age groups and for conducting epidemiologic and clinical research on the links between diet and health [21, 22]. Finding from the present study revealed the overall energy intake (EI) to be higher ($p<0.05$) among male (2014.4±194.6kcal) than their female (1441.1±169.3kcal) counterparts. Intakes of vitamin A represent only 14% of the total energy intakes in females and 15% in male respectively.

Data for dietary vitamin A intakes among male and female adolescents were not abounding in Nigerian [23]. Of four represented Nigerian data on vitamin A for both genders combined [24,25], the overall vitamin A mean intakes were observed in south-west female study participants (860.0 µg/kg) and urban participants had higher intakes (950.8 µg/kg) than their rural counterparts (815.0 µg/kg) [26]. In general, there was no study to indicate whether vitamin A intake increased with age among Nigerian adolescents [23]. Also, there was no evidence for any geographical trend in VAD [23].

Mean vitamin A concentration from the present study (female: 15.55±6.14µg/dL and male: 15.74±6.33µg/dL) indicated a moderate deficiency among our study population. People with serum retinol concentrations of less than 20µg/dL are considered vitamin A deficient, and those with serum concentrations of less than 10µg/dL are considered severely deficient [11]. [27] recommends using the prevalence of serum retinol concentrations of less than or equal to 20µg/dL to define public health problems involving vitamin A deficiency as mild (2-9%), moderate (10-19%) or severe (≥20%). Data on vitamin status among Nigerian adolescents were not widely reported [23]. [28] also reported low serum vitamin A concentration in both male and female university undergraduate students from south-west Nigeria.

Table 1: Average Energy intake for female adolescent

Nutrient content	Analysed value (mg)	Recommended value/day (mg)	Fulfillment (%)
Energy	1441.1±169.3***	2036.3***	71
Water	501.7±72.5**	2450.0**	20
Protein	36.0±9.6**(10%)	60.1**(12 %)	60
Fat	6.0±2.9**(4%)	69.1**(< 30 %)	9
Carbohydr.	305.4±11.2**(86%)	290.7**(> 55 %)	105
Dietary fiber	18.9±2.4**	30.0**	63
Alcohol	0.0**	-	-
PUFA	1.8±0.6**	10.0**	18
Cholesterol	6.3±1.7	-	-
Vit. A	158.9±29.6*	1100.0*	14
Carotene	0.8±0.2	-	-
Vit. E (eq.)	2.2±0.8	14.0	16
Vit. B1	0.4±0.1	1.4	32
Vit. B2	0.2±0.1	1.6	16
Vit. B6	0.5±0.1	1.4	39
Tot. fol.acid	50.7±6.8*	400.0*	13
Vit. C	2.3±0.2	100.0	2
Sodium	1644.1±27.3	2000.0	82
Potassium	475.1±32.7	2000.0	24
Calcium	71.6±5.8	1200.0	6
Magnesium	93.4±36.9	310.0	30
Phosphorus	328.3±23.6	1250.0	26
Iron	6.1±1.7	12.0	51
Zinc	2.8±0.8	9.5	30

*Unit in µg; **g; ***kcal

Table 2: Energy intake for male adolescent

Nutrient content	Analysed value (mg)	Recommended value/day (mg)	Percentage (%) fulfillment
Energy	2014.4±194.6***	2036.3***	99
Water	736.3±11.8**	2800.0**	26
Protein	48.3±9.**(10%)	60.1**(12 %)	80
Fat	24.5±7.3**(11%)	69.1**(< 30 %)	35
Carbohydrate	393.7±26.1**(79%)	290.7**(> 55 %)	135
Dietary fiber	23.5±8.2**	30.0**	78
Alcohol	0.0**	-	-
PUFA	10.8±2.8**	10.0**	108
Cholesterol	0.3±0.1	-	-
Vit. A	132.4±23.1*	900.0*	15
Carotene	0.8±0.2	-	-
Vit. E (eq.)	11.2±2.9	12.0	94
Vit. B1	0.9±0.2	1.0	88
Vit. B2	0.2±0.1	1.2	18
Vit. B6	1.0±0.2	1.2	81
Tot. fol.acid	70.3±21.5*	400.0*	18
Vit. C	15.9±4.3	100.0	16
Sodium	25.8±11.7	2000.0	1
Potassium	651.1±27.3	3500.0	19
Calcium	122.1±31.6	1200.0	10
Magnesium	152.6±12.7	350.0	44
Phosphorus	481.1±45.2	1250.0	38
Iron	9.3±2.5	15.0	62
Zinc	5.1±1.9	7.0	72

*Unit in µg; **g; ***kcal

Table 3: Vitamins concentrations by age among female adolescents in Kano

Age (years)	Vitamin A (female) (µg/dL)	Vitamin A (male) (µg/dL)
12	11.57±5.15[a]	16.50±5.74[a]
13	15.60±4.71[b]	15.17±8.44[b]
14	14.93±7.06[c]	15.68±5.87[c]
15	15.44±6.30[d]	15.85±5.20[d]
16	17.23±5.39[e]	15.63±6.82[e]
17	15.00±6.69[f]	16.02±6.05[f]
18	15.70±4.33[g]	14.59±8.03[g]
19	13.48±8.76[h]	17.20±7.92[h]
Mean	15.55±6.14	15.74±6.33

[a-h]Values are mean±SD, values with same superscripts within the same column are considered not significant ($p>0.05$).

Findings from this study did not clearly indicate increase of vitamin A with age among both sexes. In British children, β-carotene levels increased with age in both sexes [29]. [30] hypothesize that iron and vitamin A requirements are increased for growth in adolescence and that deficiencies may be a consequence of growth on marginal diets among adolescent girls. The relationship of serum retinol binding protein and retinol with puberty level suggests an important role of vitamin A in sexual maturation [31]. Though this present study did not clearly show the influence of age on vitamin A status; [32] observed the risk of vitamin A deficiency tends to decline with age, which often extends in adolescence and early adulthood, especially among women [33].

The adverse effects of VAD are heightened in developing countries, where abject poverty often prevents people from eating and growing more nutritious food [1]. In such areas, the development and dissemination of highly nutritional, fortified crop varieties has lagged behind that of more developed countries [34]. Therefore, Strategies to control vitamin A deficiency include dietary diversification, food fortification, and vitamin A supplementation [35]. Other dietary sources of provitamin A include vegetables such as carrot, pumpkin, papaya and red palm oil; animal foods rich in preformed vitamin A include dairy products (whole milk, yogurt, cheese), liver, fish oils and human milk [36,37].

CONCLUSION

Moderate VAD is evident among adolescents (irrespective of age) in our study. This deficiency (if not arrested) progresses into the adulthood and will ultimately affect negatively all facets of development in the community. Therefore, there is urgent need for public enlightenment and provision of supplements to avert the scourge of VAD.

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