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Vitamin A Status of Pregnant Women in Calabar Metropolis, Nigeria

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Abstract: The vitamin A status of 101 pregnant women attending clinic at the University of Calabar Teaching Hospital (UCTH), Calabar, Nigeria was assessed based on 24 h dietary recall, serum retinol concentration, history of night blindness, physical appearance and clinical eye signs. The study revealed that the mean dietary vitamin A intake of the respondents (2645.31±188.91 μg RE) and their mean serum retinol concentration (31.18±2.94 μg dL^{-1}) were significantly ($p<0.05$) higher than the FAO/WHO recommended intake and cutoff level for VAD. No case of night blindness, physical signs and symptoms, or clinical eye signs attributable to VAD was observed. There was a significant ($p<0.01$) correlation between the amount of 24 h vitamin A intake of the women and their serum retinol concentration ($r = 0.31$). Also, women who had above 50% of their vitamin A intake from provitamin A sources had a significantly ($p<0.05$) lower serum retinol concentration (23.10±21.12 μg dL^{-1}) than those who had above 50% intake from preformed sources (49.54±42.63 μg dL^{-1}) and those with about equal intake from both sources (55.75±30.80 μg dL^{-1}). There was a significant ($p<0.05$) and steady decline in serum retinol concentration in the women from the first trimester (37.79±6.65 μg dL^{-1}), through the second trimester (35.12±4.72 μg dL^{-1}), to the third trimester (21.54±1.46 μg dL^{-1}) of pregnancy.

Key words: Vitamin A, pregnancy, vitamin A intake, serum vitamin A, night blindness, Calabar metropolis

INTRODUCTION

Vitamin A is required in the body for a number of biological roles including vision, growth and reproduction. A satisfactory vitamin A status allows all the physiological functions of vitamin A to be adequately expressed and a reserve of the vitamin that would protect from deficiency within a given period (WHO/FAO, 2004). In vitamin A deficiency (VAD), which often results from a habitual dietary inadequacy, a number of functional disorders are observed (Newman, 1994). Deficiency in vitamin A has been recognized as a major health risk during infancy, pregnancy and lactation (McGuire and Galloway, 1994).

According to a number of studies (Rahmathullah *et al*., 1990; Sommer, 1993), VAD is the single most important cause of preventable childhood blindness in developing countries and contributes significantly to morbidity and mortality from common childhood infections. Nigeria has one of the highest maternal and child mortality rates in the world and VAD has been identified as a major contributory factor (UNICEF, 1996). VAD has also been implicated in iron deficiency anaemia especially in pregnant women (Semba *et al*., 1992) and therefore has been recognized as a major public health problem (OMNI, 1993; WHO, 1995; Ajaiyeoba *et al*., 1996; Maziya-Dixon *et al*., 2006). VAD has been reported in Nigerian mothers and children with serious clinical signs such as xerophthalmia manifesting in the four geographical zones (UNICEF, 1993; Ezepue, 1995).

It is quite obvious that the eradication of VAD is imperative in Nigeria. To help achieve this goal, efforts have been made to determine the magnitude of the problem among the at risk population groups. The pregnant mothers and children appear to be the bulk of this at risk group as evidenced by reports that night blindness resulting from VAD is commonly reported in pregnant women and in lactating mothers (Gopalan and Jayarao, 1972; WHO, 1997). Longitudinal studies have also shown an association between VAD and increased risk of mother-to-child transmission of HIV (Semba *et al*., 1994). Thus, deficiency of vitamin A in children is due to a precipitating deficiency in their mothers. Therefore, alleviation of VAD must first be targeted at eliminating it in pregnant women.

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A survey of available literature on the studies of VAD in Nigeria indicates that they are mostly national prevalence studies lacking detailed information on actual levels of serum retinol in relation to dietary vitamin A intake in pregnant women. It is therefore possible that those who are clinically normal may have latent VAD, which may affect the foetus. This study was therefore designed to determine whether VAD exists among the clinically normal pregnant women at different trimesters of pregnancy attending clinic at the University of Calabar Teaching Hospital (UCTH), Calabar.

MATERIALS AND METHODS

Study area: The study took place in Calabar metropolis. To the north of the study area is the Odukpani Local Government Area (LGA); to the west is the Calabar River; to the near east stretches the Akpabuyo LGA and to the south is the Calabar South LGA. Four important streams dominate the landscape of Calabar and its neighbourhood: the Cross River on the west and south, the Calabar River on whose left bank the city stands, the Great Qua River and the Akpayafe in the east. The study was conducted between the months of May and June 2006.

The two major seasons characteristic of Nigeria also apply in Calabar metropolis-the wet (rainy) season and the dry season. The wet season generally begins in March and ends in October. The annual rainfall varies from about 60 inches in the north to 150 inches on the coast. Temperatures are fairly constant throughout the year, varying according to season between 94 and 71°F (Offiong, 1987). According to history (Jeffreys, 1935), the Quas were the original inhabitants of Calabar before the arrival of other ethnic groups. Today, Calabar metropolis is a cosmopolitan city embracing virtually all the ethnic groups in Nigeria and therefore presents a good case study.

The indigenes are fish farmers, traders and are also involved in wild games. The riverain communities are reputed for seafoods such as fish, prawns and bivalves. Food crops include yam, cassava, cocoyam, plantain and maize while economic crops include oil palm trees, rubber and Cocoa and kola. Vegetables cultivated and consumed in Calabar include fluted pumpkin, waterleaf, okro, afang, atama, editan, inyang-afia and bitterleaf. They are mainly included in soups or sauces, which are used in consumption of main meals that in majority of households are cassava-based.

Subjects and sampling: The study group comprised of women at different stages of pregnancy, attending antenatal clinic at the Department of Obstetrics and Gynaecology in the University of Calabar Teaching Hospital (UCTH), Calabar. UCTH, being a tertiary referral centre, draws its patients from various socioeconomic groups and from urban, semi-urban and rural areas in its catchment area, which includes all the towns that make up the Calabar metropolis. Women attending this clinic are, therefore, of mixed background.

Pregnant women with no evidence of febrile illness, history or clinical evidence of renal or hepatic disorders and women who are known not to be suffering from sickle cell disease or malignancies were recruited into the study. Women on prolonged therapy with anticonvulsants, corticosteroids and anti-tuberculosis drugs; those who recovered from a febrile illness less than 2 weeks, women with clinical evidence of protein-energy malnutrition, as well as women who had previously been included in a vitamin A supplementation programme, were excluded from the study. Informed consent was obtained from the women and the study took place for eight clinic days between the month of May and June. Of the 143 subjects interviewed, only 101 agreed to bloodletting even after an initial expression of interest to participate in the study.

Dietary method: The consented subjects were interviewed by selected hospital staff who had previously been trained for the purpose of the study. Nutrition information was obtained using the 24 h dietary recall.

Clinical investigation: The subjects were examined for signs and symptoms of VAD. A physician carried out general body examination while ophthalmologists sought history of night blindness and also conducted visual acuity test with and without glasses followed by an eye examination. The findings were graded according to the WHO standard.

Biochemical analysis: About 5 mL of fasting blood sample was drawn from the ante-cubital vein of each subject by a laboratory scientist, immediately placed in a plain 10 mL bottle, screw-capped tightly, protected from light and left at room temperature for about two hours to allow for clotting. Each sample was then centrifuged and the serum placed in a 5 mL test tube and immediately frozen at -20°C until analyzed. HPLC analysis of retinol in the serum samples was by Thurnham *et al*. (1988).

Statistical analysis: The data obtained in this study was subjected to statistical analyses using the Students' t-test, one-way analysis of variance (ANOVA) and correlation in SPSS statistical package. Statistical significance was accepted at 5% probability level or less.

RESULTS

The overall mean±SEM vitamin A intake of 2645.31±188.9 µg RE was reported among the women. Comparatively, this intake was higher than the FAO/WHO recommended intake for pregnant women (600 µg RE/day) (Table 1). The difference was statistically significant ($t = 0.83$, $p<0.05$). Also, the mean±SEM serum vitamin A concentration of the women (31.18±2.94 µg dL^{-1}) was significantly higher ($p<0.05$) than the WHO cutoff for both low (20 µg dL^{-1}; $t = 3.80$) and deficient (<10 µg dL^{-1}; $t = 7.21$) vitamin A levels.

The mean±SEM serum retinol was 37.79±6.65 µg dL^{-1} for women in the first trimester (1-3 months gestation), 35.12±4.72 µg dL^{-1} for those in the second trimester (4-6 months gestation) and 21.54±1.46 µg dL^{-1} for women in the third trimester (6-9 months gestation). The results showed that gestational age had a significant ($p<0.05$) influence on the serum vitamin A levels of the pregnant women studied ($F = 3.32$). Additionally, serum vitamin A levels in sixteen (15.8%) of the women fall within the range considered as deficient (<10 µg dL^{-1}) while 33 (32.7%) are within the range considered to be low (10-19 µg dL^{-1}). It is worth noting that 36 (35.6%) of the subjects had serum vitamin A levels considered as adequate (20-49 µg dL^{-1}) while sixteen (15.8%) had serum vitamin A levels considered to be in the high range (≥50 µg dL^{-1}) (Table 2).

Women whose dietary vitamin A intake was predominantly from pro vitamin A sources (N = 73) had a significantly ($p<0.05$) lower mean serum retinol concentration (23.10±2.47 µg dL^{-1}) than those whose vitamin A intake was predominantly from preformed vitamin A sources (49.56±10.65 µg dL^{-1}; N = 16), while those women whose vitamin A intake came equally from both sources (N = 12) had the highest mean serum vitamin A concentration (55.75±8.89 µg dL^{-1}) (Table 3). There was a significant ($p<0.01$) association ($r = 0.31$) between the amounts of 24 h dietary vitamin A intake of the women and their serum retinol levels (Table 4).

Table 1: Comparison of dietary vitamin A intake and serum vitamin A (retinol) concentration of the women to FAO/WHO requirement and cutoff levels

Variable	Mean±SEM
Vitamin A intake (µg RE day $^{-1}$)	2645.31±188.91*
Recommended intake (µg RE day^{-1})	600.00±0.0000
Vitamin A concentration (µg dL^{-1})	31.18±2.9400**
WHO cutoff, low (µg dL^{-1})	20.00±0.0000
WHO cutoff, deficient (µg dL^{-1})	10.00±0.0000

*Significantly different from RDI ($p<0.05$);
**Significantly different from WHO cutoff levels ($p<0.05$)

DISCUSSION

Dietary vitamin A intake and serum vitamin A (retinol) concentration of pregnant women were assessed with a view to determine whether VAD exists in this at risk group. The mean±SEM dietary vitamin A intake compared well with levels obtained in some population groups of pregnant women (Ortega *et al*., 1994, 1997) but was higher than those reported by Tyler *et al*. (1991), Borrud *et al*. (1993), Ash (1995) and van den Berg *et al*. (1996). This geographical location-dependent observation is not surprising. Interestingly, the mean intake observed in this study is much lower than that observed in groups of pregnant women who were reported to consume liver or its products within the period of the survey (van den Berg, 1996). These variations offer support to the proposition that some animal products are very high in vitamin A content and may be good sources of the vitamin for intervention programmes in VAD endemic areas. The result obtained in this investigation seems to suggest an adequacy of vitamin A intake in the population under study since the mean dietary vitamin A intake is higher than the intake recommended by FAO/WHO, United States RDA, Dutch RDA and the Indian Council of Medical Research (ICMR).

The mean serum levels of the vitamin recorded for the three trimesters were lower than those observed for pregnant women in Western countries (Howells *et al*., 1986; Basu *et al*., 1994; Ackurt *et al*., 1995) and in some developing nations such as Taiwan (Chen *et al*., 1996). The values were however higher than those reported by Venkatachalam *et al*. (1962) for pregnant women in poor communities of India. Also observed was a progressive lowering of serum vitamin A concentration with advancing gestation. This interesting observation had earlier been made by Venkatachalam *et al*. (1962). Similarly, Howells *et al*. (1986) reported this observation in Asian and non-Asian pregnant women

Table 2: Influence of gestational age on serum vitamin A (retinol) concentration of respondents

Gestational age	Serum retinol conc. (Mean±SEM)	Frequency distribution of serum retinol (µg dL^{-1}) A(<10)	B(10-19)	C(20-49)	D(≥50)	Total
1-3 months	37.79±6.65^{a}	11	13	3	12	39
4-6 months	35.12±4.72^{a}	2	7	12	4	25
7-9 months	21.54±1.46^{b}	3	13	21	0	37
Total	31.18±2.94	16(15.8)	33(32.7)	36(35.6)	16(15.8)	101(100)

Values with different superscripts are significantly different ($p<0.05$); $F = 3.32$; Values in parentheses are percentages

Table 3: Influence of major 24 h dietary sources of vitamin A on serum vitamin A levels of respondents

Dietary sources	N	Mean	SEM
Over 50% from provitamin A sources	73	23.10	2.470
Over 50% from preformed vitamin A sources	16	49.56	10.650
50% from provitamin A, 50% from preformed sources	12	55.75	8.890
Total	101	31.18	2.940

$p<0.05$; $F = 1.59$

Table 4: Correlation between 24 h dietary vitamin A intake of respondents and serum vitamin A concentration

Variable	ΣX ΣY	ΣX^2 ΣY^2	ΣXY	r
X (Serum vitamin A μg dL^{-1})	3149	185413	6571394	0.31*
Y (Vitamin A intake)	267176	1.1E+09		

*Value is statistically significant ($p<0.01$)

living in South London. A hospital-based study on pregnant women in Ibadan, Nigeria (Adeyefa, 1991) also made similar findings. However, the pattern of changes in serum vitamin A concentration observed in the present study was different from that reported by McGamity *et al.* (1969), Gal and Parkinson (1972), Sunalini-Basu and Arulanantham (1973) and by Panth *et al.* (1990) who noticed a general decline in early gestation, a mid-gestation increase and a tendency to decline towards term.

Lewis *et al.* (1947) had attributed this pattern of fall in serum vitamin A concentration with the progress of gestation to poor nutritional status of pregnant women. In the present study, there was significant association ($p<0.05$) between the amounts and major sources of dietary vitamin A intake and serum vitamin A concentration (Table 3, 4). However, the serum vitamin A observed in this study and the fall in its concentration towards the third trimester may not be attributed to low intake of the vitamin since the women in this study recorded very high intakes of dietary vitamin A. It is however possible that the utilization of vitamin A in the women might have been compromised by bioavailability factors. Firstly, the major form of vitamin A available to the women was provitamin A from vegetable sources. Animal products did not make any significant contribution to the vitamin A intake of the women since only 16 (15.84%) of the women had over 50% of their vitamin A intake from animal sources (Table 4). Studies by Erdman (1988) showed that the utilization of both retinol and carotenoids is improved with increased protein intake. Thus, the low intake of animal foods culminating in low protein intake may have reduced the utilization of provitamin A carotenoids from vegetable sources consumed by these women, hence the low serum levels of vitamin A. This, coupled with usual pregnancy-induced changes including haemodilution, increased urinary excretion and foetal utilization of vitamin A, as well as a change in the equilibrium between the liver and blood vitamin A, may have resulted in the progressive lowering of vitamin A levels as pregnancy advanced.

The fact that the mean serum vitamin A concentrations recorded in this study were higher than that reported for women in some developing countries could be due to the study design. The women in the present study were in apparent good health. Pregnant women who had conditions known to be associated with low serum vitamin A levels such as febrile illnesses and infection or those who recovered from such conditions less than two weeks to the time of the survey, were excluded from the study. Women suffering from chronic illnesses including tuberculosis, sickle cell anaemia, malignancies, renal and hepatic disorders, were also excluded since these diseases are known to alter serum vitamin A levels (Smith and Goodman, 1971). Similarly, women on prolonged drug therapy, such as anticonvulsants, were excluded as these drugs could increase the mobilization or degradation of vitamin A, thereby altering its serum levels (Leo *et al.*, 1984).

Sixteen of the women in this study had serum vitamin A levels in the chronically deficient range (<10 μg dL^{-1}) while 33 were in the low range (10-19 μg dL^{-1}). The WHO biochemical criteria for the diagnosis of VAD of public health significance is that 5% or more of the at risk population should have serum vitamin A levels below 10 μg dL^{-1} (WHO, 1982). Also, the Pan American Health Organization considers VAD a public health problem if 15% or more of a population has serum vitamin A levels below 20 μg dL^{-1} (Bendich and Langseth, 1989). In this study, 15.8% of the women had serum levels <10 μg dL^{-1} while 32.7% had levels <20 μg dL^{-1}. Although these criteria are meant for community-based studies, our study population was highly selected, but these criteria have been applied for the purpose of determining the magnitude of VAD in this study population. It is noteworthy that the population studied here met the two criteria stated above and hence the conclusion that VAD was a major health problem among healthy pregnant women attending the University of Calabar Teaching Hospital. While the few data available on the vitamin A status of pregnant women in industrialized countries do not suggest that VAD is a public health problem (Butte and Calloway, 1982; Duitsman *et al.*, 1993; Underwood, 1994), studies in some developing countries have reported findings such as those observed in this study (Kusin *et al.*, 1980; Suharno *et al.*, 1992).

On clinical examination of the study population, none of the women had signs of xerophthalmia even though almost half (48.5%) of them had serum vitamin A levels below 20 μg dL^{-1}. It is reported that VAD is often not evident from observable signs in the mother while the rapidly developing foetus may be more vulnerable to subclinical deficiency (Underwood, 1994). Moreso, the development of xerophthalmia is suspected to be more closely related to the levels of liver stores of vitamin A than with serum vitamin A levels (WHO/FAO, 2004). When the liver store is not critically low, xerophthalmia may be absent even though serum level is low. However, according to Gadomski *et al*. (1989), biochemical changes precede clinical changes. Experiments with conjunctival impression cytology have also confirmed that subclinical conjunctival changes occur well before clinical xerophthalmia is observed (Wittpenn *et al*., 1986; Reddy *et al*., 1989). According to WHO (1995), clinical eye signs are rare events and usually require large representative samples to establish significance. Even though the sample size is too small for valid inference to be drawn concerning the prevalence rate of xerophthalmia in this study, the biochemical analysis supports the inference that VAD is a major health problem in the population under study.

We conclude that clinically normal pregnant women examined, on the average had serum vitamin A levels above FAO/WHO cutoff. A significant number of the women go through pregnancy with poor vitamin A status even though clinical manifestation of VAD may not be apparent. The study also reveals that serum retinol levels declined with age of pregnancy.

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