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Relationship between vitamin A status and anaemia among school age children in Benin

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Abstract *Background:* Anaemia and vitamin A deficiency are two major public health problems affecting many developing countries world-wide. Vitamin A deficiency, in addition to other health problems, can contribute to anaemia. Therefore, the objective of this study is to determine the relationship between vitamin A status and anaemia among school age children in Benin City.

Methods: This is a cross-sectional study carried out between June 2005 and February 2006 on one hundred and fifty-two children within the age range of 6 and 12 years, randomly selected from primary schools in a Local Government Area of Edo State. Plasma vitamin A was assessed by Bessey's Spectrophotometric method, while the Haemoglobin concentration was assessed using the photometric principle of analysis.

Results: The mean plasma vitamin A level was $27.7 \pm 12.4 \mu\text{g/dl}$, with a range of 10 - $64 \mu\text{g/dl}$. The

prevalence of vitamin A deficiency (plasma retinol $<20 \mu\text{g/dl}$) was 29.6%. There was no subject with severe vitamin A deficiency (plasma retinol $<10 \mu\text{g/dl}$). The mean haemoglobin concentration was $10.5 \pm 1.1 \text{g/dl}$, with a range of 7.3 - 13.4g/dl . The prevalence of anaemia (haemoglobin concentration $<11 \text{g/dl}$) was 58.6%. There was no statistically significant correlation between vitamin A deficiency and anaemia, although the haemoglobin levels tended to increase with increased vitamin A status.

Conclusion: This study shows high prevalence rates of vitamin A deficiency and anaemia in this part of Nigeria. There was a trend of increasing haemoglobin levels with higher vitamin A status which however, was not statistically correlated.

Key Words: vitamin A deficiency, Anaemia, school age children.

Introduction

Vitamin A deficiency and anaemia are major health problems affecting young children in many developing countries world-wide. Vitamin A deficiency is the single most important cause of childhood blindness in developing countries¹. It also contributes significantly, even at sub-clinical levels, to morbidity and mortality from common childhood infections¹. An estimated 78 - 253 million preschool age children are suffering from vitamin A deficiency globally.¹ The prevalence of subclinical vitamin A deficiency (serum retinol value below $0.7 \mu\text{mol/L}$ or $20 \mu\text{g/dl}$) among pre-school children world-wide ranges from 9.8%–35.6%.² Higher prevalence rate of 63%³ has been reported in pre-school age children in Western Nigeria. In school age children a prevalence rate of 20%, and 46.3% was reported in Bangladesh and North West Mexico^{4,5} respectively.

Vitamin A deficiency results from inadequate dietary intake, increased utilization during rapid growth, increased losses and inefficient utilization during infections such as diarrhoea, malaria, urinary tract infection, measles and helminthic infestations.⁶ The consequences of vitamin A deficiency are enormous, ranging from reduced body immunity, anaemia, growth impairment, reduced fertility to xerophthalmia which may lead to blindness.⁷ The prevalence of anaemia (which is defined as a reduction in the haemoglobin concentration below 11g/dl)⁸ in developing countries is about 42% among pre-school and 53% in school aged children.⁹ In Nigeria the overall prevalence of anaemia was 29.4% as reported in the 1993 FMOH/UNICEF study with the highest prevalence occurring in the South-east (49.6%) and the lowest in the North-east region (11.1%).⁸ Causes of anaemia in developing countries include iron deficiency, malaria, hookworm infestation, and other nutritional deficiencies that influence haemoglobin metabolism

including vitamin A.⁹ Nutritional iron deficiency and vitamin A deficiency are the two most prevalent nutritional deficiencies in developing countries.¹⁰ Anaemia is a major contributor to infant and under-five mortality in Nigeria, and may lead to irreversibly impaired mental development and cognitive function during the critical years of development.¹¹ Vitamin A deficiency is postulated to cause anaemia through three mechanisms:⁹ modulation of erythropoiesis, reduction of the body's immunity to infectious diseases thus leading to anaemia of infection and modulation of iron metabolism.

Various studies worldwide have reported a close association between vitamin A status and anaemia. A high correlation between haemoglobin concentration and plasma/serum retinol concentration was found among school aged children in Bangladesh.⁴ Various studies have been carried out on vitamin A in Nigeria, some of which have reported on the prevalence rate of vitamin A deficiency^{3,8}, and vitamin A levels in children under the age of five years.¹² These studies however, did not include school age children in which vitamin A deficiency have been reported in studies outside Nigeria.^{4,5} An unpublished study carried out in Benin-city by Otobo showed a high correlation between vitamin A deficiency and anaemia. The study was however a hospital-based study among pre-school age children with malaria. This study is therefore aimed at examining the relationship, if any, between vitamin A status and anaemia at the community level in public primary school children in Egor Local Government Area of Edo State.

Materials and methods

This study was undertaken in public primary schools in Egor Local Government Area of Edo State. The public schools were chosen for this study because of their larger population size. Ten schools, which amounted to thirty percent of the total of 33 public schools in the Local Government Area, were randomly selected for the study. A total of 152 subjects were selected by multi-stage sampling from the ten public primary schools.

After obtaining ethical clearance from the Ethical committee of the University of Benin Teaching Hospital, Benin, a consent form and self administered questionnaire were given to each subject to be completed by their Parent/Guardian. Mebendazole tablet, an anti-helminthic, was administered orally, three weeks before sample collection to each subject at a dose of 100mg twice daily for three days. This was aimed at deworming the children, thereby eliminating any possible transient drop in serum retinol level that is known to occur with helminthic infestations.¹¹ The subjects were examined for presence of palor, jaundice, bossing of the skull, splenomegaly and hepatomegaly which might be indicative of sickle cell anaemia. Their eyes were examined for features of xerophthalmia such as bitot spots and corneal ulceration which are signs of vitamin A

deficiency. Their weights and heights were taken to assess their nutritional status.

Seven milliliters (7mls) of blood was withdrawn from a peripheral vein. The blood was emptied into two EDTA bottles – five millilitres (5mls) into the container for plasma vitamin A estimation which was wrapped with aluminium foil, and two millilitres (2mls) into the container for haemoglobin estimation. The sample bottle for vitamin A estimation was placed in ice pack for onward transfer to the laboratory where the plasma was separated by centrifuging. The analysis of plasma vitamin A was by Bessey's method of ultraviolet destruction of retinol, and was carried out in the Edo State Waste Management Laboratory in Benin City. The haemoglobin concentration was estimated by the photometric principle of analysis using the Swelab's AutoCounter.

Inclusion Criteria: Primary school children between the ages of 6 and 12years in the selected schools.

Exclusion Criteria:

1. Children with a history of fever or diarrhoea in the preceding four weeks to the time of recruitment.
2. Children with measles or history of measles in the preceding six weeks.
3. Children with sickle cell anaemia and those with overt malnutrition

Results

A total of one hundred and fifty-two subjects, comprising eighty females (52.6%) and seventy-two males (47.4%), ultimately participated in the study. The ages of the subjects ranged from 6 – 12 years with a mean age (\pm SD) of 9.36 ± 1.78 years. The mean age of the male subjects was $9.23 (\pm 1.92)$ years while that of the females was $9.44 (\pm 1.65)$ years. There was no statistically significant difference in the mean age between both sexes ($t = 0.7251, p = 0.4695$). The plasma vitamin A level of all the subjects ranged from 10 - $64\mu\text{g/dl}$ with a mean level of $27.7 (\pm 12.4) \mu\text{g/dl}$. The mean plasma vitamin A level of the female subjects ($28.7 \pm 13.6\mu\text{g/dl}$) was higher than that of the male subjects ($26.6 \pm 11.0\mu\text{g/dl}$) as shown in Table 1, although the difference was not statistically significant ($t = 1.526, p = 0.8597$).

Table 1: Gender distribution of vitamin A status

Sex	Vitamin A Status			Total
	Deficient	Normal	Mean ($\mu\text{g/dl} \pm \text{SD}$)	
M	22	50	26.6 ± 11	72
F	23	57	28.7 ± 13.6	80
Total	45	107	27.7 ± 12.4	152

$$t = 1.526, p = 0.8597$$

Of the 152 subjects, 45 (29.6%) consisting of 22 males and 23 females had vitamin A deficiency with plasma vitamin A level below $20\mu\text{g/dl}$. All the vitamin A

deficient subjects had mild/moderate deficiency with plasma vitamin A levels between 10µg/dl and 19µg/dl. None of the subjects had severe vitamin A deficiency (<10µg/dl). 45 subjects (29.6%) had plasma vitamin A level between 20µg/dl and 29µg/dl while 62 subjects had levels of ≥30µg/dl.

The range of the haemoglobin concentration was 7.3 to 13.4g/dl with a mean (±SD) concentration of 10.5 (± 1.1g/dl). There was no statistically significant difference in the haemoglobin concentration between males and females ($t = 1.571$, $p = 0.1198$). The prevalence of anaemia was 58.6% with 89 subjects having haemoglobin concentration less than 11g/dl. Forty-six (30.3%) had mild anaemia (Hb level between 10 – 10.9g/dl) while forty-three (28.3%) had moderate anaemia (Hb between 7 – 9.9g/dl). There was no subject with severe anaemia (Hb < 7g/dl).¹³ Fifty-five percent (55%) of the female subjects were anaemic as compared to 62.5% of the male subjects, showing no significant statistical difference.

Table 2: Relationship between vitamin A status and anaemia

Haemoglobin Status	Vitamin A Status		Total
	Normal (%)	Deficient (%)	
Anaemic	59 (66.3)	30 (33.7)	89 (100)
Non – Anaemic	48 (76.2)	15 (23.8)	63 (100)

Table 2 shows the relationship between vitamin status and anaemia. Of the anaemic subjects, 33.7% were deficient in vitamin A in contrast to 23.8% in the non-anaemic subjects. There was however no statistically significant difference in the vitamin A status of the anaemic and non- anaemic subjects ($\chi^2 = 0.1879$, $p = 0.2105$).

The mean haemoglobin concentration of the subjects in relation to their vitamin A status is shown in Table 3. The mean haemoglobin concentration was highest for the subjects with plasma vitamin A ≥30µg/dl.

Table 3: Mean Haemoglobin concentration in relation to vitamin A status

Vitamin A Status µg/dl	n	Mean Hb conc ± SD (g/dl)
< 20	45	10.32 ± 1.20
20 - 29	45	10.47 ± 1.02
≥ 30	62	10.70 ± 1.05

ANOVA $p = 0.209$

Similarly, the mean haemoglobin concentration of the subjects with vitamin A level between 20 and 29µg/dl was higher than those with vitamin A level below 20µg/dl. This difference was however, not statistically significant ($p = 0.209$). There was no statistically significant correlation between vitamin A levels and haemoglobin concentration of subjects in this study (Pearson's $r = 0.0523$, $p = 0.5220$, 95% CI = - 0.1078 - 0.2098), despite increased haemoglobin levels with improved vitamin A status.

Discussion

Vitamin A deficiency and anaemia often co-exist in some communities and are associated with high mortality rates especially in children under five years of age.¹⁴ Vitamin A deficiency and anaemia have however been reported in school age children.^{4,5}

The mean (± SD) plasma vitamin A level of 27.7 (± 12.4) µg/dl in this study is similar to 31.8 (± 18.6) µg/dl reported by Ajaiyeoba¹⁵ in pre-school age children in a nation-wide study in Nigeria, and 26.8 (±7.0) reported by Persson et al⁴ in school age children in Bangladesh. This finding however differs from the report of Valencia et al⁵ with lower mean of 21.6 (± 5.2) µg/dl. This difference in the mean plasma vitamin A level is also reflected in the prevalence of vitamin A deficiency which was higher in the report of Valencia et al⁵ (46.3%) compared with 29.6% in this study. The difference between the mean plasma vitamin A level in this study and that of Valencia et al⁵ may be due to differences in the population studied. While this study was carried out in an urban setting Valencia et al⁵ studied a rural population. Other authors have reported lower vitamin A levels in rural compared with urban populations.¹⁶ The prevalence of vitamin A deficiency of 29.6% in this study, which is of public health significance,¹⁷ is similar to the 28.1% reported by Ajaiyeoba in Nigeria.¹⁵

The mean (±SD) haemoglobin concentration of 10.5 (±1.1) g/dl found in this study is similar to 10.7 (±2.1) g/dl reported by Cornet et al¹⁸ in Southern Cameroon. This is however, lower than 11.9 (±2.3) g/dl reported by Adewuyi¹⁹ in the middle belt of Nigeria. This difference might be as a result of the difference in the population studied. Adewuyi¹⁹ studied a mixture of urban and rural children comprising both pre-school and school age children in contrast to urban school age children in this study. The anaemia prevalence rate of 58.6% in this study is similar to the global prevalence rate of 53%⁹ in school age children in developing countries, reported by the United Nations.

A lower prevalence rate of anaemia 31% and 1.4% was reported by Persson et al⁴ and Valencia et al⁵ in school age children in Bangladesh and North west Mexico respectively. This difference may be attributed to the possible different aetiological factors responsible for anaemia in the population studied. The low prevalence of anaemia reported by Valencia et al⁵ was associated with a low prevalence of iron deficiency (4.4%) which was attributed to the Yaqui Indian diet (corn tortillas, pinto beans, wheat flour tortillas), which is rich in energy, protein and iron. Although the diet of the population studied by Persson et al⁴ was not evaluated in relation to anaemia, there was a comparative prevalence rate of anaemia (31%) and iron deficiency (30%). In this study the prevalence of iron deficiency was not evaluated to ascertain its possible contribution to anaemia. Other possible contributors to the high prevalence of anaemia may include helminthiasis, which was reported by Persson et al⁴ in their study. Adewuyi¹⁹ reported malaria and nutritional iron deficiency as the main contributors to

anaemia in Central Nigeria.

The trend of an increasing mean haemoglobin concentration with increasing plasma vitamin A level (when stratified into <20µg/dl, 20 - 29µg/dl and ≥30µg/dl) found in this study is similar to that reported by Persson et al⁴ in Bangladesh. This association was however, not statistically significant in this study, in contrast to the finding of Persson et al⁴ where the association between the mean haemoglobin concentration and vitamin A status was statistically significant. This difference might be due to the different method of analysis of plasma vitamin A level; spectrophotometry in this study versus High Performance Liquid Chromatography in Persson et al's⁴ study. It could also have resulted from the population studied; urban in this study versus rural in Persson et al's⁴ study. This difference could also have resulted from intrinsic factors within the population in this study as similarly reported by Mejia et al²⁰ in Central America. Mejia et al²⁰ reported a significant association between haemoglobin concentration and plasma vitamin A level in children between the ages of 5 and 8 years, but not in the age group of 1 - 4 and 9 - 12 years. Similarly,

Nabakwe et al²¹ did not find any statistically significant association between vitamin A status and haemoglobin concentration in pre- school children in Western Kenya. The use of Spectrophotometry instead of High Performance Liquid Chromatography (HPLC) is a limitation in this study, since HPLC is more sensitive and specific than Spectrophotometry.

Conclusion

This study shows that there is a high prevalence of vitamin A deficiency and anaemia amongst school age children in Egor Local Government Area of Nigeria, which is of public health significance. It therefore indicates that vitamin A deficiency and anaemia are not limited to under-fives and that programmes directed at reducing the prevalence of vitamin A deficiency and anaemia might need to also focus on this age group. There was a trend of increasing haemoglobin levels with higher vitamin A status. This was however not statistically correlated.

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