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IRON AND VITAMIN A STATUS OF BREASTFEEDING MOTHERS IN ZAMBIA
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ABSTRACT

Objective: **To determine the prevalence of vitamin A deficiency and iron deficiency anaemia in breastfeeding mothers.**
Design: **Cross sectional descriptive survey.**
Subjects: **Breastfeeding mothers bringing their children to under five clinic.**
Setting: **A shanty compound in the outskirts of Ndola city, Zambia, Central Africa.**
Main outcome measures: **Concentrations of vitamin A, iron, haemoglobin and correlation between vitamin A and iron.**
Results: **Anaemia was found in 29% while iron deficiency was present in 41% of the women studied. Iron deficiency anaemia was responsible for 22% of the anaemia cases. A positive correlation was found between serum vitamin A and haemoglobin concentrations (r=0.184) and a significant statistical relationship existed ($p<0.05$). This statistical significance was even greater when a correlation was made between haemoglobin concentrations and vitamin A concentrations below or equal to 30 μg/dl (1.05 μmol/1) (r=+0.351, $p<0.01$).**
Conclusion: **Vitamin A deficiency and iron deficiency anaemia need to be urgently addressed in this shanty compound and others like it surrounding Ndola city. Supplementing breastfeeding women with vitamin A will not only reduce vitamin A deficiency, but could also help to reduce anaemia.**

INTRODUCTION

Vitamin A deficiency and iron deficiency anaemia are the most common nutritional deficiencies in most developing countries, probably second only to protein energy malnutrition (PEM). Rapidly growing infants, children, pregnant and lactating women are especially at high-risk(1). It is estimated that about 1.3 billion people worldwide, especially in developing countries suffer from iron deficiency anaemia(2). In such countries close to 50% of the women are anaemic and approximately half of them have iron deficiency(3,4). At least 254 million children of pre-school age world-wide are vitamin A deficient with an estimated 2.8 to 3 million of them having clinical signs of the deficiency(5).

Severe iron deficiency results in anaemia, which can lead to reduced work performance(6). For this reason individuals with iron deficiency anaemia who are engaged in hard physical labour have low productivity and therefore realise low income(7). This has serious implications for women in Zambia as they are the main food producers for the family. Reduced cellular immunity(8) and lack of concentration(9,10) are also common. Vitamin A is important for cell division, differentiation and development.

Both vitamin A and iron are needed by the growing foetus in the womb and children below six years of age. Before children are able to eat solid food they depend entirely on maternal supply for these and other micronutrients. Throughout the gestation period, the foetus draws vitamin A and iron from the mother through the placenta. At birth a normal child will have a vitamin A concentration 5 μg/g of liver(11) and a total body iron averaging 75mg/kg(12) gained from the mother during the nine months gestation period. The concentration of vitamin A in normal mature milk is enough to meet the infant's daily requirements and to accumulate safe and adequate stores of vitamin A such that by six months of age the child is able to store adequate amounts in the liver. This amount is drawn from the mother's stores. Demand for vitamin A by the mother during this period is therefore quite high. Vitamin A deficiency in the mother will have a direct effect on the breastfeeding child since vitamin A content of human milk depends on the mother's own vitamin A status. Infants of well-nourished mothers can increase their vitamin A stores about twenty fold from birth to about one year of life compared to their counterparts from mothers with inadequate amount(11). Such children with low vitamin A concentrations have increased risk of higher mortality compared to children without the deficiency(13). Furthermore, diarrhoea, upper respiratory infection(14) and measles(15) are more severe in such children. The aim of the present study, therefore, was to determine the vitamin A and iron status of breastfeeding mothers.

MATERIALS AND METHODS

Study design/sample frame: This was a descriptive survey involving breastfeeding mothers ranging in age from eighteen to fifty five years. All the women came from within Nkwazi, a shanty compound located in the outskirts of Ndola, a commercial city on the copperbelt of Zambia.

Sample size: As no survey has been conducted before in breastfeeding women in Zambia, no prevalence levels exist for iron deficiency anaemia and vitamin A deficiency. A conservative prevalence value of 0.5 was therefore chosen. Using a precision of 10% at 95% confidence, a minimum sample size of 100 was calculated.

Sampling method: The breastfeeding mothers were randomly selected from the mothers bringing their children to the under five clinic at Nkwazi council clinic. Thus, after being attended to by the nursing staff every fifth mother was selected and sent to our team. The purpose of the study was explained and consent sought from the mothers before they were enrolled into the study. The study was cleared by the Tropical Diseases Research Centre (TDRC) ethical committee.

Sample collection: For the purpose of the Modified Relative Dose Response (MRDR) test, each participating mother was orally given a fixed (2.5mg) dose of 3,4-didehydroretinyl acetate (vitamin A_2) dissolved in cottonseed oil. A teaspoonful of peanut butter was then orally given to the mother to enhance absorption of the dose. They were then released to go home and requested to return five hours later. This is the time it takes for the dose to equilibrate in the body(16). After this period, blood was collected from the antecubital vein using needle and syringe for the analysis of vitamin A, vitamin A_2, iron, Total Iron Binding Capacity (TIBC) and Haemoglobin.

Serum/blood analysis: Vitamin A and vitamin A_2 were analysed by HPLC(17) and iron and TIBC by colorimetry (CTMA/CAB with acetate buffer)(18). Haemoglobin estimations were performed on a Haemoglobinometer (isoton, Zapoglobin)(19).

Cut-off points: The following cut-off points were used in our analytical methods. Anaemia was defined as HB<12g/dl (20); iron deficiency was defined as [iron]<7 μg/dl(18); iron deficiency anaemia was present if the following results were found from the analysis of a sample from the same participant: Hb<12g/dl, TIBC>69% and iron<7μg/dl(21). The MRDR is a calculated molar ratio of vitamin A_2 to vitamin A. This ratio has been found to be inversely related to the liver concentration of vitamin A at a cut-off point of 0.060(22,23). It has been found to be an indicator of vitamin A status in a number of studies(24, 25).

RESULTS

Although a total of 242 mothers were entered in the study some of the blood samples collected were not enough for the analysis of all the required parameters. Furthermore, some women absconded the bleeding session after the five-hour period. Table 1 shows a summary of the results.

Table 1

Summary of analysed parameters of blood samples from breast-feeding mothers

Parameter	Total analysed	Mean ± SD	Abnormal if	Abnormal (% of total)
Vitamin A	152	34.2 ± 9.9	≤30 μg/dl (1.05 μmol/l)	38
MRDR	151	0.069±0.044	≥0.060	56
Hb	199	12.63	<12 g/dl	29
Iron	168	10.67 ± 4.03	<7.0 μg/dl	41
Iron deficiency anaemia				22

As shown in Table 1, both the MRDR test and the vitamin A concentrations indicate that the problem of vitamin A deficiency does exist in this population of women. Anaemia was found in 29% of the 199 women studied. Iron deficiency was present in 41% of the 168 women studied and was responsible for 22% of the anaemia cases.

Figure 1

Correlation between vitamin A and haemoglobin levels

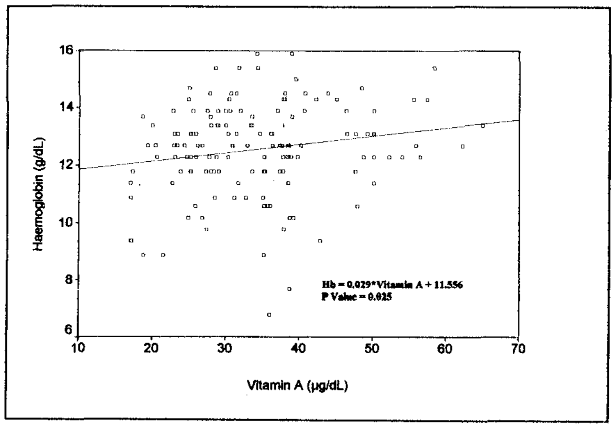
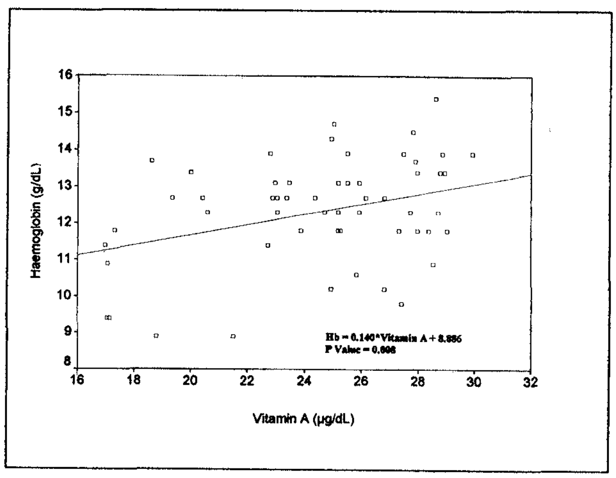


Figure 2

Correlation between vitamin A levels ≤30 μg/dl and haemoglobin levels



A positive correlation was found between serum vitamin A and haemoglobin concentrations (r=0.184, Figure 1) and a significant statistical relationship existed (p<0.05). This statistical significance was even greater when a correlation was made between haemoglobin concentrations and vitamin A concentrations below or equal to 30 μg/dl (1.05 μmol/l) (r=+0.35 1, p<0.01 Figure 2).

DISCUSSION

These results show that vitamin A deficiency and iron deficiency anaemia are common in the community studied. Both the MRDR test and vitamin A concentrations show that a problem of vitamin A deficiency exists. Thus, 56% of the women had MRDR ratios equal to or greater than 0.060 indicating inadequate vitamin A status while 38% of them had serum vitamin A levels below or equal to 30 µg/dl (1.05 µmol/l) indicating vitamin A deficiency. To the author's knowledge this is the first time that vitamin A and iron status have been determined in this category of people in Zambia and the surrounding region. Although Semba *et al*(27) determined vitamin A levels in breast-feeding Malawian mothers, these were all HIV-positive. Tanumihardjo *et al*(26), used the MRDR test in Indonesian lactating women and found 70% of them with inadequate vitamin A status.

Anaemia was found in 29% of the women studied. Iron deficiency was responsible for 22% of the anaemia cases. The only published study on anaemia in Zambian women was by Fleming(28), but this was a hospital-based study in pregnant women. Fleming found 35% of the cases with severe anaemia to be due to iron deficiency

The positive correlation between haemoglobin and vitamin A levels ($p<0.05$) suggests that there may be a metabolic relationship between the two parameters. Studies at the turn of the century(29-32) showed that vitamin A may play a catalytic role in haematopiesis. The actual reactions involved in this process are not yet fully understood but have to do with mobilisation of iron for erythropoiesis. Some epidemiological studies conducted in children in the late seventies did indicate that vitamin A deficiency and anaemia co-existed(33,34). The present study has shown that this relationship is also present in adults with vitamin A deficiency. Most recent studies have shown that supplementation with vitamin A can improve haemoglobin concentrations and other iron status parameters(35,36).

Although it is well known that infections such as malaria and gastrointestinal parasites can lower both blood vitamin A and iron concentrations, the author does not think that these infections could have affected the results in the present study for two reasons. Firstly, this study was conducted before the rain season. The incidence of both malaria and hookworm infestation are very low before this period. Secondly, both malaria and hookworm are less common in adults than children.

The author is also aware that iron levels are influenced by diurnal variations. However, the involvement of the MRDR test required that participants are bled five hours after oral administration of the vitamin A_2 dose in the morning. For this reason fasting blood samples were avoided as this was going to mean bleeding them twice, a situation that would have resulted in most of them absconding the second bleeding session. The participants were oral dosed at about eight hours in the morning within about thirty minutes depending on the number available on the day and bleeding was performed five hours later within the same thirty minutes.

In our earlier work in this same community we conducted a dietary survey, which showed that the main source of micronutrients, including iron, is vegetables, which are consumed on a daily basis. Meat and meat products are the best source of non-heme iron which is more efficiently assimilated into the intestinal lumen compared to heme iron(37). But meat and meat products are not consumed on a regular basis due to financial constraints. Furthermore, fruits, which are a source of ascorbic acid (vitamin C) essential for the efficient absorption of iron(38), are rarely consumed. Meat, meat products, milk, milk products, eggs and others which are the main sources of active vitamin A are equally beyond the reach of most people for the same reason.

Vitamin A deficiency and iron deficiency in this community therefore seem to have their roots in the social economic cycle. Most of the people in this area are semi-literate with no regular income. In our earlier study of under five children in the same compound we found that 78% of the children had inadequate vitamin A status by the MRDR test(39). A similar study showed that 55% of them had poor iron status (unpublished data). There is, therefore, need for intervention strategies to reduce vitamin A deficiency and iron deficiency anaemia in this community, especially among breastfeeding mothers and their children. Supplementation with vitamin A could assist to boost not only vitamin A, but also haemoglobin concentrations. This, however, needs further evaluation.

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