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RESEARCH ARTICLE

IMPACT OF MALARIA ON THE CONCENTRATION OF ZINC IN PREGNANT WOMEN IN NNEWI (SOUTH EAST NIGERIA)

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ABSTRACT

Malaria during pregnancy continues to be a major health problem in endemic countries, with clinical consequences including death of both mother and child and attendant derangements in trace elements. This study is aimed at evaluating the relationship between the trace element antioxidant; Zinc and malaria density in pregnant women with malaria. A total of 460 subjects were recruited for the study, comprising 160 pregnant women with malaria attending the ante natal clinic of NnamdiAzikiwe University Teaching Hospital Nnewi, Anambra, South East,Nigeria. The controls are 100 pregnant women without malaria attending the same clinic, 100 non-pregnant women with malaria and 100 non-pregnant women without malaria. The concentration of zinc was determined by atomic absorption spectrophotometry while the malaria density was determined by counting the parasites against white cells. From the results,zinc showed a significant decrease in pregnant women with malaria 7.81±4.28 µmol/L ($p < 0.05$) compared to pregnant women without malaria 8.68 ± 2.25 µmol/L, non-pregnant women with malaria 9.10 ± 3.36 µmol/L and non-pregnant women without malaria 10.48 ± 4.08 µmol/L ((F=11.01; $p < 0.05$). Zinc also showed a strong negative correlation with parasite density (r=0.41; p=0.001).

INTRODUCTION

Malaria is an important public health problem in developing countries. *Plasmodium falciparum* a pathogenic agent remains a major cause of morbidity and mortality to mother and child (Jeffrey and Pia, 2012). There are about 300 million cases of malaria each year, 9 of 10 cases occur in Africa. Women and children are most at risk (WHO, 2011). About 30 million African women are pregnant yearly, for these women; malaria is a threat both to themselves and their babies (Menendez *et al.,* 2000; WHO, 2011). In Malaria endemic areas, malaria during pregnancy may account for up to 15% of maternal anemia, 5-14% of low birth weight, 30% of preventable low birth weight (WHO, 2011). Pregnant women are particularly vulnerable to malaria as pregnancy reduces a woman's immunity to malaria infection and increases the risk of illness, severe anemia and death for the unborn child. Maternal malaria increases the risk of spontaneous abortion, still birth, premature delivery and low birth weight (WHO, 2003). Pregnancy is a period of increased metabolic demands with changes in a woman's physiology and requirements of a growing fetus (Broughton, 2007).

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Insufficient supplies of essential vitamins and micronutrients can lead to a state of biological competition between the mother and fetus which can be detrimental to the health status of both (King, 2003). Some authors have associated malaria acquisition and its severity to the concentration of micronutrients in pregnant mothers, the protection against acute infection through a moderate deficiency in iron (Nyakeriga *et al.,* 2004); the reduction of risk of fever and clinical malaria episodes through a zinc supplementation (Zeba *et al.,* 2008) and the copper associated with zinc, with the reduction of the ratio copper/zinc is an increasing factor of the oxidative stress (Mezzetti *et al.,* 1998). Deficiencies of specific antioxidant activities associated with the micronutrients iron, selenium, copper, zinc and manganese can result in poor pregnancy outcomes including fetal growth restriction (Fall *et al.,* 2003), pre eclampsia and associated risk of diseases in adulthood, including cardiovascular diseases and type 1 diabetes (Lykke *et al.,* 2009). Another consequence of oxidative stress resulting from antioxidant deficiency is the development of malaria anemia (Kremsner *et al.,* 2000). Micronutrients are known to be integral part of antioxidants and have been found to influence host cellular and humoral immunological functions (Spallhoiz *et al.,* 1990). Cell mediated immunological response to malaria is found to decrease during pregnancy (Riche *et al.,* 2000). These antioxidants have been shown to provide protection against

oxidative stress induced by malaria (Adelekan *et al.,* 1997). During pregnancy, zinc is used to assist the fetus to develop the brain and also be an aid to the mother in labor. Alteration in zinc homeostasis may have devastating effects on pregnancy outcome, including prolonged labor, fetal growth restriction, or embryonic or fetal death (Fall *et al.,* 2003). It takes part in gene expression, cellular growth and differentiation. Zinc deficiency decreases the ability of the body to respond to infection, affecting both all mediated immune responses and humoral responses (Okochi, 2005). Trace elements are known to be an integral part of the antioxidant status and have been found to influence host cellular and humoral immunological functions. These essential factors are very important in the body in order for the immune system to cope with the challenges imposed by infectious agents especially in pregnancy. This study is therefore aimed at evaluating the relationship between the trace element zinc and malaria density in pregnant women.

Aim and Objectives

The aim of the study is to determine the relationship between zinc and malaria density in pregnant women in Nnewi,South East Nigeria.

The objectives are as follows

- To determine the relationship between zinc and malaria density in pregnant women.
- To determine the concentration of zinc in pregnant women with malaria.

MATERIALS AND METHODS

This study was conducted at Nnamdi Azikiwe University Teaching Hospital, Nnewi. Ethical approval for this study was issued by the ethics committee of Nnamdi Azikiwe University Teaching Hospital, Nnewi. Four Hundred and sixty women were used for the study, out of this, One Hundred and Sixty pregnant women served as the test subjects, One Hundred pregnant women without malaria, One Hundred women without malaria, One Hundred women with malaria served as control. These women were selected using simple random sampling technique. The pregnant women among them were selected from their clinic while the non-pregnant women were apparently healthy women within Nnewi town. The scope, nature, aims and objectives of the study were explained to the participants for their consent. Women with malaria were later grouped according to parasite density (Melaine *et al.,* 2010).

Women with established medical risk factors for oxidative stress such as AIDS, diabetes, tuberculosis, smoking and alcohol consumers were excluded from the study. A volume 6ml of venous blood was collected from each of the participants, 2ml was dispensed into an EDTA container for total white cell count, a drop of blood from the syringe was placed on a clean grease free slide that has been labeled for a thick film while the remaining blood was dispensed into a plain tube. It was allowed to clot at room temperature for approximately one hour and then centrifuged at 2500 RPM for 10 minutes to separate the serum. The serum samples were analyzed for, zinc. The thick film was left to air dry before staining.

Statistical Analysis

This was done using graph pad prism version 5. The results were presented as mean ± standard deviation. The statistical methods utilized for the analysis were one way analysis of variance, students "t" test, and correlation.

RESULTS

Zinc concentration in Pregnant Women with Malaria and Control subjects (Mean±SD)

Zinc showed a mean serum level of 7.81±4.28µmol/L, 8.68±2.25µmol/L, 9.10±3.36µmol/L and 10.48±4.08µmol/L in pregnant women with malaria, pregnant women without malaria, non-pregnant women with malaria and non-pregnant women without malaria respectively. The result showed a statistically significant difference between the means ($F=11.01$; $p<0.0001$). Further analysis showed no significantly decreased level in pregnant women with malaria compared to pregnant women without malaria ($p>0.05$), significant lower level in pregnant women with malaria when compared with non-pregnant women with malaria ($p<0.05$) and also a significant lower level in pregnant women with malaria when compared to non-pregnant women without malaria ($P<0.0001$), (Table 1).

Table 1. Zinc in Pregnant Women with Malaria and Control subjects (mean ± SD)

	ZINC µmol/l
Pregnant Women With Malaria n=160	7.81 ± 4.28
Pregnant Women Without Malaria n=100	8.68 ± 2.25
Non-Pregnant Women With Malaria n=100	9.10 ± 3.36 [a]
Non Pregnant Women Without Malaria n=100	10.48± 4.08[a,b,c]
F – Value	11.01
P – Value	< 0.0001**

NB: a; $p < 0.05$ compared with pregnant women with malaria
b; $p < 0.05$ compared with pregnant women without malaria
c; $p<0.05$ compared with non-pregnant women with malaria

Zinc and Parasite Density in Pregnancy (Mean ± SD)

Parasite Density of <2000/µl, between 2000-10000/µl and >10000/µl showed zinc levels of 8.83±4.11µmol/L, 8.00±4.86µmol/L and 5.46±1.10µmol/L respectively. The result showed significant differences between the means ($F=4.127$; $p<0.05$). There is a decrease in zinc level as the malaria parasite density increases (Table 2).

Table 2. Zinc and parasite density in pregnancy (Mean ± SD)

	ZINC µmol/l
< 2000 /µl	
n= 44	8.83 ± 4.11
2000-10000 /µl	
n = 96	8.00 ± 4.86
>10000 /µl	
n= 20	5.46 ± 1.10 [a]
F-Value	4.127
P-Value	0.0179**

NB: **; significant difference between the means ($p < 0.05$)
a; $p < 0.05$ compared with parasite density < 2000 /µl

Zinc and parasite density in non-pregnancy (Mean ± SD)

Parasite Density of <2000/µl, between 2000 and 10000/µl and >10000/µl showed zinc levels of 9.15 ± 5.41µmol/L, 9.22 ± 2.98µmol/L and 8.768 ± 0.98 µmol/L respectively. Analysis of the results showed no significant difference between the means (F=0.1601; p>0.05). Malaria parasite density of >10000/µl showed the least zinc level (Table 3).

likely reflected an increase in zinc uptake by the placenta and fetus. Also there is a lower level of zinc in pregnant women with malaria compared with pregnant women without malaria. Also there is a progressive decrease of zinc as parasite density increases in pregnant and non-pregnant women. Asaolu and Igbaakin (2009) observed a significant decrease in serum level of zinc in pregnant women with malaria. According to Brown *et al.,* (1993); Shankar *et al.,* (2000), infection has been found to have effect on the plasma level of zinc.

Table 3. Zinc and parasite density in non-pregnancy (Mean ± SD)

	ZINC µmol/l
< 2000 /µl	
n= 23	9.15 ± 5.41
2000-10000	
n= 51	9.222 ± 2.99
>10000	
n= 26	8.77 ± 0.98
F- Value	0.1601
P- Value	0.8523^{ns}

NB: *Non significant (P > 0.05) differences between the means

Table 4. Zinc and Parasite Density in Pregnant and Non Pregnant Women (Mean ± SD)

	<2000/µl		2000-10000/µl		>10000/µl	
	Pregnant women	Non pregnant women	Pregnant women	Non pregnant women	Pregnant women	Non pregnant women
Zinc µmol/l	8.83 ± 4.11	9.15 ± 5.41	8.00 ± 4.86	9.22 ± 2.99	5.46 ± 1.10	8.77 ± 0.98
P-Value	0.8003^{ns}		0.0622^{ns}		<0.0001**	

NB: **; significant (P < 0.0001) difference between the means

Zinc and Parasite Density in Pregnant and Non Pregnant Women (Mean ± SD)

Pregnant women with parasite density < 2000 /µl showed zinc level of 8.825 ± 4.114 µmol/L while non-pregnant women showed 9.153 ± 5.409 µmol/L. The difference between them is not significant (p > 0.05). At parasite density level between 2000 and10000 /µl, the difference between the zinc concentration of pregnant women (8.002 ± 4.862 µmol/l) and that of non-pregnant women (9.222 ± 2.985 µmol/L), is not significant (p > 0.05). At parasite density level > 10000 /µl, pregnant women (5.462 ± 1.101µmol/L) showed a statistically significant lower level compared to non-pregnant women (8.768 ± 0.9837µmol/L), (P < 0.0001) (Table 4).

DISCUSSIONS

Zinc is indispensible in the proper maintenance of pregnancy. During pregnancy, it is used to assist the fetus to develop the brain and also be an aid to the mother in labor. Zinc deficiency decreases the ability of the body to respond to infection, affecting both cell mediated immune responses and humoral responses (Okochi, 2005). There is a statistically significant difference in zinc level in pregnant and non-pregnant women with and without malaria in the present study. In normal pregnancy, zinc concentration is shown to be lower compared with non-pregnant women (Yasoghara *et al.,* 1991). This is in line with the outcome of this work where a lower level of zinc was seen in pregnant women without malaria compared with non-pregnant women without malaria. Zimmerman *et al.,* (1993) also observed is a decrease both in the serum zinc when expressed as per unit of albumin during pregnancy. This was attributed to haemodilution due to expansion in plasma volume to the extent of 30% of the non-pregnant value. It was also suggested that the decrease in zinc per unit of albumin most

This might be due to the redistribution of zinc from plasma to lymphocytes and liver during the acute phase response. Plasma zinc has been found to vary inversely with malaria parasitemia and may preferentially protect against more severe malaria with increased levels of parasitemia (Gauado *et al.,* 2007). Zinc deficiency decreases the ability of the body to respond to infection, affecting both cell mediated immune and humoral responses (Okochi and Okpuzor, 2005).

Conclusion

From this study, it was observed that zinc level is reduced during pregnancy and also in malaria. Zinc level is further reduced with a higher increase in malaria parasite density. This implies that zinc level affects the way the body responds to infection especially malaria. Zinc is also a component of antioxidant enzyme superoxide dismutase. Pregnant women with malaria who have deficiency of this nutrient are at risk of suffering severe malaria attack which according to researchers can result to still birth, spontaneous abortion, premature delivery and low birth weight.

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Authors' contributions

Ozougwu Chukwuemeka O

- Conception and design, Acquisition of data, Analysis and interpretation of data.
- Final approval of the version to be published.

Meludu Samuel C

- Conception and design
- Final approval of the version to be published

Aniagolu Miriam O

- Drafting of the Article, Critical revision of the article
- Final approval of the version to be published.

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