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NUTRITIONAL STATUS OF GEOHELMINTH INFECTED PREGNANT WOMEN AND PRE-SCHOOL CHILDREN: THE NEED FOR MICRONUTRIENT SUPPLEMENT

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Abstract

This study investigated the nutritional status of geohelminth infected 120 preschool-aged children and 100 pregnant women (in their 3rd trimester) in Akinyele Local Government Area of Ibadan in Oyo State. Venous blood samples were obtained and analyzed for iron (Fe), zinc (Zn), selenium (Se) and vitamin A. T-test was Statistical analysis used and P<0.05 was considered as statistically significant. The result from this study confirms a total of 50 (41.67%) preschool-aged children and 15 (15%) pregnant women had geohelminth infection. Majority of the children (80.00%) had Ascaris lumbricoides infection while a few of them (20%) in summative, *had hookworm, Fasciola hepatica and Trichuris trichuria infections. Co-infection with different helminth species was also observed in the children. Serum levels of Fe, Zn and Se were significantly lower in helminth infected (HI) pregnant women compared with helminth negative (HN) pregnant women. In preschool aged children, serum levels of Fe, Zn and vitamin A were also significantly lower in HI compared with HN. Based on the findings of*

this study, it could be concluded that helminth infection alters the status of different types of micronutrients in children and pregnant women. The study therefore suggests monitored iron, zinc or vitamin A supplementation with anti-helminthic regimen.

INTRODUCTION

Nutrition is the process of acquiring energy and materials for cell metabolism, including the maintenance and repair of cells and growth (Taylor, Green and Stout, 2007). Malnutrition and infections have been reported as the common health problems in the developing countries. Although the two conditions can exist independently, they are also intricately associated (Katona and Katona-Apte, 2008). According to a report by the Food and Agriculture Organization of the United Nations (FAOUN, 2006), about 826 million people worldwide are presently undernourished. Similarly, about 2 billion people worldwide are affected by deficiency of micronutrients such as vitamins A, C, and E and essential minerals such as zinc and iron. This undernourishment has been identified as the primary cause of immunodeficiency affecting preschool-aged (1–4 years) and school-aged (5–14 years) children, adolescents, pregnant women and the elderly (Steketee, 2003), (Katona and Katona-Apte,2008).

Geohelminth or Soil-Transmitted Helminth (commonly known as intestinal worms) are one of the most common chronic infections worldwide and affect the poorest communities especially, in areas where sanitation is poor (WHO, 2014). The main species that infect people are the roundworm (*Ascaris lumbricoides*), the whipworm (*Trichuris trichiura*) and hookworms (*Necator americanus* and *Ancylostoma duodenale*) (WHO, 2015). Infection occurs by ingestion of infective eggs from soil contaminated with human feces, ingestion of raw agricultural products contaminated with soil containing infective eggs (*A. lumbricoides* and *T. trichiura*), or by penetration of larvae from the soil through skin (hookworms) (WHO, 2014). The main manifestations of Soil-Transmitted Helminth (STH) are related to malabsorption of nutrients. These clinical manifestations include the reduction of food intake capacity and blockage of the gastrointestinal and

bile tracts due to ascariasis, dysentery and rectal prolapse due to trichuriasis and iron-deficiency anemia due to hookworms. Serious helminth infection affects physical growth and cognitive development of children (WHO, 2014). It causes iron deficiency anemia leading to poor school performance and absenteeism in children. They also produce reduction in labor productivity of adults. The costs attributable to helminth infections in endemic communities and countries in terms of nutrient loss and reduced productivity are quite important. The STH are widely distributed in tropical and subtropical areas.

The 2010 Global Burden of Disease Study estimated that more than 5.2 million DisabilityAdjusted life Years (DALYs) are due to helminth infection and it affects mainly children due to their increased behavioral risk, frequent outdoor exposure, and poor personal hygiene (Belizario, Totañes, de Leon, Lumampao and Ciro, 2011). Based on this information, the World Health Organization (WHO) resolved that children at risk for morbidity from helminth infection are to be treated. (WHO,2012). In 2012, 6.4 million preschool-age children were administered anti-parasitic medicines (WHO, 2014).

WHO recommends preventive chemotherapy (PC), for preschool-aged children which is a periodic administration of anthelminthic medicines (albendazole or mebendazole) as a public health intervention, for reducing morbidity and transmission of infections from the four species of soil-transmitted helminth (STH): *Ascaris lumbricoides, Trichuris trichiura, Necator americanus* and *Ancylostoma duodenale* in areas of high risk for infection (once per year in areas of low risk –prevalence between 20 and 50%, and twice per year in areas of high risk – prevalence >50%), as well as, the promotion of access to safe water, basic sanitation and sanitary education through intersectoral coordinated work (WHO,2015).

Helminth infection is a significant burden in pregnancy (Shrinivas, Radhika, Sreelatha and Kavitha 2014). Annually, hookworm alone infects about 44 million pregnant women (Haider, Humayun and Bhutta, 2009). Reports have shown that pregnant women are more susceptible to geohelminth infections and usually suffer from protein-energy malnutrition and

deficiencies of micronutrients, such as iron and zinc. (Friedman, Mital, Kanzaria, Olds and Kurtis, 2007; Woodburn, Muhangi, Hillier, Ndibazza, Namujju and Kizza, 2009). This geohelminth-induced chronic malnutrition increases the maternal risk for future parasitic infections and adverse pregnancy outcomes such as premature delivery, low birth weight, poor growth and infant immune system down regulation (Petersen, 2007; Weatherhead and Woc-Colburn,2015).

Diverse associations have been reported between helminth infections and micronutrients deficiencies. Poor vitamins A, iron (Fe) and zinc (Zn) intakes predispose individuals to helminth infections which can also aggravate nutritional deficiencies thereby, helping helminth survival. (Koski and Scott, 2001 ; de Gier Campos, Van de Bor, Doak and Polman, 2014). Helminths impair the nutritional status in multiple ways. They feed on host tissues (including blood) thereby causing loss of iron and protein. They also increase malabsorption of nutrients and may compete for vitamin A in the intestine. Furthermore, some soil-transmitted helminths cause loss of appetite while some such as *T. trichiura* can cause diarrhoea and dysentery. (WHO, 2015).

Existing evidences suggest that addition of supplements to deworming programmes might offer some benefits especially in preschool-aged children (ages 1-4) who have narrow source of micronutrient supplementation (Rajagopal, Hotez and Bundy 2014), but these evidences are insufficient to make any clear or reliable suggestions. It is even more difficult in the developing countries (where malnutriention and geohelminth infections are common) as there are limited set of clear treatment and supplementation recommendations that focus on individual micronutrient (Steketee, 2003). Additionally, there is the dearth of information on the pattern of micronutrients deficiency in vulnerable groups such as preschool-aged children, school aged children and pregnant women who are more at risk of both malnutrition and geohelminth infection. The present study was, therefore, carried out to determine the significance of geohelminth infection on selected serum micronutrients in preschool-aged children and pregnant women.

Statement of Problem

Diverse associations have been reported between helminth infections and micronutrients deficiencies (Koski, Scott, 2001 ; de Gier Campos, Van de Bor, Doak and Polman, 2014). From this reports, it could be deduced that poor vitamins A, iron (Fe) and zinc (Zn) intakes predispose individuals to helminth infections which can also aggravate nutritional deficiencies thereby, helping helminth survival. Existing evidences suggest that addition of supplements to deworming programmes might offer some benefits especially in preschool-aged children (ages 1-4) who have narrow source of micronutrient supplementation (Rajagopal, Hotez and Bundy 2014), but these evidences are insufficient to make any clear or reliable suggestions. It is even more difficult in the developing countries (where malnutriention and geohelminth infections are common) as there are limited set of clear treatment and supplementation recommendations that focus on individual micronutrient (Steketee, 2003). More so, there is the dearth of information (in Oyo State) on the pattern of micronutrients deficiency in vulnerable groups such as preschool-aged children, school aged children and pregnant women who are more at risk of both malnutrition and geohelminth infection.

Aim of the Study

The present study was, therefore, carried out to determine the nutritional status of geohelminth infected pregnant women and pre-school children to justify the need for micronutrient supplements to deworming programmes.

Materials and Methods

Study Area/Population of the study

Selected rural area in Akinyele Local Government of Ibadan in Oyo State was used for the study involving 120 preschool-aged children and 100 pregnant women (in their 3rd trimester) who were screened for helminth infection (HI). After screening, 60 preschool-aged children and 75 helminth negative (HN) pregnant women were used as controls.

Informed Consent and Ethical Approval

After a written informed consent or assent has been obtained from each pregnant woman or the parents of preschool children, participants were enrolled into this study. Also, ethical approvals were obtained from the Oyo State Ministry of Health research ethical review committee.

Data and blood sample collection

Demographic data of participants were obtained using a short-structured questionnaire. About 5 ml of venous blood was obtained from each study participant and dispensed into plain bottles to obtain sera which were stored at -20^{0}C until analyzed.

Collection of stool specimens and examination for helminthes

A sample of fresh stool specimen was collected from each participant into a labeled leak-proof stool container (polypots) using an applicator stick. The stool specimens were examined microscopically within 12 hours of collection using the concentration technique. The magnifications of x10 and x40 were used to visualize and identify intestinal geohelminth ova respectively. The number of helminth ova was counted using Kato-Katz method (Arinola,
Oluwole, Oladokun, Adedokun, Olopade, Olopade, 2015).

Laboratory analysis

Serum levels of iron (Fe), zinc (Zn) and selenium (Se) were determined using Atomic Absorption Spectrophotometry (AAS). However, vitamin A was also determined in the serum samples of both participants, using High Performance Liquid Chromatography (HPLC) (Arinola, *et al*, 2014).

Statistical analysis

Differences in means of the variables (Helminth infected and Helminth negative) were assessed using the independent Student's t-test. All results are presented as mean ± standard deviation. *P*values less than 0.05 were considered as statistically significant.

RESULT

Table 1: Prevalence and types of helminth infection among pregnant women and children with helminth infection

	AL	*HW*	*TT*	*FH*	*AL + HW*	*AL +TT*	*AL + HW + TT*
Preschool-aged children	40	5	1	2	1	1	
Percentage	80.00%	10.00%	0.00%	4.00%			0
					2.00%	2.00%	
Pregnant Women	15	0	0	0			0.00%
Percentage	15%	0.00%	0.00%		0	0	
				0.00%			
					0.00%	0.00%	0
							0.00%

AL=Ascaris lumbricoides, HW=Hookworm, FH=Fasciola hepatica TT=Trichuris trichuria

Table 1 shows the distribution of geohelminths among the study groups. The result from this study confirms a total of 50 (41.67%) preschool-aged children and 15(15%) pregnant women had geohelminth infection. Majority of the children (80.00%) had *Ascaris lumbricoides* infection while a few (10%) of them had hookworm, *Fasciola hepatica* (4%) and *Trichuris trichuria* infections.

Co-infection with different helminth species was also observed in the children. Only one child (2%) had *Ascaris lumbricoides* and hookworm co-infection, another 1 (2%) had *Ascaris lumbricoides* and *Trichuris trichuria* co-infection. Only *Ascaris lumbricoides* infection (15%) was found in pregnant women.

Table 2: Comparison of selected micronutrients in the serum of the helminth infection (HI) and helminth negative (HN) pre-school aged children and pregnant women.

	Fe (µg/dl)	**Zn (µg/dl)**	**Se (µg/dl)**	**Vitamin A (µg/dl)**
Pre-school aged children				
HN	161.3 ± 34.6	142.9 ± 22.5	39.0 ± 29.6	122.6 ± 27.2
HI	110.5 ± 42.3	93.1 ± 20.0	68.9 ± 30.9	92.3 ± 21.8
P-*value*	0.003*	0.000*	0.020*	0.004*
Pregnant women				
HN	124.6± 8.4	70.8±4.4	125.0± 7.6	153.6±37.5
HI	116.8±11.4	65.1±6.0	118±10.3	119.3±11.5
P-*value*	0.024*	0.025*	0.026*	0.002*

***Significant at *P*<0.05, HI=with helminth infection, HN=without helminth infection,**

As shown in Table 2, serum Fe level was significantly lower in pregnant women or pre-school aged children with helminth infection (HI) compared with pregnant women or pre-school aged children without helminth infection (HN). Similarly, pregnant women or pre-school aged children with HI had significantly lower levels of serum Zn compared with HN. Furthermore, serum levels of vitamin A were significantly lower in pregnant women or pre-school aged children with HI compared with HN. Serum level

of Se in pregnant women or pre-school aged or school aged children with HI was significantly higher compared with corresponding HN.

DISCUSSION

It should be recalled that, growth and development of any living organism largely anchored on the nutritional intake. The coexistence of micronutrient deficiency as result of malnutrition and helminth infections continues to be a major health challenge affecting pregnant women and young children especially in Sub-Saharan Africa due to poverty, poor sanitation and poor personal hygiene. Study has shown that there is a steady association between intestinal helminth infections and reduced food intake and weight loss (Steketee, 2003).Most women in their 3rd trimester supposed to have maintained physiological stability, in terms of hormonal changes experienced in pregnancy. Based on this assertion, the frequent nausea and loss of appetite are no more and heavy nutritional intake is the order of the day. Likewise, the Toddlers (preschool-age children) under normal circumstances are voracious feeders at their ages 1-4. This is not so in the geohelminth infected pregnant women and preschool-aged children in this study, because geohelminths impaired their nutritional status by increase mal-absorption of nutrients. Reduction in serum Fe, Zn, Se and protein may be as a result of the worm feeding on host tissues (including blood) and competition with digested food materials of the host.

Iron (Fe) is an important micronutrient whose deficiency affects infants, children and women of childbearing age (Patterson, Brown, Robert, Seldon, 2001). Fe depletion could cause reduced neutrophil action (with decreased myeloperoxidase activity) and impairments in cell mediated immunity (Katona and Katona-Apte, 2008). The observed lower level of Fe in pregnant women with HI compared with HN supports the reports of Gyorkos and Gilbert, (2014). Similarly, the observed lower levels of Fe in pre-school aged children with HI compared with HN supports the reports of Ngui, Lim, Chong Kin, Sek Chuen, Jaffar, 2012. This observation could be due to blood loss, mal-absorption and poor appetite which are characteristics of chronic helminth infections. It has been reported that hookworm infection

causes mechanical laceration and enzymatic damage to the small intestine mucosa which could cause blood loss resulting in hypochromic microcytic anaemia within 3-5 months of chronic intestinal infection (MacLeod, 1988). Also, the observation could be as a result of poor absorption and the systemic effect of infection and utilization of Fe by microorganisms for their growth and multiplication. According to. Islek *et al*, (1993), helminth such as hook worm (*A. lumbricoides)* could impair Fe absorption in the duodenum and jejunum. Since anemia is a common observation in pregnancy (due to blood volume expansion, frequent vomiting and poor appetite), it is observed that helminth infection in pregnancy could aggravate pregnancy-associated Fe deficiency.

Zinc is an essential mineral required for the activities of over 300 enzymes involved in carbohydrate and protein metabolism. It plays an important role in immune response as its deficiency reduces nonspecific immunity (neutrophil and natural killer cell and complement activity), reduces numbers of T and B lymphocytes and suppresses delayed hypersensitivity, cytotoxic activity and antibody production (Katona and Katona-Apte, 2008). The observed lower levels of Zn in pregnant women and pre-school aged children with HI compared with HN are in line with the report of Kongsbak *et al,* (2006), Ejezie and Nwagha (2011) and de Gier *et al* (2015) the observed lower Zn levels in all the HI groups compared with HN could be due to low dietary intake (due to loss of appetite), gastro intestinal blood loss, mal-absorption, diarrhea or infection. Zinc deficiency decreases resistance to infectious diseases. These reports probably explain why certain parasites survive better in a zinc-deficient host than in a well-nourished host.

Selenium is an important micronutrient for effective immune response. It is an integral component of glutathione peroxidase, selenoprotein-P, and thioredoxin reductase. The dietary intake of selenium varies as its concentrations in plant-based foods reflect the concentrations in the soil where the plants were grown. Similarly, selenium concentrations in animal sources of food depend on the selenium content of the plants used for forage or whether animal feed was fortified with selenium. There is growing

evidence that serum levels of selenium and some other essential micronutrients are reduced by helminth infection (Rajagopal Hotez and Bundy, 2014). The observed lower levels of Se in pregnant women with HI compared with HN could suggest increasing blood loss, mal-absorption and poor appetite that are associated with chronic helminth infection.

Vitamin A is a fat soluble vitamin. It maintains the wellbeing of epithelium in the respiratory and gastrointestinal tracts (Katona and Katona-Apte, 2008). Susceptibility to infections may increases due to Vitamin A deficiency and it is a cause of 1.2 – 3 million deaths per year in children (Neidecker-Gonzales, Nestel and Bouis,2007). The relationship between vitamin A deficiency and helminth infections has potentially important consequences for health especially in areas where malnutrition, poor sanitation and hygiene are common (Rajagopal Hotez and Bundy, 2014). The observed low levels of vitamin A in pre-school aged and pregnant women with HI compared with HN agree with the report of Ahmed *et al* (1993). This observation could be due to vitamin A malabsorption in the study samples with HI as a result of gastro intestinal mucosal changes involving blunting of the intestinal villi and morphological changes in the intestinal crypts following. In the pre-school aged children, the observed low vitamin A could also be due the observed Zn deficiency. Inadequate Zn supply has been shown to prevent normal release of vitamin A from the liver (Katona and Katona-Apte, 2008).

CONCLUSION AND RECOMMENDATION

Based on the observations from this study, it is very clear that nutritional status of both pregnant women and preschool aged children are negatively affected by geohelminth infection. Therefore, the following recommendations are hereby made;

- Routine screening of pregnant women and children to ascertain geohelminth infections is suggested with a view to initiating appropriate clinical intervention so as to reduce possible maternal and foetal morbidity and child mortality attributed to essential micronutrient deficiencies. This is very important in Nigeria as most rural Nigerian women,

including the pregnant ones consume more of cereal or legume based diets and have little access to animal products or a variety of fruit and vegetables which are rich sources of essential micronutrients (Ladipo, 2000).

- Children and pregnant women with geohelminth infections should be involved in individualized dietary intervention (such as bio-fortification) and possible supplementation with anti-helminthic treatment.
- There is also a need for public enlightenment on dietary sources in which micronutrients may be derived and the right quantities of essential micronutrients to be consumed to ameliorate alteration caused by geohelminth infections commonly found in poor hygienic and malnourished settings.
- Studies of the nutritional status of the nursing mothers' of preschool aged children is necessary, because there is possibility of their mothers being Fe deficient, as majority of them were still being breastfed. This observation could be supported by the study of Ahmed et al.

(1993), who observed insignificant differences in Fe levels in school aged children with HI (compared with HN) who possibly could be consuming diets that are adequate in Fe unlike the pre-school aged children who solely depend on the breast milk (which may be Fe deficient) of their mothers.

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