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Full Length Research Paper

Intestinal helminth infection and anaemia during pregnancy: A community based study in Ghana

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Intestinal helminths are among the most common and widespread of human infections, contributing to poor nutritional status, anaemia and impaired growth. Anaemia and iron deficiency in pregnancy is a major public health problem in developing countries, but their causes are not always known. The objective of this study was to assess the prevalence and severity of anaemia and iron deficiency and their association with helminths, among pregnant women in the Ashanti region of Ghana. A cohort study was carried out in the Sekyere east district of the Ashanti region of Ghana. 108 pregnant women were followed until 5-10 weeks postpartum, during the period of December 2005 - November 2006. Haemoglobin and total serum iron concentrations were evaluated in venous blood samples and helminths infections were evaluated in stool samples in each trimester using standard methods. Of the 108 pregnant women, 54.9% were found to be anaemic. The highest prevalence of anaemia and low iron stores (57.4 and 32.4%, respectively) were found in the second trimester. Only 17.6% had evidence of helminths infection, with *Necator americanus* (hookworm) being the commonest (13.9%). There was a significant association between hookworm infection and low iron stores. The study concluded that hookworm infection is a strong predictor of iron status. These findings reinforce the need to provide anthelminthic therapy to infected women before conception as public health strategy in reducing the prevalence of hookworm infection in addition to providing nutritional and iron supplements to effectively control anaemia in pregnancy.

Key words: Intestinal helminth, anaemia, paragravids, primigravids.

INTRODUCTION

Intestinal helminthes are among the most common and widespread of human infections. They contribute to poor nutritional status, anaemia and impaired growth in children of school going age (Dickson et al., 2000). Epidemiological surveys have revealed that, poor sanitation and appropriate environmental conditions coupled with indiscriminate defaecation, geophagy and contamination of water bodies are the most important predisposing factors to intestinal worm infestation (Brooker et al., 2008). The prevalence and intensity of infection is especially high in developing countries, particularly among populations with poor environmental sanitation (van Eijk et al., 2009). Other practices such as hand washing, disposal of refuse, personal hygiene, wearing of shoes and others, which when not done properly may contribute to the infection or picking of these worms from the environments (Stoltzfus et al., 1997).

Anaemia

The term anaemia has been used incorrectly as a diagnosis;

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more properly, it denotes the complex of signs and symptoms associated with low haemoglobin levels. The type of anaemia defines its pathophysiologic mechanism and its essential nature, allowing for appropriate therapy (Porter and Kaplan, 1999). Globally, the most common cause of anaemia is believed to be iron deficiency due to inadequate dietary iron intake, physiologic demands of pregnancy and rapid growth and iron losses due to parasitic infections (Ayoya et al., 2006; Dreyfuss et al., 2000). However, iron deficiency is not the only cause of anaemia. Other prevalent causes of anaemia include malaria, chronic infections and nutritional deficiencies of vitamin A, folate and vitamin B-12 (Dreyfuss et al., 2000). The relative contributions of these causes of anaemia and iron deficiency vary by sex, age and population and are not well described in many populations (Dreyfuss et al., 2000).

There are two major approaches in the classification of anaemia; the "kinetic" approach which involves evaluating production, destruction and loss of red blood cells and the "morphologic" approach which groups anaemia by red blood cell size (Porter and Kaplan, 1999).

Iron deficiency is responsible for 95% of cases of anaemia during pregnancy (Porter and Kaplan, 1999). The deficiency is usually due to inadequate dietary intake (especially in teenage girls), to a previous pregnancy or to the normal loss of iron in menstruation (Porter and Kaplan, 1999).

Impact of intestinal helminth infections on anaemia during pregnancy is aggravated by low nutritional status of subjects whose staple foods, such as rice, cassava and maize are poor sources of folate and iron (Ayoya et al., 2006; Pasricha et al., 2008). The most important cause of pathological chronic loss of blood and iron in the tropics is hookworm and other soil-transmitted helminthes (Brooker et al., 2008) and malaria in pregnancy (Fleming, 1982). At a hospital in Kathmandu, Nepal, hookworm infection was associated with severe but not moderate anaemia among women receiving antenatal care (Bondevik et al., 2000). Data on the epidemiology of iron deficiency anaemia in East Africa and elsewhere point to the important contribution of hookworms to this condition (Ayoya et al., 2006; Stoltzfus et al., 1997) . Hookworm infection has been established as a strong predictor of iron deficiency and anaemia in other populations (Ayoya et al., 2006; Stoltzfus et al., 1997), but few studies have examined their relationships in pregnant women (WHO, 1993).

The occurrence of helminth infection at high rates among pregnant women is mostly indicative of faecal pollution of soil and domestic water supply around homes due to poor sanitation and improper sewage disposal (Bundy et al., 1995; van Eijk et al., 2009). Pregnant women are at high risk of infection because of their close relationship with children (Bundy et al., 1995; van Eijk et al., 2009). Most of these worms are transmitted through the soil whilst the practice of soil-eating (geophagy) is common amongst pregnant women in many communities in developing countries (Brooker et al., 2008). It is in this vain that, this study investigates the prevalence and some clinical effects of anaemia in pregnant women infected with intestinal helminthes in the Sekyere east district of the Ashanti region of Ghana. This would help largely in the management of intestinal worm burden interfering with iron stores in pregnant mothers.

MATERIALS AND METHODS

Setting

Subjects were recruited from the Sekyere east district of the Ashanti region with the Effiduase Hospital as the base laboratory. The examination center was centrally located in the study area and represented the general characteristics of the district. The analysis included data collected from December 2005 to November 2006 from pregnant women that attended antenatal clinics in the clinic sub study area.

Subject selection

The study population involved pregnant women of ages between 12 – 45 years who participated in a randomized community intervention. 300 eligible pregnant women who visited the clinic had pregnancies confirmed with a -human chorionic gonadotropin urine test.

Sample collection and analysis

Blood was collected via venipuncture. Anaemia and Iron status were assessed with haemoglobin (Hb) and total serum iron (TSI) or ferritin concentrations. Morphological study of red cells was carried out as a confirmatory test for iron deficiency anaemia (Leishman staining) . Hb was measured with a Haemocue hemoglobinometer (Mission Viejo, CA). Serum ferritin (TSI) was assessed with a fluorometric immunoassay (Delfia System; Wallac, Gaithersburg, MD). The formol-ether concentration method was used in the preparation of stool samples for microscopy and detection of helminthes.

Data analysis

Firstly, estimates of the severity of anaemia, defined by Hb concentration and of iron deficiency, defined by TSI or ferritin concentration were examined as a cause of anaemia. Anaemia was defined as Hb <10 g/dL and differentiated as Hb <10 g/dL – *'severe anaemia'*; Hb <11 – 11.5 g/dL – *'moderate anaemia'* and Hb < 12 – 15.2 g/dL -*'normal'*. Persons with TSI or serum ferritin <60 µg/dL were also described as '*anaemic' (*The Merck Manual, 1999). In the morphological examination of iron deficiency anaemia, the morphology of the red cells should be microcytic, hypochromic with anisocytosis and poikilocytosis *(* The Merck Manual, 1999). Gestation age and gravidity were also retained in all models because iron status and haemoglobin concentration is known to be strongly associated with gestation age and gravidity (The Merck Manual, 1999). Data were analyzed using SPSS (version 11.0; SPSS Inc, Chicago) whilst statistical significance was defined as a p-value of <0.05. The Pearson Chi – square test was used to examine the association between both total serum iron and haemoglobin concentrations and helminth infection as indicators of anaemia.

Table 1. Total serum iron (TSI) concentration of study subjects as distributed over the trimesters of pregnancy. Using TSI 60 persons were categorized as being anaemic as compared with 59 using Hb levels.

Gestation	Serum iron concentration		
	< 60 ug/dL (anaemic)	> 60 ug/dL (normal)	Total
1st Trimester	17 (15.7%)	13	30
2nd Trimester	35 (32.4%)	27	62
3rd Trimester	8 (7.4%)	8	16
Total	60 (55.6%)	48	108

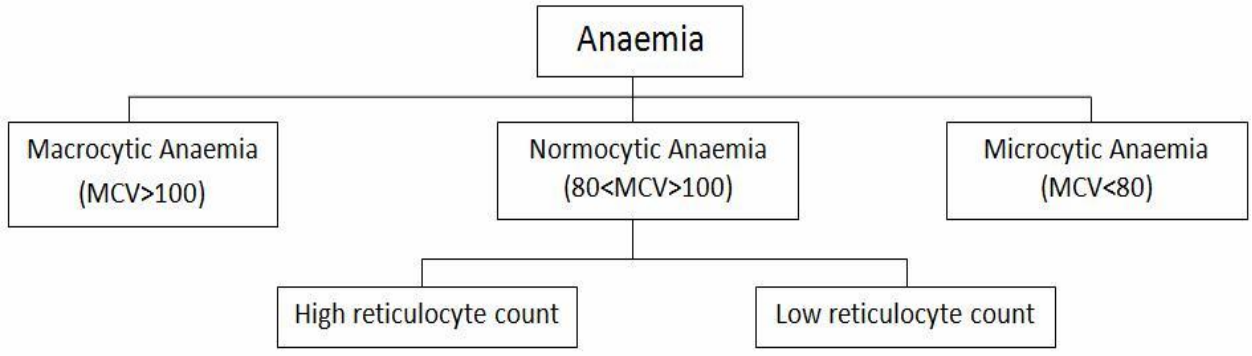

Figure 1. Differentiation of anaemia based on red blood cell size. The Merck Manual (Porter and Kaplan, 1999).

RESULTS

One hundred and eight women were recruited into the study, of whom 66 (61.1%) were paragravids and 42 (39.9%) were primigravids. Clinical data obtained within the first month of recruitment showed that 27.8% of these women were in their first trimester, whilst 57.4 and 14.8% were in their second and third trimesters, respectively. Of the paragravids 15 (13.8%), 39 (36.1%) and 12 (11.1%) were in their first, second and third trimesters, respectively and 15 (13.8%), 23 (21.3%) and 4 (3.7%) of primigravids were also in their first, second and third trimesters, respectively.

Prevalence of anaemia and iron deficiency

Anaemia was present in more than 50% of the pregnant women studied (Table 1). Iron deficiency appeared to be the dominant cause of anaemia especially moderate to severe anaemia in these communities with 60 subjects having TSI concentrations of <60 µg/dL whilst 59 persons had Hb levels < 12 g/dL (55.6 and 54.6% respectively, Table 1).

Helminth infection

Of the 108 pregnant women, only 19 or 17.6**%** were infected with helminthes; the commonest being *Necator americanus* (hookworm) infection (15 or 13.9%) followed by *S. stercoralis* (2 or 1.9%)*, A. lumbricoides* (1 or 0.9%) and *T. trichiura* (1 or 0.9%) as depicted in Figure 1*.* All 19 women infected with at least one species of pathogenic intestinal helminthes were found to have moderate to severe anaemia. All 15 pregnant women who were infected with hookworm were found to be anaemic (Hb <10.0 g/dL and/or TSI < 20 µg/dL), with 13 of them being severely anaemic (Figures 2 and 3). Hookworm infection had a strong association with all two indicators of anaemia and iron deficiency (p = 0.001 and 0.00 for TSI and Hb, respectively).

DISCUSSION

In developing countries, most pregnant women generally become anaemic and this is presumed to be primarily as a result of iron deficiency (WHO, 1996). However, the definition and identification of iron deficiency has been a problem especially in situations where there are multifactorial causes of anaemia. Nevertheless, hookworm has been established as a major predictor for iron deficiency anaemia (Van den Broek, 1996, 1998). It is also known that poverty, ignorance, geophagy, promiscuous defaecation and poor personal hygiene and environmental sanitation also predispose humans to hookworm infection (Larry and Janovy, 1996).

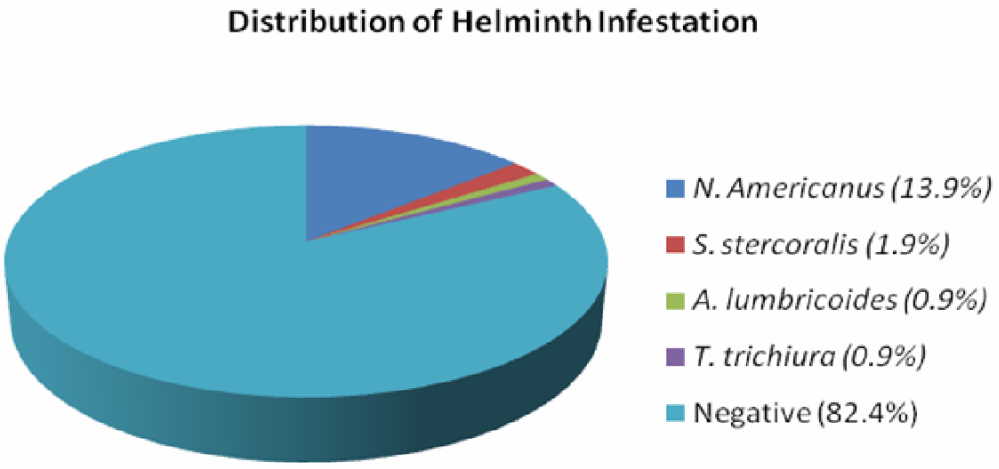

Figure 2. A pie chart indicating the species of helminthes identified among the pregnant women studied. The commonest helminth detected was *Necator americanus* (hookworm).

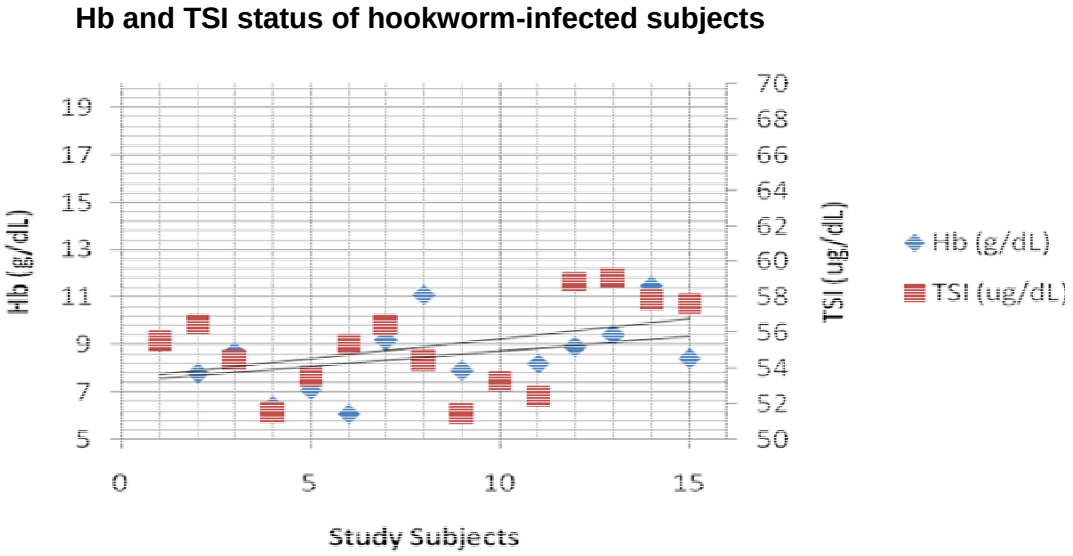

Figure 3. Graphical representation of the 15 pregnant women who had hookworm infection. All 15 were found to have Hb levels and TSI concentrations below normal, with 13 of them being severely anaemic.

Of the 108 pregnant women studied, 55.6% of them were classified as anaemic, which although is on the high side and it is not uncharacteristic of the community setting within which the study was undertaken (Jans et al., 2008; Pasricha et al., 2008). In a recent study in the Netherlands, the prevalence of anaemia in pregnancy was found to be 3.4% (Jans et al., 2008). Despite the discrepancies in the number of study subjects and the study areas of the two studies, ethnicity played a major role in defining the risk of being anaemic in pregnancy, with women of non-northern European descent more at risk than their northern European counterparts (Jans et al., 2008). In similar studies in India and Nepal, the percentages of pregnant women who were anaemic were 88 and 81, respectively (Agarwal et al., 1987; WHO, 1998). This affirms the predominance of predisposing factors of anaemia within rural settings of developing countries. In our part of the world, anaemia may also be caused by malaria, HIV and poor nutrition (Ayoya et al., 2006; Muhangi et al., 2007).

Iron deficiency appeared to be the dominant cause of anaemia in these communities as defined by TSI concentration and Hb levels (55.6 and 54.6%, respectively) and although only 19 of the 60 anaemic women (31.7%) had helminthes infection, iron deficiency was found to be significantly associated with hookworm infection ($p= 0.001$).

It was encouraging to note that only 17.6% were

infected with helminths in this study, the commonest been hookworm (13.9%), compared with a similar study in western Kenya (van Eijk et al., 2009). However, since this study is an epidemiological one and the subjects were asymptomatic, any helminth ova or larvae present would be in very low intensity and possibly undetectable (Ayoya et al., 2006; Bundy et al., 1995; van Eijk et al., 2009).

Hookworm infection has been established as a strong predictor of iron deficiency and anaemia in other populations (Bundy et al., 1995; Hopkins et al., 1997; Stoltzfus et al., 1997) and few studies have examined these relationships in pregnant women. In this study, hookworm infection was associated with severe anaemia (95% CI 0.2-0.8) which conformed to published data (Ayoya et al., 2006; Bondevik et al., 2000; Brooker et al., 2008; van Eijk et al., 2009).

A single course of anthelminthic therapy in addition to iron-folate supplementation significantly increased hemoglobin concentrations and improved iron status (serum ferritin and EP) in pregnant Sri Lankan plantation workers, suggesting that hookworm infection caused iron deficiency anaemia in that population (Atukorala et al., 1994). However, allocation to anthelminthic therapy was nonrandom and the prevalence and intensity of hookworm infection were not assessed.

The pathenogenicity of hookworm infection shows that the disease manifests in three main phases, with the intestinal phase representing the most important period. A moderate hookworm infection according to studies will gradually produce iron deficiency anaemia as the body reserves of iron are used up, with the severity depending on the worm load and the dietary intake of iron (Larry and Janovy, 1996).

In sub-Saharan Africa, up to 24 million women may become pregnant each year (Bundy et al., 1995). This high rate is often related to an increase in the susceptibility of pregnant women to infections because pregnancy is a time of high hormone activity which may exert immuno-suppressive effects on the child bearing woman (Beer and Billingham, 1978; McGregor et al., 1983). Information also shows that, iron deficiency is responsible for about 95% cases of anaemia during pregnancy usually due to inadequate dietary intake (especially in teenage girls), to previous pregnancies or to normal loss of iron in blood with menses to the interference of iron stores by parasites (Porter and Kaplan, 1999).

Findings in this study provide a population based picture of iron status during pregnancy among women in the Sekyere east district who live in conditions of poverty, malnutrition and endemic infections. After evaluation of all the commonly available variables for measuring iron status, van der Broek and Letsky in 1998 estimated TSI (ferritin) as the best predictor of iron deficiency (van den Broek et al., 1998).

Given that women in these communities are low income generating people, with majority of study subjects between the ages of 20-29, malnutrition is a possibility which could account for the high endemicity of anaemia.

Conclusion

The study concludes that anaemia is prevalent within rural communities of the Sekyere east district of the Ashanti region and that hookworm infection is a strong predictor of iron status.

Recommendation

Anthelmintic therapy is inexpensive and safe during pregnancy after the first trimester, therefore it should be part of the antenatal programme since malaria diagnosis and treatment is also part of the antenatal programme (Larocque and Gyorkos, 2006). The world health organization (WHO) recommends anthelmintic therapy for women to control hookworm infection in areas in which the prevalence of infection is high and anaemia is prevalent (WHO, 1996).

Anthelminthic therapy and improvement in the amount and quality of dietary iron intake among pregnant women should be encouraged as an important long- term goal, and if well established can meet the iron needs of pregnant women with hookworm and other intestinal helminth infections, particularly among populations who consume diets of low iron bioavailability.

Also other causes of anaemia should be looked at in the Sekyere east district to arrive at a comprehensive approach in solving the problem of anaemia.

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