Is There an Association Between Helminthiasis and Anemia in Pregnancy?: A Test Case of Pregnant Women Attending Two Hospitals in Cape Coast

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Abstract

Helminthiasis is one of the most common and widespread parasitic infections of humans, contributing to poor nutritional status, anemia, and low birth weight (LBW) in pregnancy. We investigated the possible association between helminthiasis and anemia in pregnancy and their combined effect on day zero birth weights (DZBW). A total of 83 pregnant women of ages 16 to 45 years in their last trimester (30 to 42 week gestation) were purposively and voluntarily recruited from two hospitals in the central region of Ghana for the study. Venous blood and stool samples from the participants were analyzed for Hb, malaria parasite and infective stages of helminths (ova, larvae) respectively. Participants were monitored up to delivery and the DZBW measured. Out of the 83 pregnant women, 17 (20.5%) had helminthiasis with ascariasis being the most common (10.8%). Anemia (Hb < 11g/dL) was identified in 47% of the participants and 22.9% gave birth to babies with LBWs. Prevalence of helminthiasis correlated with increased risk of developing anemia with those having trichuriasis showing the highest incidence of anemia (80%) than those who had ascariasis or strongyloidiasis. Helminthiasis in pregnancy may lead to a high risk of anemia, however, it may not increase the risk of LBW and that geohelminthiasis in pregnancy could be independent of geophagy.

Keywords: *Ascaris lumbricoides*, Helminthes, Low birth weight, *Trichuris trichuria*

Introduction

Helminthiasis among humans has assumed public health significance (Warren, 1993), particularly the geohelminthiases. For instance, a report indicates that more than a quarter of the world's population is infected with at least one or more of the common geohelminthes: *Ascaris lumbricoides*, *Necator americanus*, *Ancylostoma duodenale*, and *Trichuris trichiura* (Chan, Guyatt, Bundy, & Medley, 1994).

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The prevalence of helminthiasis has been shown to be quiet high in developing countries, particularly among populations with poor environmental sanitation (Awasthi, Bundy, & Savioli, 2003; Van Eijk et al., 2009) and poor personal hygiene (Stoltzfus et al., 1997). No wonder, hookworm infection has been implicated as the leading cause of pathological blood loss among infected populations in the developing world (Torlesse & Hodges, 2000), with about 44 million pregnancies currently complicated by maternal hookworm infections (Bundy, Chan, & Savioli, 1995). This was said to have rendered mothers and babies at high risk of death during pregnancy or delivery.

Aside permanent organ damage, poor physical growth, poor intellectual development and impaired cognitive function; helminthiasis may also cause anemia (Crompton & Nesheim, 2002). Severally helminthiasis in pregnancy was shown to be associated with anemia leading to LBW (Bamlaku, 2009; Stephenson, Chappell, Holland, & Ottesen, 2000). It was said that, at any one time in a developing country, half of the population (Mainly children and women of reproductive age) are affected by anemia (Hercberg & Galan, 1992). Therefore, anemia in pregnancy has been associated with poor birth outcome, such as LBW and increased maternal morbidity and mortality (Allen, 2000; Brabin, Hakimi, & Pelletier, 2001; Crompton, 2000; Steer, 2000; Viteri, 1994) and that close to 500,000 maternal deaths occur every year, with vast majority from the developing world (Guidotti, 2000; McDermott et al., 1996; WHO, 1996). WHO, (1994) had reported that most pregnant women in the developing world harbour helminthes and more than 10% suffer worm burdens heavy enough to adversely affect intrauterine growth leading to premature birth or LBW. Helminthes induce deficiencies of iron, total energy, protein and possibly folate and zinc leading to anemia (Stephenson et al., 2000). The effect of helminthiasis on anemia in pregnancy is further aggravated by poor nutritional status of pregnant women in the developing world (Ayoya, Spiekermann-Brouwer, TraorÃ©, Stoltzfus, & Garza, 2006; Pasricha et al., 2008); and the practice of soil-eating (geophagy) common among pregnant women from developing countries (Brooker, Hotez, & Bundy, 2008).

However, contributions of helminthiasis-related causes of anemia in pregnancy leading to LBW may vary on the basis of parasitic infections, gestational age and population and are poorly described in many populations worldwide. The present study therefore investigated the association between helminthiasis, anemia and LBW among a population of pregnant women in their 30 - 42 week gestation selected from two hospitals in the central region of Ghana.

Materials and Methods

Study area

Cape Coast Metropolis lies approximately between latitudes 5°.07’ to 5°.20’ north of the Equator and between longitudes 1°.11’ to 1°.41’ west of the Greenwich Meridian. It has common boundaries with Twifo Heman Lower Denkyira District in the north, Gulf of Guinea in the south, Abura Asebu-

Kwamankese District in the east and Komenda-Edina-Eguafo-Abrem (K.E.E.A) District in the west. It has 84 communities including Efutu, Adisadel, Apewosika, Nkanfoa, Abura, Pedu and Nyinesin.
The total population of Cape Coast Metropolis is 118,106 out of which 57,365 are males and 60,741 females. Farmers, fishermen as well as those into agriculture-related activities form about 60% of the population (Projection from the 2000 Housing and Population Census, Ghana Statistical Service). The people are of different educational backgrounds ranging from illiterates to university graduates who are involved in occupations such as trading, artisanship, farming, teaching, health services, fishing, transport, government employment, construction, financing, tourism and religious activities.

Ethical considerations

Ethical clearance was sought for and was granted by Ethics Committee of the Hospitals involved. Permission was also obtained from Administrators of the Hospitals before the study commenced. In addition, all the pregnant women recruited into the study agreed to a written informed consent after thorough explanation of the rationale of the study.

Study population

A total of 83 pregnant women from Central Regional Hospital (CRH) and University of Cape Coast Hospital (UCCH) were randomly selected for the study. The convenience sampling method was used and this permitted only the willing and available pregnant women who at the time of the study satisfied the inclusion and exclusion criteria to be recruited into the study.

Inclusion/Exclusion Criteria

Pregnant women of 30 to 42 weeks gestation visiting the antenatal units of the CRH and UCCH hospitals were voluntarily recruited into the study. However, pregnant women who had any of the haemoglobinopathies (G6PD, sickle cell diseases) and malaria infections were excluded. Also, those who were on de-wormers and blood tonics or had taken de-wormer in the cause of pregnancy were excluded. Subjects below 30 weeks gestation and those with parity were also excluded.

Study Design

A well-structured closed-ended questionnaire was administered to each participant to obtain biometric data and host behavioural characteristics. Medical data relevant to the study were obtained from the medical folders of participants. Participants were given sample bottles for stool after they had been taught on how to take samples. All experiments were carried out at the microbiology and parasitology sections of the Clinical Laboratory Department of CRH.

Sample Collection and Processing

Stool samples submitted in the morning by participants were collected in a clean, wide mouth, and well capped labelled containers. Venous blood was collected from each participant into MediPlus ethylene-diamine-tetra-acetic acid (EDTA) K3 anticoagulant tubes (Sunphoria Co. Ltd., Taiwan) for estimation of Hb level and to check for the presence of malaria parasites.

Stool Routine Examination

Stool samples were examined using both direct smear and formol – ether concentration methods.

Direct smear

A direct smear mount of stool in normal saline was prepared immediately upon arrival at the laboratory and examined for the presence of the various infective forms (larvae and ova) of helminthes under a microscope. Lugol's iodine staining was used to aid easy detection of cysts of protozoa.

Formol-Ether Concentration Method

With the aid of an applicator stick, a 1g of stool sample was placed in a clean 10 ml conical centrifuge tube containing 4 ml of 10% formalin. The sample was mixed by shaking for 20 seconds. The emulsified stools were sieved and the suspension collected in a beaker. The sieved suspension was poured back into a fresh tube and the debris discarded. An equal volume of ether 4 ml was added, mixed and centrifuged at 3000 rpm for 1 min. The supernatants were then decanted and the tube placed in a rack. The sediments were later transferred onto a slide and covered with a cover slip. The entire area under the cover slip was then examined microscopically.

Haematological Tests

A 5 ml of blood was collected in EDTA tubes and labelled with each participant's identification code. Rapid diagnosis test (RDT) was performed on each sample to rule out the possibility of malaria infection. A 5 µl of blood was added to the RDT cassette (CareStart™, M/S Access Bio, USA) and then 3 drops of assay buffer added. The results were read after 20 min. Those who tested positive were excluded from the study.

Hb levels of the participants who tested negative were obtained using automated full blood count (FBC) analyzer (ABX pentra 60 by HORIBA ABX Diagnostics, France). Each blood sample was inverted slowly several times to mix, and then placed in the analyzer to obtain the FBC estimates.

Statistical Analysis

Analysis between subjects with helminth infection and their haemoglobin level were performed with Statistical Package for the Social Sciences (SPSS v.16.0). Values obtained from the quantitative analysis were matched to the answers from the questionnaire.

Results

Out of the 83 pregnant women, 17 (20.5%) had helminthiasis. The helminthes identified in ascending order of prevalence were *Strongyloides stercoralis*, *Trichuris trichiura* and *Ascaris lumbricoides*. However, pregnant women infected with *Trichuris trichiura* had the highest incidence of anemia (Table 1).

Table 1. Relationship between type of Helminthiasis and Anemia in Pregnancy

Helminth	No. Infected	Prevalence (%)	Prevalence of Anemia (%)
Ascaris lumbricoides	9	10.8	4 (44.4 %)
Strongyloides stercoralis	3	3.6	1 (33.3 %)
Trichuris trichiura	5	6	4 (80.0 %)
Total	**17**	**20.5**	**9 (52.9%)**

Comparatively, pregnant women from CRH recorded the highest prevalence of helminthiasis (22%) and anemia (50%) compared to those from UCCH who had 18.2% and 42.4% for helminthiasis and anemia respectively, however, UCCH recorded a higher LBW (24.2%) compared to CRH (22%) (Table 2).

Table 2. Comparison of helminthiasis, anaemia and LBW among the Participants from the two Hospitals

Variables	UCCH	CRH	Total
	N = 33	N = 50	N = 83
Helminth infections	6 (18.2%)	11 (22.0%)	17 (20.5%)
Anaemia	14 (42.4%)	25 (50.0%)	39 (46.9%)
LBW	8 (24.2%)	11 (22.0%)	19 (22.9%)
Hb (Mean ± s.e.m)	11.28 ± 0.23	11.1 ± 0.91	11.17 ± 0.56
Birth weight (Mean ± s.e.m)	2.88 ± 0.16	3.02 ± 0.12	2.97 ± 0.75

University of Cape Coast Hospital (UCCH); Central Regional Hospital (CRH); Haemoglobin (Hb)

The highest prevalence of helminthiasis occurred within the ages of 21 and 25 years, however, prevalence of anemia was highest among ages 16 to 20 and LBW was highest in pregnant women who were above 35 years (Table 3).

Table 3. Distribution of Helminthiasis, Anemia and LBW Among the Various Age Groups

Age range (years)	Frequency	Prevalence (%)	Helminth infection	Anaemia	LBW
16-20	11	13.3	2 (18.2 %)	6 (54.5 %)	2 (18.2 %)
21-25	16	19.3	6 (37.5 %)	8 (50.0 %)	2 (12.5 %)
26-30	28	33.7	4 (14.3 %)	14 (50.0 %)	8 (28.6 %)
31-35	17	20.5	4 (23.5 %)	7 (41.2 %)	2 (11.8 %)
> 35	11	13.3	1 (9.1 %)	4 (36.4 %)	5 (45.5 %)
Total	**83**	**100**	**17 (20.5 %)**	**39 (47.0 %)**	**19 (22.9 %)**

Pregnant women who had helminthiasis got higher incidence of anemia compared to those who had no helminthiasis, however, LBW was higher among those without helminthiasis (Table 4).

Table 4. Comparison of Anemia and LBW among Helminth Infected and Non-Infected Participants

	Anemia	LBW
Helminth Infected	9 (52.9%)	4 (23.5%)
Not Infected	30 (45.5%)	15 (24.2%)

It was observed that certain host behaviours and activities predisposed pregnant women to helminthiasis (Table 5)

Table 5. Effect of Host Factors on Helminthiasis, Anemia and LBW

Variables	Helminth Infected	Anaemia	LBW
Iron supplement intake			
Regular	13 (76.5%)	13 (26.5%)	11 (57.9%)
Not regular	4 (23.5%)	26 (73.5%)	7 (42.1%)
Pica			
Crave	4 (23.5%)	8 (36.7%)	2 (10.5%)
Does not crave	13 (76.5%)	31 (63.3%)	17 (89.5%)
Hand washing with soap			
Yes	5 (29.4%)	19 (48.7%)	10 (52.6%)
No	12 (70.6%)	20 (51.3%)	9 (47.4%)
Buying food from vendors			
Yes	13 (76.5%)	37 (75.5%)	15 (78.9%)
No	4 (23.5%)	2 (24.5%)	4 (21.1%)

Discussion

We investigated the relationship between helminthiasis and anemia in pregnancy and their combined effect on DZBWs. From 83 stool samples analyzed, the overall prevalence of helminthiasis was 20.5% with the study identifying three kinds of geohelminthes (*Ascaris lumbricoides*, *Trichuris trichiuria* and *Strongyloides stercoralis*) in the infected population. Helminthiasis incidence of 20.5% is quiet on the high side and this is attributable to both host and non-host factors. Host factors may include poor personal hygiene such as poor hand washing habits, eating poorly cooked fast foods, and keeping of long nails, which might have haboured infective stages of helminths. Although pica, particularly geophagy has been linked to increase risk of helminthiasis, particularly ascariasis and trichuriasis (Geissler, Mwaniki, Thiong'o, & Friis, 1997; Hunter, 1973), we found no association between pica and helminthiasis in pregnancy, substantiating a report by Shinondo & Mwikuma, (2008) who have concluded that, geophagy was an unlikely risk factor for geohelminthic infections in pregnancy. Non-host factors that could have predisposed the infected participants may include living in compound houses with shared toilet facilities, lack of potable drinking water and poor waste and sewage disposal facilities. These findings agree with earlier reports (Ozumba, Ozumba, & Anya, 2005; WHO & UNAIDs, 2002) which have attributed helminthiasis to poor personal hygiene and sanitation.

Many reports (Ayoya et al., 2006; Baidoo, Tay, & Abruquah, 2010; Brooker et al., 2008) have associated hookworm infections with anaemia in pregnancy. However, results from our study did not identify any hookworm infection but rather trichuriasis, which correlated with anemia in pregnancy and this observation agrees with Bamlaku, (2009) who had identified trichuriasis as a potential risk for anemia in pregnancy. It is highly probable that helminthiasis in pregnancy may depend on the endemicity of a particular helminth in a geographical location at specific period of time since the geographical distribution of helminthes varies from one place to another.

Expectedly, pregnant women from CRH had the highest incidence of helminthiasis and anemia compared to UCCH, possibly due to the fact that, CRH is a regional hospital and receives referral cases from all the district hospitals within Cape Coast including UCCH.

The number of pregnant women who had helminthic infections and anemia varied among the age groups with the highest incidence of helminthic infection and anemia occurring in the 21-25 age groups, this could mean that pregnant women in this age group are highly predisposed to infection factors, probably due to their peculiar sexual activities and low observance of personal hygiene to the neglect of predisposing tendencies. Pregnant women above 35 years recorded the highest incidence of LBWs. This observation in addition to other factors may be linked to unknown biological factors such as increased physiological demands, physiological stress, psychological and emotional pressures which normally peaks in women after age thirty and above. This observation however is consistent with earlier reports (Reichman & Pagnini, 1997) who have linked LBW to maternal age beyond thirty years, relating the underlying reasons to biologically derived factors.

Consistently, pregnant women with helminthiasis presented anemia during pregnancy than those who had no helminthiasis (Baidoo et al., 2010; Brooker et al., 2008; Yatich et al., 2010). It has always been maintained that heavy and moderate helminth infections, particularly, hookworm infection cause anemia in pregnancy and could lead to fetus-related complications including LBW. Surprisingly, we observed that pregnant women who had no helminthiasis rather recorded the highest LBWs as compared to those with helminthiasis. Though our observation agrees with Fairley et al., (2013) who have suggested that helminthiasis in pregnancy do not have any association with LBW, however, it stands at variance with an earlier report (Yatich et al., 2010) who had suggested that intestinal helminthiasis increases the risk of LBW by two folds. It is probably possible that other pro-anemic factors aside those of helminthiasis could be responsible for the unusual observation. Due to the contradictory observations regarding the association between helminthiasis in pregnancy, anemia and LBW, it may be appropriate that a future study investigates further to better clarify the exact relationships. Also, results from our study showed that pregnant women who complied with their regular iron supplement intake were less likely to develop anemia than those who did not comply and this was consistent with earlier reports (Allen, 2000; Moulessehoul, Demmouche, Chafi, & Benali, 2004) who have shown that regular intake of iron supplements during pregnancy significantly reduce anemia.

Conclusion

All put together, helminthiasis in pregnancy may lead to a high risk of anemia, however, it may not increase the risk of LBW and that geohelminthiasis in pregnancy could be independent of geophagy.

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