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Intestinal parasitic infections and anaemia among pregnant women in the highlands of Papua New Guinea

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SUMMARY

This study determined the prevalence of intestinal parasitic infections and associations with risk factors among pregnant women in their second or third trimester in Goroka, Eastern Highlands Province, Papua New Guinea. Among the 201 pregnant women enrolled in this study, 163 (81%) were infected with one or more intestinal parasites. Infections with protozoan parasites (65%) were more prevalent than infections with nematodes (31%); protozoan infections included *Entamoeba histolytica* (43%), *Giardia lamblia* (39%) and *Pentatrichomonas hominis* (14%), and nematode infections included hookworm (18%), *Ascaris lumbricoides* (14%), *Strongyloides stercoralis* (3%) and *Trichuris trichiura* (2%). Factors associated with higher risk of intestinal parasitic infections in pregnancy included being a primigravida for protozoan-only infections and education limited to primary school for nematode infections. Altitude-adjusted haemoglobin levels were assessed at the beginning of labour for 110 women, with 69 (63%) found to be anaemic (haemoglobin <11 g/dl). There were no associations found between being infected in pregnancy and anaemia.

Introduction

Intestinal parasitic infections affect more than 3.5 billion people worldwide, of whom 450 million manifest clinical signs (1). Clinical signs include iron deficiency anaemia, growth retardation in children and malnutrition (2).

In the 1990s it was estimated that 44 million out of 124 million annual pregnancies (35%) globally involved infections with hookworm, with the highest prevalence of infection occurring in very poor, rural populations in Sub-Saharan Africa, South-East Asia and China (3). A systematic review estimated hookworm prevalence during pregnancy in Sub-Saharan Africa to be 6.9 million out of 25.9 million pregnant women (27%) (4). This high prevalence is of concern, considering that intestinal parasitic infections are associated with an increased risk of developing anaemia during pregnancy. Anaemia in pregnancy is an important cause of maternal morbidity and mortality, preterm birth, low birthweight and poor iron status in the infant (5).

Risk factors such as poor environmental health and contamination of food and drinking water are major contributors to the high prevalence of intestinal parasites in Papua New Guinea (PNG) (6,7).

Previous studies have reported on the prevalence of intestinal parasites in different community groups in PNG, including school-age children and adults (7-13); however, to our knowledge the prevalence of intestinal parasitism in pregnant women in PNG has not been reported previously. The purpose of this study was to assess the patterns of intestinal parasitism and anaemia during pregnancy in women in the highlands of Papua New

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Methods

Study location and population

Goroka is the capital of the Eastern Highlands Province of PNG. The town lies 6° south of the equator and at approximately 1500 m above sea level. Goroka General Hospital is the main health service serving a rural population of 380,000 inhabitants. This study included pregnant women in their second or third trimester recruited from Goroka town and surrounding rural villages. In Goroka town most people live in fenced modern-style permanent houses, while in the rural areas people live in hamlets, with most houses made out of bush materials. The majority of the rural people have a subsistence farmer livelihood, but earn cash through smallholder production of coffee and marketing of garden products. The urban people have limited land for farming, so make their living through employment with government or business or by owning a small- to medium-size business.

Between April 2008 and September 2009, 201 pregnant women visiting the Antenatal Care Unit (Antenatal Clinic) at the Goroka Hospital were recruited into this study after they and their partners consented to participate.

Ethical clearance

The study was reviewed and approved by the Papua New Guinea Institute of Medical Research Institutional Review Board (IRB 0714), the Papua New Guinea Medical Research Advisory Committee (MRAC 07/01) and the Princess Margaret Hospital Ethics Committee in Perth, Australia (1431/EP). Written informed consent was obtained from every participant and their partner. Participants identified with intestinal parasitic infection were treated using standard antihelminthic drugs under the supervision of a local nurse. The participants were informed about their right to withdraw from the study at any stage.

Data collection

At the time of enrolment a questionnaire was completed through interview by a research nurse in the local language. Information was collected on the women's age, education, last menstrual period, number of previous pregnancies and living conditions such as housing, source of drinking water and type of toilet used. Information on the pregnancy was collected from the Mother Health Books of all participants.

Haemoglobin (Hb) levels were measured at the time of delivery. The World Health Organization (WHO) and US Centers for Disease Control and Prevention (CDC) define anaemia in pregnancy as a Hb level of less than 11 g/dl, with mild, moderate and severe anaemia in pregnancy defined as Hb measurements of 9-10.9 g/dl, 7-8.9 g/dl and less than 7 g/dl respectively (14).

Participants were given a plastic stool container to take home for faeces sample collection, and these were collected the day after by home-visiting research nurses or sometimes handed in personally.

Intestinal parasitic infections

All parasitology laboratory work was conducted at the Bacteriology Laboratory of the PNG Institute of Medical Research (IMR) in Goroka. At the time of collection, the consistency of the stool sample (formed, soft, semi-soft or watery) was recorded. A portion of stool was examined by direct wet mount with saline (0.85% sodium chloride solution) to observe motile intestinal parasites and trophozoites under light microscopy at 100× and 400× magnifications. Lugol's iodine staining technique was performed to identify cysts of intestinal protozoan parasites.

Data analysis

Statistical analysis was performed with STATA software version 12. The Chi-squared (χ^2) test (or Fisher's Exact test when at least one cell in the contingency table had a population size of 5 or less) was used to verify possible associations between infection, anaemia and exposure to different risk factors. Probability values were considered to be significant when the p value was ≤0.05.

Results

Of the 201 tested pregnant women, 81% (n = 163) had a stool sample that was positive for one or more intestinal parasites: 130 women (65%) were infected with one or more intestinal protozoa, whereas 63 (31%)

were positive for one or more intestinal nematodes. Protozoan infections included *Entamoeba histolytica* (n = 87; 43% of all studied women), *Giardia lamblia* (n = 79; 39% of all studied women) and *Pentatrichomonas hominis* (n = 28; 14% of all studied women), while nematode infections included *Necator americanus* (hookworm) (n = 36; 18% of all studied women), *Ascaris lumbricoides* (n = 29; 14% of all studied women), *Strongyloides stercoralis* (n = 6; 3% of all studied women) and *Trichuris trichiura* (n = 4; 2% of all studied women) (Figure 1). Women who were free of protozoan infections were more often infected with a nematode (34/71; 48%) than women who had a protozoan infection (ie, co-infections, 29/130; 22%) ($p < 0.001$), indicating that a protozoan infection may lower the risk of nematode infections.

Overall the majority of the study population of pregnant women were characterized by: being younger than 25 years of age (109/193, 56%), having been pregnant at least once before (67/108, 62%), recruited into the study during their third trimester of this pregnancy (142/188, 76%), having completed more years of education than primary school only (102/197, 52%), sharing their house with 10 people or less (176/200, 88%), not having access to a flush toilet (175/197, 89%) (using open pit toilets or the river instead), and not having access to piped drinking water (107/200, 54%). In Table 1 associations between these potential risk factors and the women's infection status for intestinal protozoa and/or nematodes are summarized. No differences were found for the women's age, gestational age at recruitment, household crowding, access to a flush toilet or access to piped drinking water in relation to whether the women were infected with protozoa and/or nematodes during pregnancy. Being a primigravida (versus a multigravida) was found to be a risk factor for infections with protozoa, with 21% of the non-infected women versus 51% of the women with a protozoan-only infection being pregnant for the first time ($p = 0.031$). A history of restricted school education (completing primary school at the most) was found to be a risk factor for nematode infections in pregnancy, with 32% of the non-infected women versus 61% of the nematode-only infected women and 62% of nematode-protozoan co-infected women having had limited schooling (p value 0.018 and 0.016, respectively).

Haemoglobin levels were measured at the beginning of labour and were available for 110 women. Using altitude-adjusted haemoglobin levels, 63% (69/110) of the pregnant women

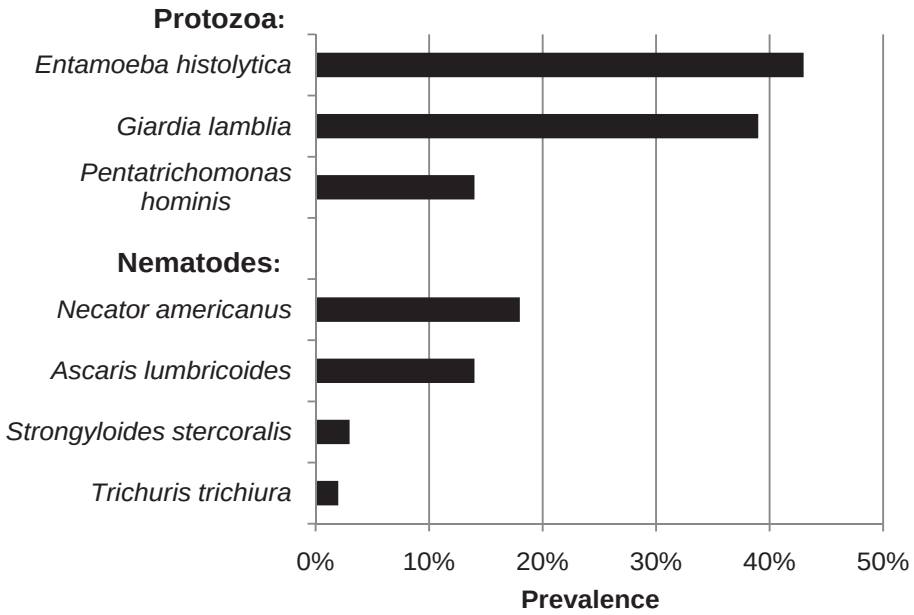

Figure 1. Prevalence (%) of intestinal parasitic infections among 201 pregnant women in Goroka.

TABLE 1

Association between intestinal protozoan and nematode infection during pregnancy and potential risk factors in 201 pregnant women in Goroka, Papua New Guinea

	No infection	Nematode infection only	Protozoan infection only	Nematode and protozoan co-infection	p value
Age 25 years or older	19/36 (53%)	13/32 (41%)	42/97 (43%)	10/28 (36%)	0.560
Multigravida	15/19 (79%)	13/19 (68%)	25/51 (49%)	14/19 (74%)	0.060
Third trimester of gestation	27/35 (77%)	23/33 (70%)	68/92 (74%)	24/28 (86%)	0.501
Education after primary school	25/37 (68%)	13/33 (39%)	53/98 (54%)	11/29 (38%)	0.043
More than 10 household members	3/37 (8%)	5/34 (15%)	15/100 (15%)	1/29 (3%)	0.305
Access to flush toilet	7/37 (19%)	5/33 (15%)	9/98 (9%)	1/29 (3%)	0.179
Piped drinking water	17/37 (46%)	16/34 (47%)	46/100 (46%)	14/29 (48%)	0.997

The Chi-squared (χ^2) test, or Fisher's Exact test when at least one cell in the contingency table had a population size of 5 or less, was used to determine the p values

were found to be anaemic (Hb <11 g/dl); most of these women had mild anaemia (9-10.9 g/dl) (62/110, 56%) and 6% (7/110) had moderate anaemia (7-8.9 g/dl).

There were no associations found between being infected with an intestinal parasite in pregnancy and being anaemic: 47/81 (58%) of the infected women were anaemic versus 12/16 (75%) of the non-infected women (p = 0.267). Also no differences were found in anaemia status or haemoglobin levels when these were related to whether the intestinal parasite was a protozoon or a nematode (Table 2).

Of the host risk factors tested earlier in relation to intestinal infections, overcrowding was possibly a risk factor for anaemia at the end of pregnancy (Table 3); however, this association was not considered significant (p = 0.076). No other associations were found.

Discussion

To our knowledge this is the first study reporting on the prevalence of intestinal parasitic infections among pregnant women in Papua New Guinea: the high prevalence (81%) reported here is comparable to that found for other low-resource settings such as Ecuador (93%), Venezuela (74%) and Indonesia (70%) (15-17).

Infections with the protozoan parasites *E. histolytica* and *G. lamblia* were the most common in this study. Blood-sucking nematode parasites such as hookworm and *S. stercoralis* were found in 18% and 3% of participants, respectively. The comparatively low prevalence of these parasites may explain the lack of relationship between intestinal parasitic infection and anaemia in this study.

We included *P. hominis* detection in the current study. This organism is generally considered commensal in humans; however, there is some evidence to suggest that *P. hominis* can be the cause of gastrointestinal illness (17).

Relationships between the prevalence

TABLE 2

PROPORTION ANAEMIC AND MEAN ALTITUDE-ADJUSTED HAEMOGLOBIN LEVELS AT THE BEGINNING OF LABOUR IN RELATION TO INTESTINAL PARASITIC INFECTIONS DURING PREGNANCY

	No infection	Nematode infection only	Protozoan infection only	Nematode and protozoan co-infection	p value
Anaemic (Hb<11 g/dl) (%)	12/16 (75%)	9/16 (56%)	29/46 (63%)	9/19 (47%)	0.387
Hb (g/dl) Mean ± SEM	10.41 ± 0.18	10.79 ± 0.31	10.68 ± 0.16	10.76 ± 0.28	0.737

The Chi-squared (χ^2) test was used to test for statistical differences in the proportions of women with anaemia in the different groups, while the one-way analysis of variance (ANOVA) was used to test for statistical differences in mean Hb levels between the groups
Hb = haemoglobin
SEM = standard error of the mean

TABLE 3

PROPORTION OF PREGNANT WOMEN ANAEMIC AT THE BEGINNING OF LABOUR IN RELATION TO THE HOST RISK FACTORS STUDIED

	Anaemic		
	No	Yes	p value
Age 25 years or older	19/40 (48%)	27/68 (40%)	0.429
Multigravida	25/41 (61%)	39/68 (57%)	0.710
Third trimester of gestation	30/38 (79%)	51/61 (84%)	0.559
Education after primary school	20/41 (49%)	37/66 (56%)	0.463
More than 10 household members	2/41 (5%)	12/68 (18%)	0.076
Access to flush toilet	5/41 (12%)	9/67 (13%)	0.853
Piped drinking water	18/41 (44%)	36/68 (53%)	0.361

The Chi-squared (χ^2) test, or Fisher's Exact test when at least one cell in the contingency table had a population size of 5 or less, was used to determine the p values

of intestinal infections and socioeconomic and environmental risk factors were also studied. Being a primigravida was found to be a risk factor for protozoan-only infections, and limited school education was found to be a risk factor for nematode infections. A study in PNG by King and Mascie-Taylor (7) showed previously that a lower education of the mother was the best predicting risk factor for children to be infected with *Strongyloides* and for higher *Ascaris* infection loads.

Despite the protective effects of iron supplementation against anaemia and its provision free of charge through antenatal clinics, less than half of the study participants reported taking it. In addition to iron supplementation, antihelminthic therapy could be given to infected women before conception as a public health strategy to improve their iron status (18). WHO's current recommendation is to provide antihelminthics after the first trimester of pregnancy in hookworm-endemic regions where anaemia is prevalent, and to support concomitant provision of iron supplements in areas with high rates of anaemia (19). The evidence to date is insufficient to recommend use of antihelminthics in pregnant women after the first trimester of pregnancy (20). From the meta-analysis of four randomized controlled trials, antihelminthics in pregnancy had no overall benefit on maternal anaemia, low birthweight or perinatal mortality. However, an observational study showed that antihelminthics in pregnancy significantly decreased the prevalence of soil-transmitted helminthic infection, improved maternal iron status and had beneficial effects on birthweight, and two studies found a beneficial effect on infant survival (21). More well-designed, large-scale randomized controlled trials are needed to establish the benefit of antihelminthic treatment during pregnancy. Meanwhile, increased efforts to improve the implementation of current protocols such as iron supplementation are needed in PNG and other low-income settings.

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