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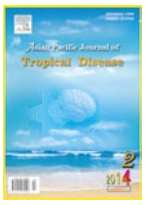

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Iron deficiency anaemia associated with helminths and asymptomatic malaria infections among rural school children in Southwestern Nigeria

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ABSTRACT

Objective: To estimate the relative contribution of causes of anaemia in the rural communities and evaluate the association between parasitic infections and anaemia.

Methods: A total of 292 blood and stool samples of aged 1-15 years school children were collected and analyzed using direct smear saline preparation and concentration methods for examination of ova of parasites in the stool samples with thick and thin blood films stained using Giemsa and Leishman stains as described by World Health Organization. Serum was estimated using ELISA test kit by Syntron Bioresearch, Inc., USA.

Results: The overall prevalence rate of parasitic infection was 66.4% with four species of intestinal helminth identified. *Ascaris lubricoides* (50.0%) was the most common followed by hookworm (8.9%), *Trichuris trichiura* (6.2%) and *Schistosoma mansoni* (1.4%). The mean haemoglobin level of plasmodium positive school children without intestinal helminth infection (10.8 g/dL) was slightly higher than those with intestinal helminth (10.0 g/dL). The mean serum ferritin of plasmodium positive without intestinal helminth (23.7 g/L) was also higher than those with helminth (22.5 g/L) and the differences were not statistically significant ($P>0.05$). Age and gender also made no significant differences in the distribution of the infections. However, there was a significant effect on weight and height by intestinal helminth infections ($P<0.05$).

Conclusions: It is recommended that the public be adequately health educated on the epidemiology of intestinal helminth infection. A periodic mass treatment of school children with iron supplementation is advocated.

1. Introduction

Anaemia continues to be a major public health problem worldwide and is estimated to affect half of the school age children in developing countries. Intestinal helminth infection, malaria and low iron intake are the main causes. Iron deficiency anaemia is the most prevalent nutritional deficiency worldwide and over 90% of affected individuals live in developing countries[1]. It is estimated to affect 1.3 to 2.2 billion persons[2]. Iron is an essential micronutrient that contributes to the production of haemoglobin, the transport of electrons in cells and the synthesis of a range of enzymes. When iron deficiency is sufficiently severe, red blood cell synthesis becomes impaired and anaemia results. Adverse consequences are most common and severe in women of reproduction age and young children[1].

Anaemia is a clinical condition characterized by a reduction in haemoglobin concentration of blood below a specified cut-off value for a particular age range and for the sex of the individual[3]. The World Health Organization (WHO)[4] defines anaemia in man as Hb<13 g/dL, woman with Hb<12 g/dL, children 6 month to 6 years with Hb<11 g/dL and those aged 6-14 years with Hb<12 g/dL[3].

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 infection. And parasitic infection, malaria, *Trichuris trichiura*, hookworm

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Schistosoma haematobium infection are known to contribute to iron status and iron deficiency anaemia[5,6]. However, iron deficiency is not the only cause of anaemia. Other prevalent causes of anaemia include chronic infections and nutritional deficiency of vitamin A, folate and vitamin B12[7].

In view of the insidious nature of these infections and paucity of report on the infection in these communities, our goal was to estimate the relative contribution of causes of anamiea in the rural communities in Osogbo and evaluate the association between parasite infection and anaemia in order to provide a basis for more effective prevention and control.

2. Materials and methods

2.1. Study area

The study was conducted in three communities, located in two local government areas of Osun State. The communities are Ara and Okinni located in Egbedore local government area, and Ilie located in Olorunda local government area. The communities have a tropical climate with temperature ranging from 25 °C to 32 °C. The two distinct seasons in the areas are the wet/raining and dry seasons. The three communities are developing rural communities whose inhabitants are predominantly Yoruba (Osogbo dialect), who engage mainly in subsistence farming. In the communities, sanitation is very poor. Health care services are not widely available and portable water supply is infrequent, therefore the inhabitants usually depend on streams, well and harvested rain water.

2.2. Study population

The study population consisted of both male and female children aged 1-15 years in school and available healthcare centres. Prior to the commencement of the study verbal permission was obtained from the local education authority of the two local government areas and from the community leader/traditional institutions.

2.3. Data collection

Personal hygiene and environmental sanitation information were obtained about the children, which was done directly through the teachers and health centre nurses who were familiar with the local condition. The questionnaire included information on age, sex and nutritional level was administered by a trained interviewer. Anthropometric measurements were obtained during each visit. Weight was measured to the nearest 0.1 kg with a standard standing scale. Height was measured to the nearest 0.1 cm with a paper stadiometer attached to a straight wall.

2.4. Sample collection

The subjects were given a stool receptacle on the eve of the day of examination with specific instruction to collect the fresh stool samples that was passed in the morning while blood samples were collected into ethylenediaminetetraacetic acid bottle.

2.5. Laboratory analysis and classification of parasites

Direct smear saline preparation of stool was examined for ova of parasites under the microscope within 24 h of collection using ×10 and ×40 objectives lenses as recommended by WHO[8]. Negative samples were subjected to concentration method as described by WHO[8]. Thick and thin films were made from collected blood samples and stained with Giemsa and Leishman respectively, employing the methods[9] in order to detect and identify the species of plasmodium parasites in the blood. The haemoglobin concentration was evaluated using cyanmethaemogbloin method[9]. Serum ferritin was estimated using ELISA test kit (Microwell Ferritin EIA) produced by Syntron Bioresearch, Inc. CA, USA. The procedure was according to the manufacturer's instruction.

2.6. Statistical analysis

Differences in mean haemoglobin values between plasmodium infected pupils with and without intestinal helmnith infections were tested for statistical significance using chi-square analysis. The mean serum ferritin differences values between plasmodium infected pupils with and without intestinal helminth infections were also tested for stastical significance.

3. Results

3.1. Prevalence of intestinal helminthes among the school children

Intestinal helminthiasis among the pupils in three communities is shown in Table 1. Of the 292 stool samples examined, 194 (66.4%) were infected with helminth consisting mainly of *Ascaris lumbricoides* (*A. lumbricoides*), hookworm, *Trichuris trichiura* (*T. trichiura*) and *Schistosoma mansoni* (*S. mansoni*) with prevalence rate of 50.0%, 8.9%, 6.2% and 1.4% respectively.

3.2. Haemoglobin distribution among plasmodium positive subjects with and without associated helminth infections

Table 2 shows the mean haemoglobin of plasmodium positive school children with and without helminth infections. This illustrated the effects of plasmodium with

Table 1
Prevalence of intestinal helminth infections in plasmodium positive school children.

Helminths	Ilie (n=142)		Ara (n=118)		Okinni (n=32)		Overall (n=292)	
	No. infected	% Infected	No. infected	% Infected	No. infected	% Infected	No. infected	% Infected
A. lumbricoides	66	46.5	64	54.2	16	50.0	146	50.0
Hookworm	14	9.9	10	8.5	2	6.3	26	8.9
T. trichiura	18	12.7	–	–	–	–	18	6.2
S. mansoni	4	2.8	–	–	–	–	4	1.4
Total	102	71.8	74	62.7	18	56.3	194	66.4

and without helminth infection. The mean haemoglobin values of plasmodium without intestinal helminth infection (10.8 g/dL) is higher than those with intestinal helminth (10.0 g/dL), but the difference were not statistically significant (P>0.05).

Table 2
Mean haemoglobin of plasmodium positive school children within the communities with and without helminth infection.

Communities	Mean haemoglobins (g/dL)	
	With IHI	Without IHI
Ilie	10.50±0.73	11.30±0.97
Ara	9.70±1.49	10.80±1.17
Okinni	7.80±0.00	8.90±0.71
Total	10.00±1.31	10.80±1.22

Data are expressed as mean±SD. IHI: Intestinal helminth infection.

3.3. Serum ferritin levels in plasmodium positive subjects with and without associated helminth infections

The mean serum ferritin of plasmodium positive school children with and without helminth infection is shown in Table 3. The mean serum ferritin level of the malaria positive without helminth (23.7 μg/L) was higher than those with helminth (22.5 μg/L), also producing no statistically difference (P>0.05).

Table 3
Mean serum ferritin of plasmodium positive school children within the communities with and without helminth infection.

Communities	Mean serum ferritin (μg/L)	
	With IHI	Without IHI
Illie	25.30±1.56	26.80±2.19
Ara	20.70±3.01	22.50±2.97
Okinni	14.90±0.00	19.10±1.56
Total	22.50±3.61	23.70±3.57

Data are expressed as mean±SD. IHI: Intestinal helminth infection.

3.4. Age, gender and weight relationship among study subjects

Table 4 shows the relationship of age, sex and weight compared with the standard weight. The degree of weight difference in both male and female school children was compared with a marked depreciation due to the rate of infection. The weight loss affected all the children with a marked depreciation. The weight loss increased along the age of the children which implied that many children were nutritionally unstable. However, the data analysis showed significant difference in the weight loss and the infective rate (P<0.05) which were inversely proportional.

Relationship of age, sex and height compared with the

Table 4
Relationship of age, sex and weight compared with the standard mean weight

Age group (years)	Sex	No. Examined	Working height mean value (m)	Standard height mean value (m)	Weight difference (kg)	Total No. infected	% Infectivity
1–5	M	100	13.3	12.0	1.3	60	60.0
	F	64	12.6	11.5	1.1	40	62.5
6–10	M	42	20.3	20.7	0.4	24	57.1
	F	48	22.6	20.1	2.5	36	75.0
11–15	M	14	25.6	34.3	8.7	12	85.7
	F	24	27.2	34.2	7.0	22	91.7

Table 5
Relationship of age, sex and weight compared with the standard mean height.

Age Group (years)	Sex	No. Examined	Working height mean value (m)	Standard height mean value (m)	Weight difference (kg)	Total No. infected	% Infectivity
1–5	M	100	88.6	87.8	0.8	60	60.0
	F	64	86.1	87.9	1.8	40	62.5
6–10	M	42	116.4	117.6	1.2	24	57.1
	F	48	126.3	117.2	9.1	36	75.0
11–15	M	14	133.3	143.8	10.5	12	85.7
	F	24	135.9	143.3	7.4	22	91.7

standard mean height is shown in Table 5. Result showed that intestinal helminth infection retarded growth rate of the school children irrespective of the sex and age which was an indicator of nutritional instability ($P<0.05$).

4. Discussion

This study has provided baseline data about anthropometric indices, anaemia and intestinal helminthic infections of school children among the three communities. Morbidity due to soil transmitted helminthiasis has remained a major problem in the areas with an overall prevalence rate of 66.4%. This study has shown that *A. lumbricoides*, *T. trichiura*, hookworm and *S. mansoni* were the commonest intestinal helminth isolates. The high prevalence is connected with the fact that poor sanitation, lack of knowledge on health care in the study, compared with poor personal and environmental hygiene practice. Also, the occurrence of helminth infection is indicative of faecal pollution of soil and domestic water supply around home dues to poor sanitation and improper sewage disposal. Studies among researchers in Nigeria have highlighted the hyperendemicity of soil transmitted helminthes, especially among children[10-12].

The most prevalent intestinal helminths infection among children in the study area was *A. lumbricoides* with a prevalent rate of 50.0%. This result is consistent with a report which shows that intestinal helminthiasis caused by roundworm is a common disease among children in Nigeria[13]. The highest prevalence of *A. lumbricoides* recorded in this study could indicate high level of an unhygienic practices and the habit of defaecating indiscriminately among children, which eventually contaminate the environment. Among the children in the study area, hookworm infection was next to *A. lumbricoides* with 8.9% prevalence rate, followed by *T. trichiura* (6.2%) and *S. mansoni* (1.4%).

Iron deficiency has been shown to be a major cause of anaemia, but malaria, thalassemia and megaloblastic anaemia can also contribute to anaemia[14]. The role of hookworm and *T. trichiura* in causing iron blood loss and reducing absorption is well documented with hookworm having the most significant effect on anaemia[15,16]. The prevalence of hookworm in this study was 8.9%, which is higher than that reported among school children in Vom, Plateau State Nigeria with the prevalence of 3.2%[17], but less than the data reported in Ijesha-Ijebu and Okun-Owa in Ogun State with the reported prevalence rate of 17%[18], and in Akoko-Edo, Edo State (65.7%)[18]. The prevalence of 6.2% for *T. trichiura* in this study agrees with the study of Nmorsi *et al.*[18], but disagrees with that obtained where 57.0% of children were reported to have *T. trichiura* infection in riverine areas of Delta State, Nigeria[19].

The occurrence of intestinal helminth infection in malaria parasitaemia school children was found to have effect on the mean haemoglobin and mean serum ferritin. This was found by grouping mean haemoglobin and mean serum ferritin of plasmodium positive school children with intestinal helminth infections separately from those without intestinal helminths. The results indicated that those school children with malaria parasites but without intestinal helminths infections had higher value of mean hemoglobin and mean serum ferritin than those with both plasmodium and intestinal helminth infection. In this study the presence of malaria with intestinal helminth and without intestinal helminth were not statistically significant with anaemia since the mean hemoglobin and mean serum ferritin values had no significant association between plasmodium with intestinal helmith and without intestinal hemith among the school children in the communities. Reduced mean hemoglobin and mean serum ferrItin levels in plasmodium positive school children with intestinal helminth are attributed to chronic loss of blood and iron. The most important cause of pathological chronic loss of blood and iron in the tropics are malaria and soil transmitted helminths such as hookworm, *T. trichiura* and *S. mansoni*[20]. Plasmodium/intestinal helminth co-infections anaemia among children is aggravated by low nutritional status of subject whose stable foods such as rice, cassava, and maize are poor sources of folate and iron[13].

This study has shown that the weight of the school children has been adversely affected by the parasitic infection that has given a picture of low weight compared to their height and age, a clear indication of adverse effect of infection on the subject. These was a presentation of low weight and shoddy height among the children. There is an adverse effect on normal growth using weight and height chat as growth marker. This has been supported by report that worms antagonize the child metabolism and diminish appetite, which reduces the weight of the children and shows common symptoms of malnourishment[21].

The public health significance of these parasitic infections aiming at reducing anaemia prevalence should include the control of these infection in the community. It is therefore suggested that only well organized health education programmes on personal hygiene and community health and adequate supply of portable and safe water in addition to the provision of a basic sanitation facilities like toilet, shall bring a long lasting solution to the menacing problem of the infection. Also, anthelminthic mass treatment should be performed with supplemental iron which will percent iron deficiency anaemia.

Conflict of interest statement

We declare that we have no conflict of interest.

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