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Prevalence of Helminth Infection in Children Living Under Different Living Conditions in Southern Nigeria

[1]*AM Awanye, [1]CNEIbezim, [1]CN Stanley, [1]G Uchendu, [1]NC Oreh, and [2]M Jubril

[1]Department of Pharmaceutical Microbiology and Biotechnology, Faculty of Pharmaceutical Sciences, University of Port Harcourt, Rivers State, Nigeria; [2]Department of Pharmacology, Faculty of Pharmaceutical Sciences, Bayero University, Kano, Nigeria
**Corresponding author: AM Awanye*

ABSTRACT: *Intestinal helminthic infections are serious health problems because of complications such as iron-deficiency anaemia, growth retardation in children and other physical and mental health problems. The incidence of helminthic infection has been linked with several factors such as poverty and poor levels of hygiene and sanitation. This study was carried out to determine the relationship between living conditions and helminth infection in children. The prevalence and outcome of gastrointestinal helminth infection was studied among 100 children aged 0 – 12 years of Rumuekini community, Obio-Akpor area of Rivers State, Nigeria. A total of 100 samples were collected from children living in both informal and formal housing accommodations. Examination of stool and blood samples revealed presence of intestinal helminths in 15 children (15%), with a higher prevalence (11%) in children living in informal housing accommodation as compared with those in formal housing (4%). The highest incidence of helminth infection was recorded with Ascarislumbricoides in both study groups. In children living in informal housing accommodation, 20% with helminth infection were also anaemic and 16% were also eosinophilic. Whereas in the formal housing study group, 4% and 6% had anaemia and eosinophilia respectively. A correlation is observed between helminthiasis and eosinophilic state in both study groups.It is therefore recommended that adequate housing accommodation and facilities should be provided in order to combat helminthic infection especially in children.*

KEYWORDS: *Helminth infection, gastrointestinal parasite, anaemia, housing accommodation*

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I. INTRODUCTION

Parasitic intestinal infections such as roundworm (*Ascarislumbricoides*), whipworm (*Trichuristrichiura*) and hookworm (*Necatoramericanus* and *Ancylostomaduodenale*), constitute major health problems throughout the world. These parasites are a major cause of mortality and morbidity especially in people that live in under-developed countries. It is estimated that about 1 billion people living in resource-limited countries are infected with intestinal helminths and majority of these infections occur in children de Silva, Brooker (1). Factors such as poverty and poor health care facilities contribute to the prevalence of helminthic infections in developing countries (2). In addition, poor environmental conditions such as unsanitary environments, inadequate housing facilities, and lack of adequate water supply also increase the risk of exposure to these intestinal parasites. Children are at a higher risk of infection. Parasites get into their intestines mainly through ingesting contaminated food and water. In addition to the mortality and morbidity associated with chronic helminthiasis, infected children are also predisposed to stunted growth, malnutrition and weakened immune system (3-5).

Nigeria has the highest burden of disease in Africa (6). Several epidemiological studies have indicated a high prevalence of intestinal helminthic infections in children living in Nigeria (3, 7, 8). However, none have investigated the influence of living accommodation on the parasite carriage. Therefore the aim of this study was to determine the effect of environmental conditions such as housing, water supply, number of occupants per household on the incidence of helminth infection in children below 12 years of age, living in southern Nigeria.

II. MATERIALS AND METHODS

Study Area

The study was carried out amongst children living in Rumuekini community, Obio-Akpor Local Government Area of Rivers State in Southern Nigeria. Rumuekini community lies within the tropical rain forest zone of Africa. It has the characteristic wet and dry seasons although with more wet days than dry days. The area is a semi urban area comprising of people of different ethnic origins. The area is unindustrialized with no tourist centre and has farming and petty-trading as the major sources of livelihood. An observation of the residential area showed that most of the buildings were clustered with many blocked drainages. Some of the buildings within this area are well structured and planned and comprise mainly of apartment buildings or flats. However, many buildings were also temporal structures or informal housing that share a common toilet that is often pit latrine or a water system that is manually flushed with water.

Study Population

The study population comprised children between the ages of 0 – 12 years old living in the community. The respondents were grouped into two categories, formal housing and informal housing, based on their living conditions. Table 1 shows the characteristics of study area. In addition, children grouped under formal housing live in less congested and spaced living environments, mainly well structured apartments, with portable water. The living conditions for informal housing lacked basic civic amenities such as electricity, portable water and proper waste disposal system. These dwellings lack a defined kitchen or bathroom with more than 4 people sharing a bedroom.

Ethical Approval

Approval to carry out the study was obtained from the University of Port Harcourt Teaching Hospital Research and Ethics Committee UPTH/ADM/90/S.II/VOL.X/250. Written informed consent was obtained from parents or guardians of the children.

Inclusion and Exclusion Criteria

Non-febrile children below 12 years of age residing in the study area whose parents or legal guardians signed the voluntary informed consent forms were enrolled into the study. Febrile children, those who had spent less than a month in the area, children older than 12 years and those whose parents or guardians did not consent to their participation were excluded from the study.

Questionnaire administration

Questionnaires were administered to all parents and guardians of children enrolled in the study to obtain the demographic information and to evaluate their knowledge and perception of helminth infection.

Sample Collection

Stool samples were collected from randomly selected children. Clean dry bottles were used for collection of their morning stool. A total of 50 samples were collected from children living in formal housing conditions and 50 samples from children living in informal housing conditions. Stool samples were examined within 2 hours of collection. Blood samples were also collected from the children and stored in sterile EDTA-containing plastic bottles. Blood samples were examined within an hour of collection. Each sample collected was assigned an identification number for identity protection. The weight and height of the children were also determined and questionnaires were also distributed to their parents.

Examination of Stool Sample

A total of 100 stool samples were examined macroscopically for consistency, colour and for the presence of mucus, blood and adult worms, or their segments. Microscopic examination was carried out on the faecal samples collected using wet preparation method as described by Cheesbrough(9). In brief, a drop of fresh physiological saline was placed on one end of a clean slide and a drop of iodine was placed on the other end of the slide. Using an applicator stick, a small amount of stool specimen was emulsified in saline and iodine solution. Each preparation was covered with cover slip and examined under the microscope for the presence or absence of intestinal parasite, larvae, ova or cysts. The preparation was observed under the microscope using x10 and x40 objectives respectively.

Differential White Blood Cell Count

This was carried out by using WHO modified chart method as described by Cheesbrough(9). In brief, a drop of the blood sample was placed on a clean dry slide using Pasteur's pipette. A clean slide was used as the spreader to create a thin film of the blood sample on the slide. The slide with the thin blood film was air dried by waving the slide back and forth. The blood film was stained with some drops of Leishman stain and allowed 10 minutes incubation before adding twice the number of drops Leishman stain of electrophoresis buffer. This was allowed to air dry for 24 hours, and then a drop of immersion oil was placed on the blood film and examined microscopically. The shape and sizes of various white blood cells were observed by focusing with x10 and x40 objectives. The number of each white blood cell was counted using WHO modified chart Cheesbrough(9).

Packed Cell Count

The heparinised capillary tube was filled to three quarter with the heparinised blood. The unfilled end of the capillary tube was filled with sealant material. The filled capillary tube was carefully slotted into the micro-haematocrit rotor with the sealed end against the rim gasket of the micro-haematocrits, with a number apportioned to each slots of the capillary tubes. The capillary tubes were centrifuged for 5 minutes at 10,000 revolutions per hour. After centrifugation, the packed red cells were read using a micro-haematocrit reader, by aligning the base of the red cell column (above the sealant) on the 0 lines and the top of the plasma column on the 100 lines. The packed cell volume of sample was read from the scale and compared with reference standard (9).

Analysis of Data

Statistical analysis of the data was performed using Statistical Package for Social Sciences (IBM SPSS) for Mac version 26 (IBM Corp., Armonk, N.Y., USA). Descriptive statistics and correlation analyses were carried out. The level of significance for each test was set at $P< 0.05$.

III. RESULTS

Demographic characteristics of respondents

A total of 100 children, 38 males and 62 females, living in Rumuekini area of Obio-Akpor Local Government Area of Rivers State were recruited for the study; stool and blood samples were obtained from each child. The characteristics of each study area are defined in Table 1. The distribution of the subjects based on socioeconomic class and health characteristics are shown in Table 2. Equal numbers of children (50) were recruited from both formal and informal housing study groups. The mean age for children living in informal and formal living conditions that were recruited in this study are 8.08 ± 3.19 and 7.42 ± 3.34 respectively. The body mass index (BMI) assessment for these children showed that most of the children were within the normal healthy weight and only 28% and 20% of the recruited children from informal and formal housing study groups respectively were underweight. Children with anaemia were detected in 52% and 48% of respondents from informal and formal housing accommodations respectively. In addition, 24% and 16% of children showed high levels of eosinophils in informal and formal housing accommodations respectively.

Table1: Characterization of study area with the predisposing risk factors that is typical of the respective populations within the community.

Risk Factors	Informal Housing	Formal Housing
House structure	House made from wood	House made from cement
	Single room for multi-purpose	Bedroom separate from other rooms
Water Source	Rain water	Bore hole
	Fetched with buckets	Tap/running water
Toilet Type	Open field defecation	Water closet
	Pit latrine	
Disposal of refuse	Dumpsite	Waste management company

n = 50 for each study group

Table 2: Socio-demographic and health characteristics of study population.

Characteristic	Informal Housing		Formal Housing	
	Frequency (n)	Relative frequency (%)	Frequency (n)	Relative frequency (%)
Age group				
0 - 2 years	3	6	4	8
3 - 6 years	13	26	15	30
7 - 9 years	15	30	15	30
10 - 12 years	19	38	16	32
Gender				
Male	17	34	21	42
Female	33	66	29	58
BMI (Kg/m^2)				
Underweight	14	28	10	20
Healthy weight	31	62	36	72
Overweight	3	6	2	4
Obese	2	4	2	4
PCV count				
Normal	24	48	26	52
Anaemic	26	52	24	48

Eosinophil count				
Normal	38	76	42	84
Eosinophilic	12	24	8	16
Helminth infection				
No infection	39	78	46	92
Ascarislumbricoides	7	14	3	6
Hookworm	3	6	0	0
Trichuristrichiura	1	2	1	2
Total Infection	11	22	4	8

n = 50 for each study group; BMI: Body mass index; PCV: Packed cell volume

Overall prevalence of helminth infection

Macroscopic evaluation of the stool samples showed absence of adult worms or blood in all 100 samples collected. However, 4% of the stool samples from children living in informal living conditions showed evidence of mucus in their stool. The result is represented in Fig. 1. As shown in Fig. 2, 15% of the total population sampled had evidence of helminthiasis. Of the 50 children tested in each study group, 22% and 8% of children living in informal and formal housing respectively had parasite ova detected in their stool. Among the infected children (Table 2), Ascaris worm infection had the highest prevalence in both informal and formal housing study groups (14% and 6% respectively), followed by hookworm infection in informal housing group (6%). Helminth infection caused by *Trichuristrichiura* recorded the least prevalence (2%) in both study groups.

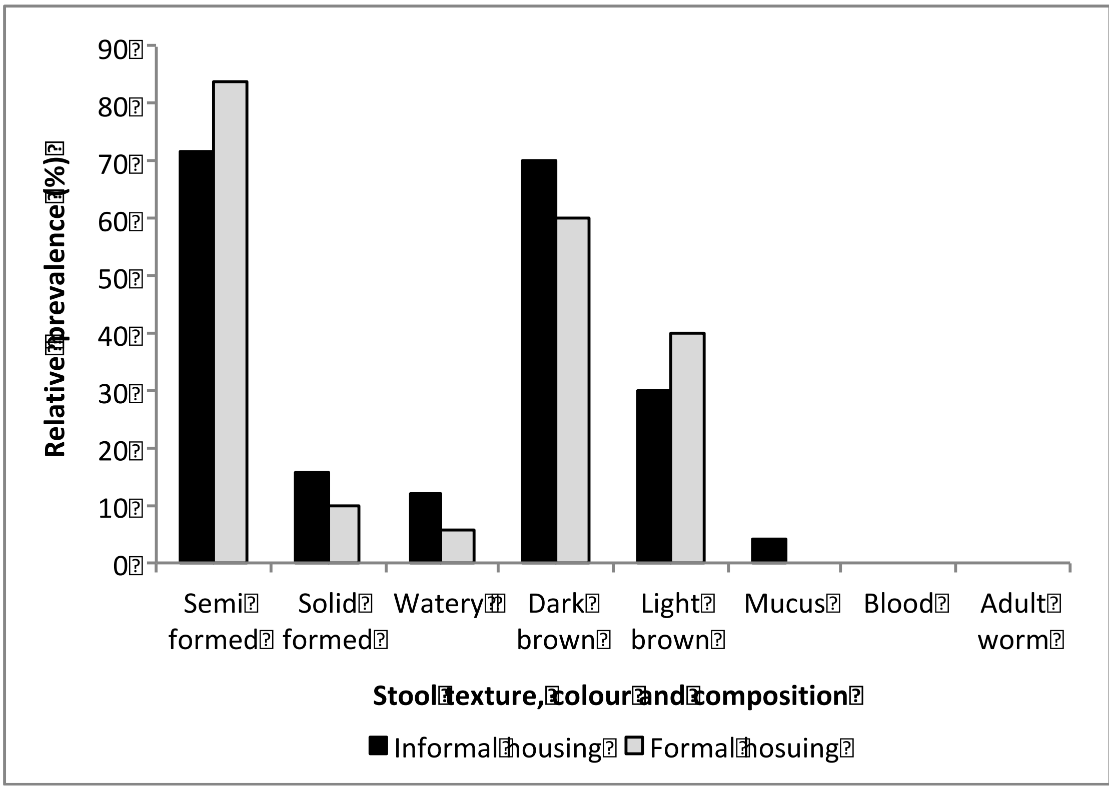

Fig. 1: Macroscopic examination of stool samples showing absence of adult worms or blood in the stool sample of study population. A 4% mucus-containing stool was evident among children living in informal living conditions (n=50).

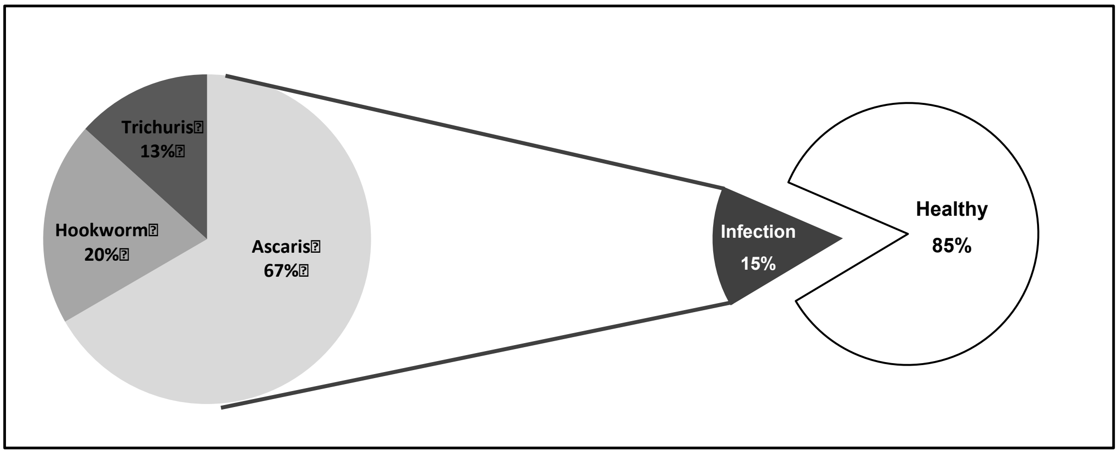

Fig. 2: Total prevalence of helminth infection. Among the studied population (N=100), there was 85% healthy and 15% infected children. Prevalence of helminthiasis revealed Ascaris worm infection (67%) as the highest while *Trichuristrichiura* recorded the least prevalence (13%).

Relationship between helminth infection and health and weight status of respondents

The body mass index (BMI) cut-off used for weight categories is based on recommendations proposed by an expert committee organized by the Centre for Disease Control and Prevention (CDC), Centre for Human Resources Services Administration (HRSA) and American Medical Association (AMA). The weight categories for children were classified as follows: Underweight, when the BMI is less than the 5^{th} percentile; Normal weight, when the BMI falls between the 5^{th} and 85^{th} percentile, Overweight, when the BMI falls between the 85^{th} and 95^{th} percentile and Obese when the BMI is equal or greater than the 95^{th} percentile (10). As shown in Table 2 and according to the proposed guidelines, 48% of all respondents were found to be underweight; 28% and 20% from the informal and formal housing study groups respectively. Of the 28% of children in the informal housing study group that were underweight, 20% of them had evidence of helminthic infection (Table 3), comprising 12% *Ascaris*, 6% Hookworm and 2% *Trichuris* infections. Only 2% of the sample population group had Ascaris infection but were within the normal healthy weight category. In comparison to the formal housing study group, 20% was underweight and 2% of this is associated with Ascaris infection. The other 6% of children with evidence of helminth infection were within the normal healthy weight.

As shown in Table 2, 52% of children in informal housing were anaemic, 20% of these children also had evidence of worm infection (Table 3). Only 2% of non-anaemic children had worm infection. Similarly, 16% out of 24% of children showed evidence of eosinophilia with worm infection while 6% despite having worm infection were not eosinophilic (Table 3). In the formal housing study group, 4% and 6% of children had anaemia and eosinophilia respectively in combination with worm infection. Despite having worm infection, 4% and 2% of the children were neither anaemic nor eosinophilic respectively (Table 3).

Table 3: Prevalence of helminth infection.

	Number of children with helminthic infection					
	Informal Housing (n = 11)			Formal Housing (n = 4)		
Characteristic	Ascaris (n = 7)	Hookworm (n = 3)	Trichuris (n = 1)	Ascaris (n = 3)	Hookworm (n = 0)	Trichuris (n = 1)
Prevalence, n (%)	7 (14%)	3 (6%)	1 (2%)	3 (6%)	0 (0%)	1 (2%)
Age group						
0 - 2 years	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
3 - 6 years	1 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
7 - 9 years	3 (6%)	1 (2%)	0 (0%)	3 (6%)	0 (0%)	0 (0%)
10 - 12 years	3 (6%)	2 (4%)	1 (2%)	0 (0%)	0 (0%)	1 (2%)
Gender						
Male	2 (4%)	1 (2%)	0 (0%)	1 (2%)	0 (0%)	1 (2%)

Female	5 (10%)	2 (4%)	1 (2%)	2 (4%)	0 (0%)	0 (0%)
BMI (Kg/m^2)						
Underweight	6 (12%)	3 (6%)	1 (2%)	1 (2%)	0 (0%)	0 (0%)
Healthy weight	1 (2%)	0 (0%)	0 (0%)	2 (4%)	0 (0%)	1 (2%)
Overweight	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Obese	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
PCV count (%)						
Normal	1 (2%)	0 (0%)	0 (0%)	1 (2%)	0 (0%)	1 (2%)
Anaemic	6 (12%)	3 (6%)	1 (2%)	2 (4%)	0 (0%)	0 (0%)
Eosinophil count (%)						
Normal	1 (2%)	1 (2%)	1 (2%)	1 (2%)	0 (0%)	0 (0%)
Eosinophilic	6 (12%)	2 (4%)	0 (0%)	2 (4%)	0 (0%)	1 (2%)

BMI: Body mass index; PCV: Packed cell volume

The relationships between helminthic infection and body weight, anaemic or eosinophilic states were determined using correlation analysis (Table 4). In children living in informal accommodations, the result showed no correlation between helminth and age or gender. A negative correlation was observed between helminth infection and weight status. While anaemic and eosinophilic states showed a positive correlation with helminth infection. These relationships were all statistically significant, p-value <0.05. Conversely, besides eosinophilic state, there was no correlation between helminthiasis and other body measurements for children living in formal housing. Differences observed were not statistically significant, p-value >0.05.

Table 4: Relationship between helminth infection and other conditions.

	Informal Housing				**Formal Housing**			
	r	p-value	Significance	Remark	r	p-value	Significance	Remark
Gender	0.075	0.603	NS	No significant correlation	-0.048	0.742	NS	No significant correlation
Age	0.247	0.084	NS	No significant correlation	0.052	0.721	NS	No significant correlation
Weight	-0.589	0.0001	S	Negative correlation	-0.08	0.581	NS	No significant correlation
PCV	0.414	0.003	S	Positive correlation	0.012	0.935	NS	No significant correlation
Eosinophile count	0.606	0.0001	S	Positive correlation	0.475	0.0001	S	Positive correlation

r:Pearson's correlation coefficient; NS: Not significant; S: Significant; PCV: Packed cell volume

IV. DISCUSSION

From our study, intestinal helminth infections caused by *Ascarislumbricoides* was the most prevalent intestinal parasite identified in both study groups (10%). This is in agreement with other studies that showed that amongst *A. lumbricoides, T. trichiura* and Hookworm; *A. lumbricoides* remained the most prevalent helminthic infection in school children in Nigeria (5). Despite several studies that had been done to determine the prevalence of intestinal helminth infection in children in Nigeria, there is still a paucity of epidemiological information in our locality. In addition, despite the increased awareness on the effect of poor hygiene in the incidence of soil transmitted helminth infections, people living in poor living conditions still find it difficult to practice good sanitation and hygiene. There are relatively few studies that have investigated the influence of living condition on the prevalence of helminth infection especially in children. Our findings show a significant effect of living accommodation with the incidence of helminth infection. A higher prevalence of helminth infection among the school age children (3-12 years) could be attributed to the climatic condition of the study area. Rainy season influences soil moisture and survival of egg and larvae of soil transmitted helminths(8), which exposes the children to moist environment with likelihood of infection during school hours. More so, those living in informal accommodation seem to observe little or no hygienic or sanitary practices including open-air defecation and use of pit latrines without regular deworming due to low financial income. The negative correlation observed between helminth infection and body weight observed in this study is a reflection of the nutritional status of this study category. It has been proposed and reported that mechanisms of adverse effects of helminth infection on nutrition includes decreased appetite and nutrient intake, impaired absorption, increased nutrient loss or altered metabolism (11). According to Hurst and Else (12), *Ascaris* worms express a range of retinol binding proteins, retinol dehydrogenase, and retinoic acid receptors which use retinol for growth. In congruence with the report and studies of Darlan and Huang (13, 14), eosinophilia is a marker and central feature of the host response to helminth infection as evidenced in both study groups. It has been documented that the larval stages of parasitic worms are killed by eosinophils in the presence of specific antibodies or complement proteins (14).

From the study, it is evident that soil transmitted helminth infections with its attendant effects exist among children of Rumuekini community. It is therefore recommended that adequate housing accommodation and facilities should be provided in order to combat helminthic infection especially in children. In addition, education and counselling on adequate personal hygiene and sanitary practices be inculcated into the residents especially the school age children. Teachers and parents should pay greater attention to the cleanliness of their children so as to reduce the burden associated with this public health challenge.

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Conflict of interest
There are no conflicts of interest

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