A COPROLOGICAL SURVEY OF GEOHELMINTH INFECTIONS AMONG SCHOOL CHILDREN IN RURAL EBONYI STATE, NIGERIA

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ABSTRACT

A cross-sectional coprological survey involving 420 primary school pupils of both sexes aged 6-14 years, was conducted in 8 primary schools at different locations in Ishielu Local Government Area (L.G.A.) of Ebonyi State, Nigeria, to determine the prevalence and intensity of infection of the geohelminth (soil-transmitted helminth) parasites. The dominant geohelminth parasites identified were Ascaris lumbricoides (32.9%), Trichuris trichiura (20.5%), and hookworms (3.8%). Altogether 240 respondents composed of 124 (29.4%) males and 116 (27.6%) females were infected with one or more of the parasites thus establishing an overall prevalence of 57.1%. In 7/8 (87.5%) of the study primary schools, over 50% of the children harboured the ova of the parasites. The distribution of the infections were not gender-dependent, and the between-sex prevalence was not statistically significant ($p > 0.05$). The prevalence of the infections appeared to be generally age-dependent but not over- dispersed as there was a marked association between age of the pupil and the infectious process. Concomitant infection involving 13.3% of all the infected pupils was recorded. Generally, the intensity of the geohelminthiasis was of the light category for A. lumbricoides ($\leq$ 4999 eggs per gram faecal matter(epg); T trichiura ($\leq$ 999 epg); and hookworm ($\leq$ 999 epg). Moderate infections (1000 – 9999 epg) of trichiuriasis was recorded in all the study schools. A deworming programme of the infected schools and the at–risk population is recommended.

Keywords: Coprological survey, Geohelminth, Prevalence, Intensity of infection, Concomitant infection

INTRODUCTION

Despite the availability of suitable anthelmintic drugs, the human intestinal helminths continue to represent an undesirable global scourge in the developing countries of Africa, Asia and Latin America where their prevalences continue to increase. Humans are known to serve as hosts for over 300 species of helminths about 200 species of which have been reported from the alimentary tract and its associated ducts and organs. By for the most abundant and widely distributed species of human helminths are the nematodes (*Ascaris lumbricoides*, hookworms (*Ancylostoma duodenale* and *Necator americanus),* and whipworm (*Trichuris trichiura).* The two species of the hookworm together with *A. lumbricoides and T. trichiura* make up the quartet of major soil-transmitted helminths or geohelminths. These four nematode species undergo monoxenous (direct) life cycle pattern and transmission to human depends on faecal contamination of the soil and environment. While *A. duodenale* and *N. americanus* are transmitted via their soil-inhabiting filariform larvae that actively penetrate the skin of their hosts, *T. trichuris* and *A. lumbricoides* are transmitted to man directly through the accidental ingestion of their ova.

Recent estimates suggest that more than one billion people are infected globally with human geohelminth-induced disease while the at-risk population is over 2 billion people, (Montressor *et al.*, 1998; Brooker *et al.*, 1999). Morbidity due to geohelminthiasis is usually pronounced in children and pregnant women because it influences the nutritional status causing growth retardation in children and decreases work capacity and fitness in women (Crompton and Savioli, 1999). It further reduces cognitive development and increases absenteeism from school (Adams, 1994; Nokes *et al.,* 1992; Chan, 1997). The most serious consequences of geohelminth infections stem from chronic infection during the vulnerable years of childhood. It has been estimated that *N. americanus* is responsible for a mean ($\pm$ SD) blood loss of 0.03 $\pm$ 0.012 ml per day. Similarly *A. duodenale* has been estimated to cause a mean blood loss of about 0.08 $\pm$ 0.02 ml per day (Awogun *et al.,* 1995; WHO 1994). These measurements of feeding activity explain the pathogenicity of hookworm and account for their contribution to the development of iron-deficiency (hypochromic) anaemia.

Over the past four decades various studies have been conducted in different parts of Nigeria to elucidate principally, the epidemiological profiles of intestinal and other human infections. Okpala (1961), Okpala and Njoku-Obi (1978) carried out investigations on the prevalence of intestinal helminths in Lagos and Nsukka areas respectively while Onubogu (1978) and Udonsi (1984, 1992) conducted epidemiological investigations in parts of old Anambra, Imo and Rivers States on features of intestinal nematode infections.

There is a dearth of published data on geohelminth epidemiological surveys in parts of Ebonyi State since the state was excised out of the former Enugu and Abia States in 1996.

Understanding the environmental limits of infection can aid the targeting of national control strategies. The gathering of information on the prevalence of infection and morbidity is an essential prerequisite for control implementation. For effective control strategies parasitological surveys have to be area-specific since nation-wide prevalence statistics do not say much (Montressor *et al.*, 1998).

This preliminary survey is aimed specifically at establishing the status of, and providing the baseline information on the prevalence and intensity of the soil-transmitted infections among school children within the study localities. The data derived from the study could be incorporated into the Primary Health Care (PHC) delivery programme currently receiving attention by the three tiers of government.

MATERIALS AND METHODS

The Study Area: Ishielu Local Government Area (LGA) where the study was conducted is one of the thirteen local government areas of Ebonyi state and is located within longitudes 7° 45' E to 8° 00' East, and latitudes 6° 15' N to 6° 39' N. It lies about 37 km west of Abakaliki, the state capital. The LGA is bounded by Benue State to the north, Onicha LGA to the south, Enugu State to the west while to the east lie Ohaukwu and Ezza-North Local Government Areas. Ishielu LGA is composed of 17 autonomous communities, namely Obogu, Egedege, Emazu, Umuhuali, Nkalagu, Edema, Ezillo, Abonyi, Isinkpuma, Ntezi, Okpoto, Lobo, Ogboji, Agba, Egbuho, Ohafia Agba and Ezzagu. The estimated population of the LGA is 153,846 based on the 1991 Nigerian national population census figures and a WHO annual population growth rate of 2½ %. The LGA is also the location of a cement factory at Nkalagu and a state-owned agricultural farm at Ezillo. In terms of soil and climate the area is ecologically homogeneous and the vegetation is of the typical guinea savanna mosaic type with gently undulating rocky lowland composed mostly of limestone (Ofomata, 1978).

The water supply system of the LGA is generally poor. The Ebonyi river with its major tributary, the Ora river system meanders in a north-south direction and roughly bisects the local government. In many communities the United Nations International Children's Emergency Fund(UNICEF)-assisted bore-hole hand pumps and the Japanese International Cooperation Agency (JICA)-built water mini reservoirs have broken down, compelling the affected villagers to resort to the seasonal streams, stagnant pools and ponds created by road construction and quarrying activities for their water needs.

Farming is the major occupation of the inhabitants of the study area. Farm produce include cassava, yam, rice, groundnut, mangoes, oranges, tomatoes and vegetables, most of which are grown in farms around the homesteads. Compost and human wastes are routinely used as farm manure to compensate partly for inadequate availability of commercial fertilizers and other farm inputs.

To a large extent, health care facilities are provided by health clinics, patent medicine dealers, drug peddlers and traditional herbal homes. Toilet facilities are generally discharged indiscriminately in lands surrounding the human habitation where vegetables and other crops are grown. This practice creates favourable environment for the development and transmission of the soil-transmitted helminth parasites.

Study Design and Population: Before the commencement of the survey, the local government education secretary was consulted on the purpose of the study and his permission and support were obtained. Prior to the enrolment of the pupils into the study, the head-teachers, teachers and parents/guardians of the pupils were briefed comprehensively on the benefits of the study to the population and the relevance of the diseases investigated. This was done to dispel any misconception and ensure community cooperation.

The target population of the survey was primary school children because the peak prevalence of geohelminth (except hook worms) is usually found in this age-group (Bundy *et al.*, 1987). Secondly, primary schools are accessible and there is generally good compliance from pupils and parents. Thirdly, data derived from primary school children can be used to assess not only whether geohelminthiasis threatens the health of school-age children, but also as a reference for evaluating the need for community intervention.

As the study area is ecologically and environmentally homogeneous, and in order to achieve the objective of the study, a sample size of 420 pupils was used drawn from 8 schools. The study was conducted in the months of May and June – the period of high humidity and temperature.

Selection of Schools and Data Collection: A list of primary schools and the number of pupils enrolled in each was obtained from the local government education authority at Ezillo – the Local Government headquarters. The eight (8) schools were selected using the simplified method for cluster sample utilizing sampling with probability proportional to size, to ensure coverage of the entire local government area, and which allows every school listed the chance of being selected. Schools were eligible for selection if there were more than 150 pupils enrolled and if there were enough pupils to be studied in the different age categories. Pupils in primaries 1 to 6 were eligible for study. Eligible pupils were excluded from the survey if they did not obtain parental/guardian permission to participate or did not provide stool samples, or had severe diarrhoea or had of recent been transferred to the school from outside the local government area.

Every eligible pupil was provided with a clean stool specimen container with provision for name, age, sex and locality in which to bring a fresh stool sample the following day. 10 % formalin was added to each specimen in order to preserve the ova of the helminths. Samples of equal numbers of male and female pupils in the age groups were randomly selected for study in each school.

Faecal Examination: Parasitological diagnosis of the parasites was carried out by analysing stool samples for presence of the ova using the Kato-Katz technique (WHO, 1994) as follows.

1. Cellophane strips 25 x 30 mm or 25 x 35 mm were soaked in 50 % glycerol-malachite green (or methylene blue) solution for 24 hours before use
2. A small amount of faeces was transferred onto a piece of newspaper
3. A plastic screen of 60 – 105 mesh was pressed on top of the faecal sample.
4. Using a flat-sided applicator stick, the upper surface of the screen was scrapped to sieve the faecal sample.
5. A plastic template was then placed on a clean microscopic slide
6. A small amount of the sieved material was transferred into the hole of the template and the hole was carefully filled and leveled with the applicator stick.
7. The template was then carefully removed making sure that all the faecal material was left on the slide and none was left sticking to the template.
8. The faecal sample on the slide was covered with glycerol-soaked cellophane strip wiping off excess glycerol if present on the upper surface of the cellophane with toilet tissue.
9. The microscope slide was then inverted and the faecal sample pressed against the cellophane on a smooth surface to spread the sample evenly.
10. The slide was then removed by gently sliding it sideways and holding the cellophane firmly.

Quality Control and Data Analysis: The slides were examined within one hour of preparation to avoid over clarification of the hookworm eggs. A random sample of 10 % of the faecal smears was read by two different parasitologists to evaluate the accuracy of the diagnosis and the precision of the egg counts. Slides were re-examined if the quality control showed a>10 % difference in egg counts.

As the sensitivity of the Kato-Katz method could be influenced by the intensity of infection, analysis of variance was used to compare the logarithmically transformed egg counts and estimated as ($\sum$ log (epg + 1) / n) – 1, where $\sum$ log (epg + 1) is the sum of the logarithm of each individual epg. A value of 1 is added to each egg count to permit calculation of the logarithm in case the number of eggs per gram (epg) was zero.

Data from the parasitological examination together with the name, age and sex of the pupil examined were recorded on a form and entered on computer software for statistical and epidemiological analysis using the EpiInfo software package. χ^2 and students't – test were used to asses differences in the prevalences and intensity of infection respectively. Results were considered statistically significant at $p < 0.05$.

Table 1: Thresholds for the classes of intensity for different helminthiases in stools

Geohelminth	Light Intensity Infection	Moderate Intensity]Infection	Heavy Intensity Infection
Ascaris lumbricoides	1 – 4,999 epg	5,000 – 9,999 epg	≥ 50,000 epg
Trichuris trichiura	1 – 999 epg	1,000 – 9,999 epg	≥ 10,000 epg
Hookworm	1 – 1,999 epg	2,000 – 3,999 epg	≥ 4,000 epg

Intensity of Infection: At individual level the intensity of infection was measured indirectly as eggs per gram of faecal matter (epg). The intensity of infection allows for the quantification of the proportion of individuals suffering severe consequences and was classified as follows, based on the thresholds proposed by WHO (1987) (Table 1).

RESULTS

The gender-related prevalence of geohelminthiasis among primary school children in different localities of Ishielu Local Government Area (LGA) is shown in Table 2. Out of the 420 pupils of both sexes screened for the presence of the ova of the parasites in 8 localities, 240 children composed of 29.4% males (n = 124) and 27.6 % females (n = 116) were infected with one or more of the parasites indicating an overall prevalence of 57.1 %. The geohelminth (soil-transmitted) parasites identified were *Ascaris lumbricoides* (32.9 %), *Trichuris trichiura* (20.5 %) and hookworm (32.9 %). In 7/8 (87.5 %) of the schools surveyed over 50 % of the pupils were infected with one or more of the parasites.

Infection of both sexes was generally widespread. School- specific prevalence ranged from 44 % at Nkalagu Junction primary school to 63.3 % at the community primary schools of Umuhuali in the north-west and Agba in the south of the LGA. Generally, the distribution of the infections appears not to be gender-dependent and the between-sex prevalence rate was not statistically significant ($P > 0.05$). The results also indicate that schools located along the major roads, (at Nkalagu, Ezillo and Ntezi) recorded lower prevalence rates than those situated further in the hinterland (Ohafia Agba, and Umuhuali). The association is significant statistically ($P < 0.05$).

Table 2: Gender-Specific Prevalence of Geohelminths in Different Primary Schools of Ishielu Local Government Area, Ebonyi State, Nigeria

Locality of school	Number examined (n = 420)	Soil-transmitted helminthes (%) *Ascaris lumbricoides*	*Trichuris trichiura*	Hookworm	Total (%)
Umuhuali	Male [30]	11(18.3)	7(11.3)	3(5.0)	21(35.0)
	Female [30]	7(11.7)	9(15.0)	1(1.7)	17(28.3)
Nkalagu	Male [25]	8(16.0)	4(8.0)	12.0)	13(26.0)
	Female [25]	5(10.0)	4(8.0)	0(0.0)	9(18.0)
Ezillo	Male [25]	7(14.0)	4(8.0)	1(2.0)	12(24.0)
	Female [25]	11(22.0)	5(10.0)	1(2.0)	17(34.0)
Isinkpuma	Male [25]	6(12.0)	7(14.0)	3(6.0)	17(34.0)
	Female [25]	6(12.0)	5(10.0)	0(0.0)	11(22.0)
Ntezi	Male [25]	6(12.0)	3(6.0)	2(4.0)	11(22.0)
	Female [25]	9(18.0)	5(10.0)	1(2.0)	15(30.0)
Okpoto	Male [25]	12(24.0)	5(10.0)	1(2.0)	18(36.0)
	Female [25]	918.0)	2(4.0)	0(0.0)	11(24.0)
Ohafia Agba	Male [25]	7(14.0)	4(8.0)	0(0.0)	11(22.0)
	Female [25]	12(24.0)	8(16.0)	0(0.0)	20(40.0)
Agba	Male [30]	13(21.7)	9(5.0)	1(1.7)	23(46.0)
	Female [30]	9(15.0)	5(8.3)	1(1.7)	15(30.0)
Total	**420**	**138 (32.9)**	**86(20.5)**	**16(3.8)**	**240(57.1)**

Table 3 shows the age-and locality-specific distribution of the soil-transmitted helminth parasites (geohelminths) among school children aged 5 to 14 years in the 8 study primary schools of Ishielu LGA. The infections were not over dispersed but appeared to be widespread in all the various age groups studied. The infections also appeared to be age-dependent as there was a marked association between age of the pupil and the prevalence of the infections by the various geohelminth parasites. In all the different study areas children aged 5 – 6 years had a lower rate of infection than other age groups, ranging from 2 (4.0%) at Okpoto, Ntezi, and Nkalagu schools to 6 (12.0%) in Ohafia Agba community primary school. Pupils aged 7-10 years (n = 98) had an infection rate of 23.3% while others, aged 11-14 years (n = 113) recorded the highest prevalence rate of 26.7%. Between-age difference was not statistically significant (p > 0.05). The age-related prevalence of specific geohelminths in the different study localities is shown in Table 3: The dominant geohelminth species, *Ascaris lumbricoides* was non-randomly distributed in all the various age groups in all the study areas affecting 137 (32.6%) of the study population. The infection and its distribution was not age-dependent. As with *A. lumbricoides* infection, the hookworm infection was non-randomly distributed. However, the distribution of the hookworm parasites in the study population was age-dependent as 82.3% (n = 14) of all hookworm cases detected in all the localities affected pupils in the age group (11-14) years. Generally, the hookworms affected teenagers in the (13-14) years age bracket more than any other age group within the scope of the study.

Trichuris trichiura was also not over dispersed affecting generally all age categories. At Umuhuoli in the north-west, Agba and Ohafia Agba in the south, every age category was infected with *T. trichiura.* The between-age difference in prevalence was not statistically significant (p>0.05) in trichuriasis. Slight within-age variations in the distribution pattern of trichuriasis were also recorded in the various age categories. The highest prevalence of trichiuriasis (5.0%) was recorded for pupils (n=21) aged 11-12 years, followed by 4.5% (n=19) for respondents in the 9-10 years age group. The lowest prevalence rate of 3.1% was recorded for pupils in the 5 - 6 age group.

The number of individuals of a particular parasite species in a single infected school pupil, that is, the intensity of the parasite species within a given host is shown in Table 5. Generally the mean intensity of infection of the observed geohelminths (*Ascaris*, *Trichuris*; and hookworm) were of the light category ($\leq$ 4999 epg for the *Ascaris lumbricoides;* ($\leq$ 999 epg for *Trichuris trichiura;* and $\leq$ 1999 epg for hookworm). Out of the 137 ascariasis-positive children from the study schools 48.2% (n = 66) showed mean egg count ≥ 1000 gram faecal matter; 10.2% (n = 14) had mean intensity of infection ≥ 900 ova per gram faecal matter, and 41.6% (n = 57) egg count ≥ 900 per gram faeces. The heaviest ascariasis infection was recorded for the 22 pupils of Agba primary school, mean intensity 1148 epg (range 864 - 1488). At Okpoto and Umuhuali the mean intensities of ascariasis infection were 1051 epg count (range 840-1320) and 1019 epg (range 240 - 1920) respectively. The lightest infection, mean epg 655 (range 288 - 960) was recorded for 13 infected pupils at Nkalagu Junction primary school.

Light infections of trichuriasis ($\leq$ 999) epg were recorded in all the study primary schools. The least mean intensity of infection of 707 epg (range 528 - 912) was recorded for 9 pupils of Ezillo primary school, followed in ascending order of mean epg by Nkalagu Junction primary school, mean epg 771, (range 624 - 912); Umuhuali primary school mean epg 780 (range 624 - 980); Agba primary school mean epg 804 (range 768-900); Isimkpuma primary school, mean epg 811 (range 534-920); Ntezi primary school, mean epg

Table 3: Age and Locality Related Distribution of Geohelminth Infections Among School Children in Ishielu Local Government Area, Ebonyi State, Nigeria

SCHOOL	Age Group (Year)	Number Examined (N = 420)	Number Infected (%)
Community primary school, Unuhuali	5 – 6	12	5(8.3)
	7 – 8	12	10(16.7)
	9 – 10	12	8(13.3)
	11 – 12	12	8(13.3)
	13 – 14	12	7(11.7)
	Sub-total:	**60**	**38**
Junction Primary School, Nkalagu	5 – 6	10	2(4.0)
	7 – 8	10	4(8.0)
	9 – 10	10	4(8.0)
	11 – 12	10	6(12.0)
	13 – 14	10	6(12.0)
	Sub-total:	**50**	22
Community Primary School Ezillo	5 – 6	10	4(8.0)
	7 – 8	10	6(12.0)
	9 – 10	10	7(14.0)
	11 – 12	10	7(14.0)
	13 – 14	10	5(10.0)
	Sub-total:	**50**	29
Community Primary School, Isinkpuma	5 – 6	10	3(6.0)
	7 – 8	10	3(6.0)
	9 – 10	10	8(16.0)
	11 – 12	10	6(12.0)
	13 – 14	10	7(14.0)
	Sub-total:	**50**	**27**
Community Primary School, Ntezi	5 – 6	10	2(4.0)
	7 – 8	10	4(8.0)
	9 – 10	10	6(12.0)
	11 – 12	10	7(14.0)
	13 – 14	10	7(14.0)
	Sub-total:	**50**	**26**
Central School Okpoto	5 – 6	10	2(4.0)
	7 – 8	10	4(8.0)
	9 – 10	10	7(14.0)
	11 – 12	10	7(14.0)
	13 – 14	10	9(18.0)
	Sub-total:	**50**	**29**
Community Primary School, Ohafia Agba	5 – 6	10	6(12.0)
	7 – 8	10	6(12.0)
	9 – 10	10	7(14.0)
	11 – 12	10	5(10.0)
	13 – 14	10	7(14.0)
	Sub-total:	**50**	**31**
Central Primary School, Agba	5 – 6	12	5(10.0)
	7 – 8	12	7(14.0)
	9 – 10	12	7(14.0)
	11 – 12	12	9(18.0)
	13 – 14	12	10(20.0)
	Sub-total:	**60**	**38**
Total		**420**	**240(57.1)**

822 (range 672 - 988); Ohafia Agba primary school, mean epg 838 (range 840 - 898) and Okpoto primary school, mean epg 881 (range 648 - 908). Moderate infections of trichuriasis (1000 - 9999) epg were also observed in all the study schools with the exception of schools at Ezillo and Nkalagu. At Ntezi primary school a single male pupil was recorded to have moderate infection of trichuriasis of 1010 epg.

The intensity of hookworm infection, as with other geohelminth parasites encountered, was of the light category ($\leq$ 1999) epg in the schools studied except at Ohafia Agba primary school where zero ancylostomiasis was recorded. A peak mean intensity of 168 epg (range 144 - 192) was recorded for 2 pupils at Okpoto primary school, followed by 156 epg (range 120 – 192) for 2 other pupils at Agba primary school. The lowest intensity of ancylostomiasis infection was obtained from the only pupil observed to be infected at Nkalagu junction primary school with 53 epg.

DISCUSSION

The overall prevalence of 57.1 % geohelminthiasis recorded in the present study not only establishes the endemicity of the geohelminth parasites but also indicates that *Ascariasis*, *trichuriasis* and human hookworm are the principal geohelminth nematode infections among primary school children in Ishielu Local Government Area of Ebonyi State. The study further indicates that the major soil-transmitted nematode parasites infecting susceptible pupils in primary schools and by implication the population in the ecologically homogeneous communities of north-western Ebonyi State are *Ascaris lumbricoides, Trichuris trichiura,* and the human hookworms (Table 2). The explanation revolves around various environmental, behavioural, and social factors. Of the external factors affecting the population dynamics of the geohelminths, the diet of the host is one of the most basic. It has been established that almost all of the entire parasites within a definitive host are present because the host ingested an infective stage of the parasite. Thus the distribution of *A. lumbricoides, T. trichiura,* and the human hookworm parasites (all of which possess direct life cycle patterns) depend, to a large extent on the dietary habits and the associated personal food hygiene of the affected Ishielu people. Although large quantities of fruits and vegetables are produced in the study areas and therefore constitute major sources of diet, the relative scarcity of good water supply in the study communities has affected the general standard of sanitation and personal hygiene and significantly impacted on the transmission dynamics of the parasites. The widespread prevalence of the parasites in both sexes is indicative of the general ignorance of the modes of transmission of the parasites. While the dynamics of *A. lumbricoides* infection are essentially the same as those of *T. trichiura,* both being acquired by the population through accidental ingestion of the soil contaminated eggs, the hookworm infection, on the other hand is acquired by the natives through the soil-dwelling filariform larvae that actively penetrate the skin of their bare-footed susceptible hosts.

The notion of susceptibility of the host to the acquisition of the geohelminths may be associated with the non-genetic factors such as personal hygiene, indiscriminate defaecation practices, water usage resources and socioeconomic status.

Table 4: Age-related Prevalence of Specific Geohelminths in Different Localities of Ishielu Local Government Area, Ebonyi State, Nigeria.

Locality	Number examined (n = 420)	Number infected (n=240) (%)	Age group (years)	geohelminths *A. lumbricoides* (%)	*T. trichiura* (%)	Hookworm (%)	Concomitant infection
Umuhuali	60	38(63.3)	5 – 6	4(6.7)	2(3.3)	0(0.0)	0
			7 – 8	5(8.3)	2(3.3)	1(1.7)	3
			9 – 10	4(6.7)	3(5.0)	0(0.0)	3
			11 – 12	3(5.0)	4(6.7)	1(1.7)	2
			13 – 14	2(3.3)	5(8.3)	2(3.3)	2
Nkalagu	50	22(44)	5 – 6	2(4.0)	0(0.0)	0(0.0)	0
			7 – 8	3(6.0)	1(2.0)	0(0.0)	1
			9 – 10	3(6.0)	1(2.0)	0(0.0)	0
			11 – 12	24.0)	2(4.0)	1(2.0)	0
			13 – 14	3(6.0)	4(8.0)	0(0.0)	0
Ezillo	50	29(58)	5 – 6	4(8.0)	1(2.0)	0(0.0)	1
			7 – 8	4(8.0)	0(0.0)	0(0.0)	1
			9 – 10	5(10.0)	3(6.0)	1(2.0)	0
			11 – 12	2(4.0)	3(6.0)	0(0.0)	0
			13 – 14	3(6.0)	2(4.0)	1(2.0)	0
Isinkpuma	50	27(54)	5 – 6	3 (6.0)	2(4.0)	0(0.0)	0
			7 – 8	3 (6.0)	4(8.0)	1(2.0)	2
			9 – 10	2(4.0)	3(6.0)	0(0.0)	0
			11 – 12	1(2.0)	3(6.0)	1(2.0)	1
			13 – 14	3(6.0)	0(0.0)	1(2.0)	0
Ntezi	50	26(52)	5 – 6	2(4.0)	1(2.0)	0(0.0)	0
			7 – 8	3(6.0)	0(0.0)	1(2.0)	2
			9 – 10	4(8.0)	2(4.0)	0(0.0)	1
			11 – 12	2(4.0)	2(4.0)	1(2.0)	1
			13 – 14	4(8.0)	3(6.0)	1(2.0)	0
Okpoto	50	29(58)	5 – 6	4(8.0)	2(4.0)	1(2.0)	2
			7 – 8	5(10.0)	1(2.0)	0(0.0)	1
			9 – 10	3(6.0)	2(4.0)	0(0.0)	2
			11 – 12	3(6.0)	2(4.0)	0(2.0)	0
			13 – 14	5(10.0)	0(0.0)	1(0.0)	0
Ohafia Agba	50	31(62)	5 – 6	4(8.0)	3(6.0)	0(0.0)	1
			7 – 8	3(6.0)	3(6.0)	0(0.0)	2
			9 – 10	3(6.0)	2(4.0)	0(0.0)	1
			11 – 12	48.0)	3(6.0)	0(0.0)	0
			13 – 14	5(10.0)	1(2.0)	0(0.0)	0
Agba	60	38(63.3)	5 – 6	5(8.3)	2(3.3)	0(0.0)	1
			7 – 8	6(10.8)	4(6.7)	0(0.0)	1
			9 – 10	5 (8.3)	3(5.0)	0(0.0)	0
			11 – 12	3(5.0)	2(3.3)	0(0.0)	1
			13 – 14	3(5.0)	3(5.0)	2(3.3)	0
TOTAL	**420**	**240 (57.1)**		**137(32.6)**	**85(20.5)**	**17(4.0)**	**32(13.3)**

Any of these factors could influence the transmission dynamics of these soil-transmitted parasites in such a way as to create the impression of susceptibility. The longevity of *A. lumbricoides* ova also contributes to the infectious dynamics of that parasite species as it has been shown that the eggs kept for 10 years in the soil could still be infective (Brudastor *et al.,* 1971). As a result of such longevity it is difficult to prevent infection and re-infection when hectares of farmland surrounding human habitations as found in the study have been polluted with *A. lumbricoides* ova.

Within the narrow age-limits of the study, the infectious geohelminth parasites were widespread, gender independent and not over dispersed (Tables 2, 3 and 4). The results are in conformity with those of earlier studies which established that young children are more vulnerable to many enteric infections than are adults and are the more responsible for contaminating the environment and transmitting the infections (Albonico *et al.,* 2002; Agbolade *et al.,* 2004; Adeyeba and Akinlabi, 2002).

Table 5: Intensity of infection of geohelminth parasites among primary school children in Ishielu area of Ebonyi State, Nigeria

Locality	Umuhuali		Nkalagu		Ezillo		Isinkpuma	
	No Infected	Mean epg (range)	No Infected	Mean epg (range)	No Infected	Mean epg (range)	No Infected	Mean epg (range)
Helminth Infection								
Ascaris lumbricoides	18		13		18		12	
Light 1-4,999 epg	18	1019 (240-1920)	13	655 (288-960)	18	848(600-1104)	12	808 (600-1200)
Moderate 5,000 - 9,999 epg	-	-	-	-	-	-	-	-
Heavy ≥ 10,000 epg	-	-	-	-	-	-	-	-
Trichuris trichiura	16		8		9		12	
Light 1- 4,999 epg	14	780 (624-980)	8	771 (624-912)	9	707 (528-912)	7	811 (534-920)
Moderate 5000-9,999 epg	2	1007 (1002-1012)	-		-		5	1020 (1006-1220)
Heavy ≥ 10,000 epg	-	-	-	-	-	-	-	-
Hook Worm	4		1		2		3	
Light 1-1,999 epg	4	84 (54-128)1	1		2	48 (24-72)	3	120 (48-192)
Moderate 2000 - 3,999 epg	-	-	-	-	-	-	-	-
Heavy ≥ 4000 epg	-	-	-	-	-	-	-	-
	Ntezi		**Okpoto**		**Ohafia Agba**		**Agba**	
Helminth Infection								
Ascaris lumbricoides	15		20		19		22	
Light 1-4,999 epg	15	968 (792-1104)	20	1051 (840-1320)	19	971 (720-1152)	22	1148 (864-1488)
Moderate 5,000-9,999 epg	-	-	-	-				
Heavy ≥10,00 epg	-	-	-	-				
Trichuris trichiura	8		7		12		14	
Light 1-999 epg	7	822 (672-988)	5	881 (648-908)	4	838 (840-898)	7	804 (768-900)
Moderate 1000-9,999 epg	1		2	1102 (1101-1103)	8	1004 (1002-1022)	7	1202 (1002-1020)
Heavy ≥ 10,000 epg	-	-	-	-	-	-	-	-
Hook Worm	3		2		0		2	
Light 1-1,999 epg	3	126 (96-168)	2	168 (144-192)	0		2	156 120-192
Moderate 2000-3,999 epg	-	-	-	-	-	-	-	-
Heavy ≥ 4000 epg	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-

epg= eggs per gram of faeces.

Even within the narrow age range, the results indicate that children in the 5 – 6 year age group generally showed the lowest infection rate while the older ones aged 11-14 years were the most heavily infected suggesting that even among the susceptible population of children, the infection is age dependent with a marked association between age and prevalence (Table 3) – a situation attributable to exposure to the risk factors.

In investigations involving entire local populations (young children and adults), *A. lumbricoides, T. trichiura* and hookworm parasite infections are commonly over dispersed, with a small segment of the population harbouring infections of high intensity. The small number of infected individuals seem to be predisposed to infection (Chan *et al.,* 1992; 1994; Kightlinger *et al.,* 1995). In the current study, the investigation centers specifically around the more susceptible segment of the local population; viz. infants and teenage primary school pupils aged ≤ 15 years. The age of the study population has consequently impacted on the non-random nature of the over dispersion frequency. Like susceptibility, predisposition of the children to the geohelminth parasites may also be due to behavioural, social and environmental factors acting alone or in combination. Some evidence of predisposition has suggested genetic susceptibility (Holland, *et al.,* 1992) but others have suggested that genetic factors, if any, are overwhelmed by environmental or behavioural characteristics of the host (Chan, *et al.,* 1994*).* Indiscriminate defaecation practices, inadequate personal hygiene therefore appear to be important factors in creating the different frequency distribution patterns of the three geohelminth parasites. Defaecating indiscriminately, particularly near human dwellings usually seeds the soil with the *Ascaris* and *Trichuris* ova that remain viable for considerable long periods of time. On the other hand hookworm parasites appear to have an age-dependent pattern of infection in that older teenage pupils who are more intensively exposed to infection by tilling the soil polluted with the geohelminth ova, gathering of fruits and vegetables and participation in other household chores that bring them more into contact with the soil, appear likely to have more hookworm than their younger colleagues. Although the intensity of the geohelminths infection was generally light, moderate infection of *T. trichiura* (100 – 9999) eggs per gram faecal matter was recorded in 6/8 (75 %) of the study primary schools. In terms of intensity of infection *Trichunis trichiura* is the dominant species encountered. The light intensity of infection recorded may be attributed to a number of factors including the estimating technique, and the internal environmental factors within the host affecting parasite densities and fecundity including interactions among parasite populations within species and between species. The technique of estimating the parasite density relying on the faecal egg counts as used in this study has the primary limitation in relation to the variability in the number of ova discharged by specific parasite per day over a given period of time. The internal environmental factors that may affect the geohelminth parasite densities in the study areas are complex because several phenomena such as behaviour, host and parasite genetics, natural and acquired resistance, among other factors, are involved and these factors frequently act in concert. Among the internal environmental factors possibly involved in the present study are density-dependent constraints created by interspecific parasite competition which causes the variability in daily egg output. It has also been established that egg out put by some enteric helminth parasites such as *Ascaris* sp. and *Trichuris* sp. will increase as parasite densities increase but only until a threshold is reached and then it may decline or fluctuate (Holland *et al.,* 1988; Elkins and Haswell-Elkins, 1989). From the results obtained on the intensity of infection of the geohelminths, it may be inferred that the number of parasite ova per individual host determines the risk of morbidity. It would also be inferred that in the absence of clinically overt infection, the intensity of egg output is an indicator of latent morbid state, because the greater the egg counts the greater the number of female helminth parasites present.

In conclusion the results advocate for a deworming programme to avert possible impact on the physical, mental and cognitive development of the at-risk children in the endemic localities of rural Ebonyi State.

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