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Original Research

Assessment of Soil Contamination with Soil-Transmitted Helminth Eggs and Larvae in Selected Secondary School Compounds in Calabar, Cross River State, Nigeria

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Abstract

Soil transmitted helminth (STH) is a group of parasitic worms with an essential phase of their asexual life cycle in the soil. Their (STH) persistence period in the soil during which their infective stages are protected, preserved and transmitted through contaminated soil, poor sanitation and inadequate hygiene. Evaluation of soil transmitted helminth in Secondary Schools Compounds was carried out in four secondary schools to determine the contamination and occurrence in Calabar. Soil samples were processed using the zinc sulphate flotation technique for the detection and identification of soil-transmitted helminth (STH) eggs, particularly *Ascaris lumbricoides* and *Trichuris trichiura*, based on the differential specific gravity of the parasite eggs and zinc sulphate flotation solution. Each soil sample was sieved to remove debris, coarse particles and other unwanted materials. Soil extraction for hookworm was carried out using Modified Baerman technique. Thirty-four (34) out of the Eighty (80) sample analyzed for parasites were positive for parasites eggs/larvae. The result shows that the toilet area has the highest positive samples of twelve (12) representing 35.29% of the total positive samples across the four secondary school, followed by the waste bin area with eleven (11) positive sample and has a prevalence of 32.35%. A significant association was observed between sampling location and parasite positivity, with the playground differing significantly from the other sampling areas (χ^2 test, $p < 0.05$). A total of thirty-nine (39) parasites eggs/larva were isolated, in which twenty (20) 51.28% were recovered by the zinc sulphate floatation technique, while only Nineteen (19) 48.72% was recovered by the Modified Baermann techniques. Soil transmitted helminth (STH) isolated from the school compounds include *Ascaris lumbricoides,* Hookworm and *Strongyloides* spp**.** Improved sanitation and having complete toilet/urinary structure is highly recommended to reduce the risk and contamination of soil transmitted helminth.

1. Introduction

Soil transmitted helminths (STHs) commonly known as intestinal worm-infection has been increasingly recognized as an important public health concern with infections common worldwide. The soil becomes contaminated with STH eggs or larvae when infected individuals defecate openly or when untreated sewage or waste practices facilitate the spread of STH eggs in the environment, providing an ideal breeding ground for these parasites in the poorest and most resource deprived communities The prevalence of STHs has been linked to poverty, poor environmental hygiene, inadequate facilities for water supply, poor sanitation, illiteracy, inadequate health services and overpopulation (Edema *et al*., 2023). STH eggs which are shed in the faeces of infected individuals can survive in the soil for weeks to months under favorable environmental condition. Humans become infected when they come in contact with contaminated soil, particularly through activities such as walking barefoot or working in contaminated fields (Adeyeba *et al*., 2018). STH is a group of parasitic worms, including roundworms (*Ascaris lumbricoides*), whipworms, (*Trichuris Trichiura*), hook worms (*Ancyclostoma duodenale* and *Necator Americanus*). These infections affect millions of people globally, particularly in areas with limited access to clean water and sanitation facilities. STH infections are often associated with poverty due to their prevalence in areas with poor sanitation and limited access to clean water. Humans and animal Ascariasis together constitutes one of the most important global public health challenges, the diseases found worldwide but particularly more common in the sub-Saharan Africa and Southeast (Holland *et al*., 2022, Pullan *et al*, 2014). STH can be transmitted through the faecal-oral route, whereby infective eggs are ingested via food or soil contaminated with human faeces or

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sewage sludge (WHO, 2020). The global distribution of STHs thrive more in tropical and subtropical regions, where the warm and humid environmental conditions favour the survival and development of infective stages, and where inadequate sanitation, poverty, and limited health education facilitate sustained transmission (Asaolu and Ofoezie 2018). In many endemic communities, occurrence may be in excess of 80%, which varies widely among endemic countries and the warm presents a patchy and uneven distribution among the communities (Robertson *et al.*, 2017). According to the World Health Organization (WHO), over 1.5 billion people worldwide are infected with STH, mainly in tropical and subtropical regions (WHO, 2023). Once inside the human body, STHs can cause a range of health problems, infected individuals may experience abdominal pain, diarrhea, anemia, fatigue, malnutrition and impaired physical cognitive development, particularly in children (Mehata *et al.*, 2022). The WHO emphasizes a comprehensive approach that includes regular deworming with anthelminthic medications. improved sanitation and health education for affected communities (Usang *et al.*, 2025). To assess the extent of soil contamination with soil-transmitted helminth (STH) eggs and larvae in selected secondary school compounds in Calabar, Cross River State, Nigeria, by determining their occurrence, distribution, and association with different sampling locations within the school compounds.

2. Material and Methods

2.1 Study Area

The study was carried out in Calabar, the capital of Cross River State. It is located close to the coastal region of the Atlantic Ocean. Calabar metropolis lies between latitude 4° 58' 58.3428'' N and longitude and 8° 20' 4.2108'' E. Calabar metropolis is made up of two local government areas (LGAs); Calabar-south Local Government Area and Calabar Municipal Local Government in the north, the municipal is bounded by Odukpani Local Government Area, in the north-east by the Great-kwa River in Fig. 1. Administratively, the city is divided into Calabar Municipal and Calabar South Local Government Areas. It has an area of 406 square kilometers (157 sq mi) and, as of the 2006 census, a population of 371,022. Both LGAs together had an estimated population of 571,500 in 2022. Simon (2010**).** Based on the records presented by the Climate Data of the state, the annual rainfall of Cross River state is 3306mm (130.2 inches) (Ekpe, 2018). Peak precipitation occurs in July and September. Daily temperature all through the year ranges between 22.4^0 C and 33.2^0 C, and relative humidity is from 60% to 93%. Calabar has a tropical climate.

2.2 Sample Collection

Soil samples were collected between January 2024 and June 2024 in which sample were actively collected within twenty (20) weeks once a week on Monday. Samples were collected from four different Secondary Schools in Calabar Metropolis which are Akim Secondary School, Margaret Ekpo Secondary School, Government Girls Secondary School Big Qua and

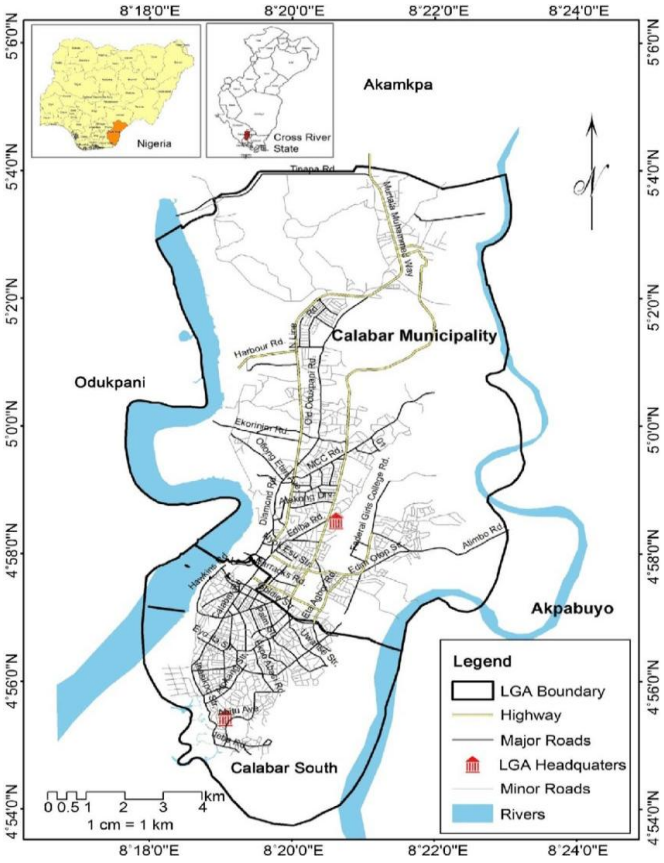


Figure 1. Map of Calabar Metropolis

Mary Slessor Academy. The study schools—Akim Secondary School, Margaret Ekpo Secondary School, Government Girls Secondary School, Big Qua, and Mary Slessor Academy—were purposively selected based on their location within Calabar, accessibility for repeated sampling, active student population, availability of exposed soil areas, and the presence of commonly used sites such as playgrounds, toilets and waste-disposal areas. The schools were also selected to provide variation in school settings and environmental conditions that could influence the occurrence and persistence of soil-transmitted helminth (STH) eggs and larvae. Permission to collect soil samples was obtained from the relevant school authorities. These criteria ensured that the selected schools provided suitable and representative environments for assessing soil contamination with STH eggs and larvae.

2.3 Limitations

The study was limited to selected secondary schools in Calabar, which may restrict the generalization of the findings to other areas. The six-month sampling period may not have captured the full annual seasonal variation in STH contamination. Uneven distribution of parasite eggs and larvae in soil, variations in seasons could affect the environmental and soil conditions, and limitations in the sensitivity of conventional laboratory techniques may have affected parasite recovery. Additionally, the study assessed environmental contamination and did not directly determine STH infection among schoolchildren

2.4 Sample analysis

Sample were analyzed using the following methods;

Zinc sulphate flotation technique

The processed soil samples were examined microscopically for the presence, detection and identification of soil-transmitted helminth eggs and larvae using the zinc sulphate flotation technique described by Badaki *et al*. (2018)

Soil samples were collected from the designated sampling points using a clean sterile spatula. Each sample was placed in a labelled sterile container and transported to the laboratory. The soil sample was thoroughly homogenized. Each soil sample was sieved to remove debris, coarse particles, stones, and other unwanted materials**.** The sieved soil was subsequently processed using the appropriate parasitological examination technique. About 20g of the soil was mixed with 10mls of distilled water. The solution was strained into a test tube and centrifuged at 2500 rpm for 3minutes. The supernatant was decanted and the sediment was mixed with 10ml zinc sulphate solution of 33% weight per volume (Specific gravity 1.20). The zinc sulphate solution was added to the brim of the test tube. The preparation was allowed to stand for few minutes with a cover slip placed on the tube to collect floating ova. The cover slip was carefully removed and placed faced down on a clean glass slide for examination under the × 10 and × 40 objective lenses.

Modified Baermann technique

Soil extraction for hookworm was carried out using the Modified Baermann technique as described by Ogbolu *et al*., (2011). The setup comprises of a modified funnel with a short piece of rubber tubing attached to the stem and a clamp closure. The funnel was supported uprightly and filled with water. Approximately 20g of soil was placed on top of a filter paper on top of a wire gauze. The enclosed soil sample was placed in the Baermann funnel (filled with distilled water). The larvae migrated through the filter paper and into the water in the funnel. The larvae settled at the bottom of the funnel by gravity and were collected after 48–72 h. The suspension was viewed under the microscope for the presence of soil transmitted helminths (STH). Parasites were identified with the aid of standard guidelines by World Health organization (WHO, 2023).

Data/Statistical analysis

The data were summarized using frequencies and percentages to describe the distribution of soil samples and parasite-positive samples across the various sampling locations. The Pearson's chi-square (χ^2) test was used to determine the association between parasite positivity and sampling location, as well as to assess differences in the frequency of positive samples among the sampling locations. A p-value < 0.05 was considered statistically significant. The results were presented in tables as frequencies, percentages, χ^2 values, degrees of freedom, and p-values.

3. Results

3.1 Occurrence and Mean Intensity of soil transmitted helminths Eggs from the school compound

The result as shown in table one (1), five (5) samples each observed from the sample location Toilet, Waste bin, Playground and Urinary in the school compound. The highest positive sample were recorded in the toilet with three (3) positive samples, with prevalence and mean intensity of 60.00% and 1.33 respectively in Akim Secondary School. While the Waste bin and Urinary recorded two (2) positive samples out of the five (5) sample each observed, with prevalence and mean intensity of 40.00 and 1.00 respectively. In Margaret Ekpo Secondary School the toilet has the highest positive sample of four (4) with a prevalence and mean intensity of 80.00% and 1.33. While in waste bin, playground and urinary recorded positive sample of three (3), one (1) and two (2) respectively and have prevalence and mean intensity of 60.00%, 20.00% and 40.00%, 1.00 each respectively. In Government Girls Secondary School Big Qua the highest recorded positive sample of three (3) were recorded from waste bin and urinary, with prevalence of 60.00% each and mean intensity of 1.00 and 1.33 respectively. This was followed by the toilet with two (2) positive out of the five (5) sample observed and has a prevalence of 40.00 % and mean intensity of 1.50. Three (3) out of the five (5) sample observed were positive from the samples obtain in toilet, waste bin and urinary each with a prevalence of 60.00%. Their mean intensity includes of 1.00, 1.33 and 1.00 respectively in Mary Slessor Academy. The playground was negative in Akim Secondary School, Government Girls Secondary School Big Qua and Mary Slessor Academy except Margaret Ekpo Secondary School as stated above.

3.2 Result of Prevalence of Positive Samples with Eggs/Larva of Parasites across the four Schools

The result as shown in table 2 show that the highest *Ascaris lumbricoides* eggs were six (6) eggs isolated from School compound B, followed by five (5) eggs in Mary Slessor Academy and four (4) in Akim Secondary School and Government Girls Secondary School Big Qua respectively, giving a total of Nineteen (19) and prevalence of 48.72%. The highest Hookworm larvae of three (3) was recorded in Margaret Ekpo Secondary School, followed by two (2) larvae each in Government Girls Secondary School Big Qua and Mary Slessor Academy, with least recorded larvae of one (1) in Akim Secondary School, which gives a total of eight (8) with prevalence of 20.51%. The highest *Strongyloides* egg found in this study was four (4) recorded in Government Girls Secondary School Big Qua, followed by three (3) each in Akim Secondary School and Mary Slessor Academy, and least of two (2) in Margaret Ekpo Secondary School. This gives a total of twelve (12) *Strongyloides* eggs which has a prevalence of 30.77%.

Table 1. Showing Prevalence and Mean Intensity of soil transmitted helminths from the school compound in Calabar

Schools compound	Location of Sample	No of Samples	No of Positive Sample	No of positive samples (%)	No of Parasite eggs/larvae	Mean Intensity
Akim Secondary School	Toilet	5	3	60.00	4	1.33
	Waste bin	5	2	40.00	2	1.00
	Playground	5	0	0.00	0	0.00
	Urinary	5	2	40.00	2	1.00
	Total	20	7	35.00	8	1.14
Margaret Ekpo Secondary School	Toilet	5	4	80.00	4	1.00
	Waste bin	5	3	60.00	4	1.33
	Playground	5	1	20.00	1	1.00
	Urinary	5	2	40.00	2	1.00
	Total	20	10	50.00	11	1.10
Government Girls Secondary School Big Qua	Toilet	5	2	40.00	3	1.50
	Waste bin	5	3	60.00	3	1.00
	Playground	5	0	0.00	0	0.00
	Urinary	5	3	60.00	4	1.33
	Total	20	8	40.00	10	1.25
Mary Slessor Academy.	Toilet	5	3	60.00	3	1.00
	Waste bin	5	3	60.00	4	1.33
	Playground	5	0	0.00	0	0.00
	Urinary	5	3	60.00	3	1.00
	Total	20	9	45.00	10	1.11
Total		80	34	42.50	39	1.14

Table 2. Showing Result of Prevalence of Positive Samples with Eggs/Larva of Parasites across the four Schools

S/N	Parasites	Location				No Isolated	Prevalence %
		Akim Secondary School A	Margaret Ekpo Secondary School B	Government Girls Secondary School Big Qua C	Mary Slessor Academy D		
1	*Ascaris lumbricoides*	4	6	4	5	19	48.72
2	Hookworm	1	3	2	2	8	20.51
3	*Strongyloides* spp	3	2	4	3	12	30.77
	Total	8	11	10	10	39	100

4. Discussion

The results showed that most of the soil samples analyzed across the four school compounds were positive for parasite eggs and larvae. This is an indication of parasitological contaminated soil and unhygienic rest room facilities and compound (Nwoke *et al*., 2013). School children in schools are mostly at risk of acquiring soil-transmitted helminths (STHs) infections due to their habits (geophagy, onychophagy and playing with barefoot) (Isaac *et al*., 2019). In Akim Secondary School compound, total of twenty (20) soil samples was analyzed for parasites only seven (7) were positives for parasites eggs/larvae, with a prevalence of 35.00% and mean intensity of 0.40. Ten (10) of the twenty (20) soil sample analyzed for parasites where positive for parasites eggs/larvae in Margaret Ekpo Secondary School, with prevalence of 50.00% and mean intensity of 0.55. Eight (8) out of the twenty (20) soil sample analyzed for soil transmitted helminth (STH) was positive for egg/larvae with prevalence of 40.00% and mean intensity of 0.50 in Government Girls Secondary School Big Qua. While nine (9) of the twenty (20) soil sample were positive and has prevalence and mean intensity of 45.00% and 0.50 in Mary Slessor Academy. This work agrees with the study of Alemu *et al* (2022) who in their study said that the prevalence of STHs infections was found to be 32.4%. and Abe *et al*., (2019) who got overall prevalence of 33.5% (67/200) helminths infections in their work, although their research was from human stool and not from soil sample. The result from this study shows that parasites isolated from the soil sample analyzed was eight (8), eleven (11), ten (10) and ten (10) from Akim Secondary School, Margaret Ekpo Secondary School, Government Girls Secondary School Big Qua and Mary Slessor Academy respectively. That parasites eggs/larvae recorded in this study were nineteen (19) *Ascaris lumbricoides* eggs, eight (8) Hookworm larvae and Twelve (12) *Strongyloides* eggs. This work aligned with the findings of

Steinbaum *et al*., (2017) who significantly improved *Ascaris* recovery by 16.2 percentage and they further reported that, among the soil-transmitted helminth (STH) eggs detected in their study area in Kenya, *Ascaris* was the most prevalent (22%), followed by *Trichuris* (21.00%). This result is similar to the work of Eze & Olayiwola (2024), who stated that thirteen soil parasites were recovered: *Ascaris lumbricoides* had the highest prevalence of 300 (27.8%), followed by Hookworm 164 (15.2%), *Balantidium coli* 152 (14.09%) etc. from their study in jetties.



Figure 2. *Strogyloides worm* (400X)

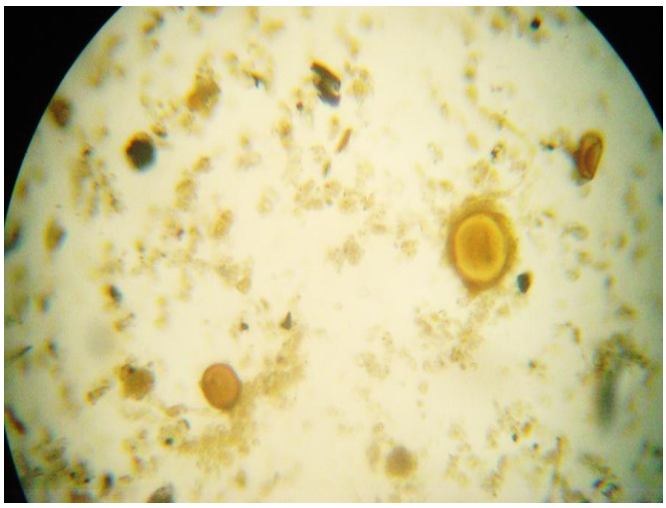


Figure 3. *Ascaris lumblicoides* eggs (200x)

5. Conclusion

In conclusion, the study demonstrated that soil contamination with soil-transmitted helminth (STH) eggs and larvae occurred in all four selected secondary school compounds in Calabar. The proportion of positive soil samples ranged from 35.00% in Akim Secondary School to 50.00% in Margaret Ekpo Secondary School, indicating varying levels of soil contamination among the schools. *Ascaris lumbricoides*, Hookworm and *Strongyloides* were detected, with *Ascaris lumbricoides* being the most frequently recovered parasite. The findings suggest that contaminated school environments and inadequate sanitary practices may increase the potential exposure of school children to STHs. Therefore, improved sanitation, regular environmental hygiene, health education and periodic monitoring of school compounds are important for reducing the risk of STH transmission among school children

Conflicts of Interest

There is no conflict of interest among the authors.

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