

# Parasitic contamination of soil in private and public primary schools in Ifedore, Southwest, Nigeria

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## ABSTRACT:

- **Objective:** As of 2020, World Health Organization (WHO) estimated that over 267 million pre-school children and over 568 million school-aged children live in areas where soil parasites are intensively transmitted and need immediate interventions. The study investigated the soil contamination rate of parasites in selected public and private primary schools in Ifedore, Southwest Nigeria.
- **Materials and methods:** A total of 192 soil samples were collected between January and October 2020. Extraction and isolation of parasite *larvae* and *ova* were all carried out following standard parasitological procedures.
- **Results:** Hookworm *larvae* (39.1%) had the highest occurrence of the total parasite stages recovered from the soil samples, followed by *Ascaris ova* (24.5%), *Hookworm ova* (17.8%), *Strongyloides larvae* (17.6%) and *Trichuris ova* (1%). Soil samples from public schools (52.9%) were more contaminated than samples collected from private schools (47.1%).
- **Conclusions:** It is evident that school-aged children in tropical region are at risk of soil-transmitted diseases. There is a need for improvements on the existing control strategies through school-based deworming programs and implementation of water, sanitation, and hygiene policies in primary schools.
- **Keywords:** Soil-transmitted, Parasites, School-aged, Contamination, Occurrence.

## INTRODUCTION

About two billion individuals worldwide have been reported to be infected with soil-transmitted parasites with school-aged children exhibiting the greatest morbidity<sup>1,2</sup>. Chronic infection can adversely affect growth and cognitive development in school-aged children due to excessive loss of essential nutrients<sup>3</sup>. For soil-transmitted parasites, soil is not only a reservoir of parasitic infective stages but also an environment where infective stages develop<sup>4</sup>. The most important soil transmitted parasites are *Trichuris trichiura*, *Ascaris lumbricoides*, *Necator americanus*, *Ancylostoma duodenale* and *Strongyloides stercoralis*<sup>5</sup>. It is known that the development of parasites in the soil depends on several behavioural

and environmental factors that create conditions favourable for their survival<sup>6</sup>. For this reason, tropical and sub-urban regions such as Ifedore Local Government Area, Nigeria, where conditions tend to be conducive for the development of infective stages are the major endemic zones. Parasitic infections among school-aged children have also been reported in various parts of Ifedore. 64% prevalence rate of intestinal helminth parasites was recorded in 2016 after examination of stool samples collected from school-aged children in the region<sup>7</sup>. Also, schistosomiasis a water borne parasitic disease was recorded among school-aged children in the region in 2018<sup>8</sup>. The transmission of these parasitic infections can also be determined by several other factors such as age, poverty, illiteracy, lack of access to potable water,



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poor faecal disposal system, as well as poor hygiene and sanitation<sup>4</sup>. Due to the persistence in the high rate of soil-transmitted infections among school-aged children in the tropical zone, this study is important for the investigation and evaluation of some factors that could further influence high prevalence of these parasites. The study is designed to investigate the soil contamination rate of parasites in selected public and private primary schools in Ifedore LGA, Ondo State. Studies in various parts of Nigeria have also investigated the occurrence and intensity of soil-transmitted parasites in primary schools<sup>9,10</sup>. This research will create more awareness on the susceptibility of school-aged children in the tropics to soil-transmitted parasites.

## MATERIALS AND METHODS

### Study Area

The study was conducted in primary schools in Ifedore Local Government Area of Ondo state, Southwest Nigeria. Ifedore LGA covers a total area of 583 km<sup>2</sup> and is located between latitude 7°26' North and longitude 5°11' East<sup>11</sup>. It is situated entirely within the tropical region. The local government area is predominantly rural, and the major occupations of the inhabitants are farming and petty trading.

### Study Population and Sampling

From the study area, a total of 8 public and 8 private schools were selected for the research. Primary schools were selected by random sampling from the Local Government Area. Georeferencing of selected schools was done using a mobile geographical positioning system device (GPRS) (Figure 1).

### Ethics Approval and Consent to Participate

Prior to the commencement of the research, verbal consent was obtained from the Local Government Health authority and advocacy visits were paid to the Heads of Schools where soil samples were collected.

### Sample Collection

About 200 g of soil samples were collected with a hand trowel at a depth of 3 cm. Soil samples were collected from 2 different locations within each school: the playground and toilet areas. Samples were collected from 3 different spots and stored in small, clean, and well-labelled polythene bags. Samples were collected between 09:00hrs and 12:00hrs. A total of one hundred and ninety-two (192) soil samples were collected. The

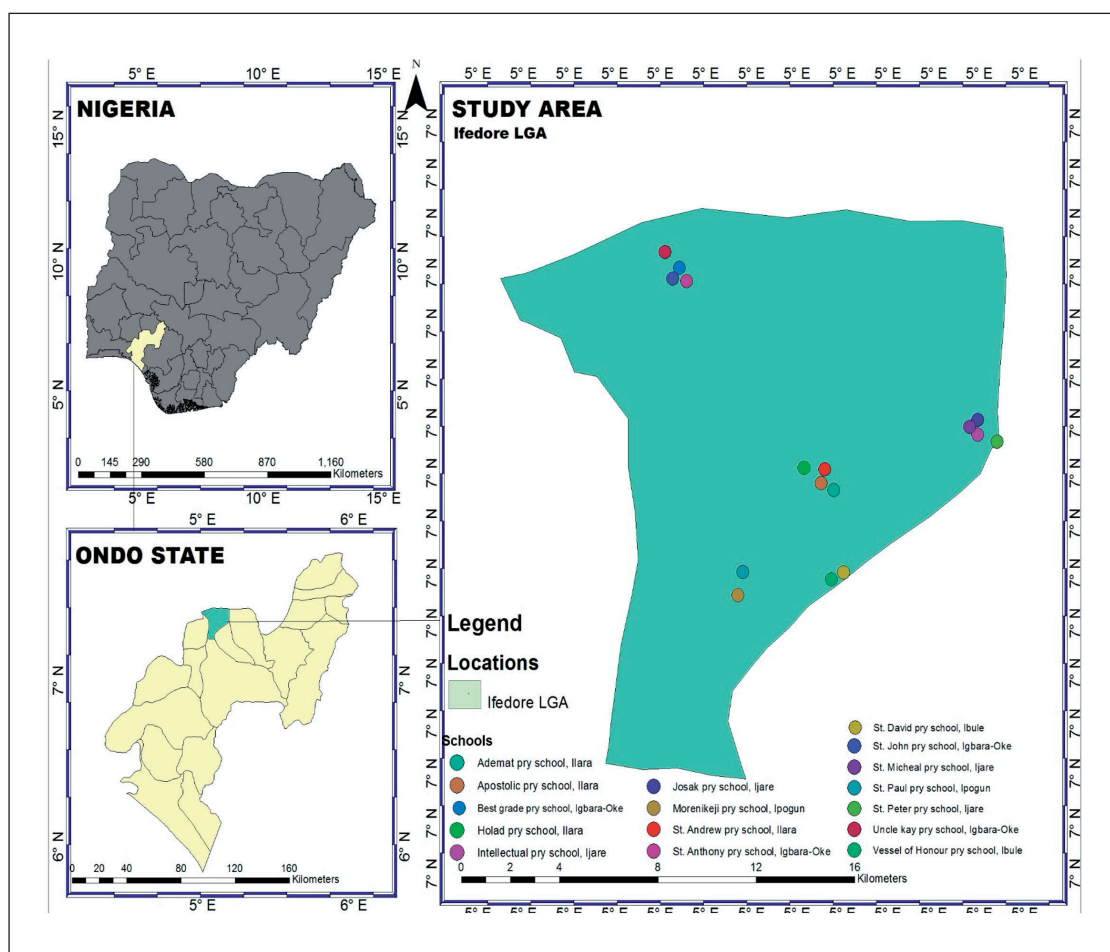


Figure 1. Map of Ifedore Local Government Area showing locations of sample collection.

samples were transported to the research laboratory at the Department of Biology, FUTA, and analysis of the soil samples was carried out within 24 to 72 hours of collection.

### Isolation and Recovery of Ova by Flootation Technique

Sodium chloride solution (1.18 specific gravity) was used for the recovery of parasites ova. 50 g of soil sample was weighed in a plastic container and mixed thoroughly with 200 ml of distilled water. The suspension was then strained using a sieve of 150 µm mesh size for removal of large particles. The solution was then allowed to stand in a glass beaker for 2 hours. After decantation, the sediment was re-suspended with 50 mL of water after which it was placed in a centrifuge tube. After centrifugation at 1500 rpm for 5 minutes, the resulting sediment was again suspended in 15 mL of NaCl solution (specific gravity 1.18). It was then poured into a test tube, allowing it to fill to the brim forming a convex meniscus. A clean slide was then placed on the test tube for 3 minutes to collect floating eggs present in the solution<sup>12</sup>. The slide was carefully observed using a compound microscope at  $\times 10$  and  $\times 40$  objectives and then examined for the presence of parasite eggs. Identification was made using standard morphological keys<sup>13</sup>.

### Extraction of Larvae by Modified Baermann Culture Technique

Modified Baermann method was used for extraction of larvae from the soil<sup>14</sup>. 20 g of soil sample was weighed and placed on a white disposable paper towel. A rubber band was then used to tie the paper towel forming a pouch. After setting up the apparatus consisting of a retort stand, funnel and a clipped rubber tubing, the pouch containing the soil sample was then suspended in the funnel already filled with lukewarm water. The apparatus was then left to stand for 72 hours (3 days), to allow active larvae present in the soil sample to settle at the bottom of the rubber tubing. The lower suspension was collected into a universal bottle. Using a Pasteur pipette, 3 drops were placed on a clean slide and viewed under a compound microscope with  $\times 10$  and  $\times 40$  objective lenses to check for presence of nematode larvae. Identification was done using standard morphological keys<sup>13</sup>.

### Questionnaire Design

Structured questionnaires were designed to obtain information on the socio-cultural factors that could play a role in the transmission of soil parasites. The information provided includes the name of schools, availability of water facility, availability of functional toilets, evidence of open defaecation, presence of dumpsites in school premises. The appropriate boxes were ticked in conformation to the information obtained.

### Statistical Analysis

Data analysis was done using Microsoft Excel 2015 version and Statistical Package for Social Sciences (SPSS) version 23.0 (IBM, Armonk, NY, USA). Pearson's Chi-square Test ( $\chi^2$ ) was used to compare soil contamination rates per collection site and school status.

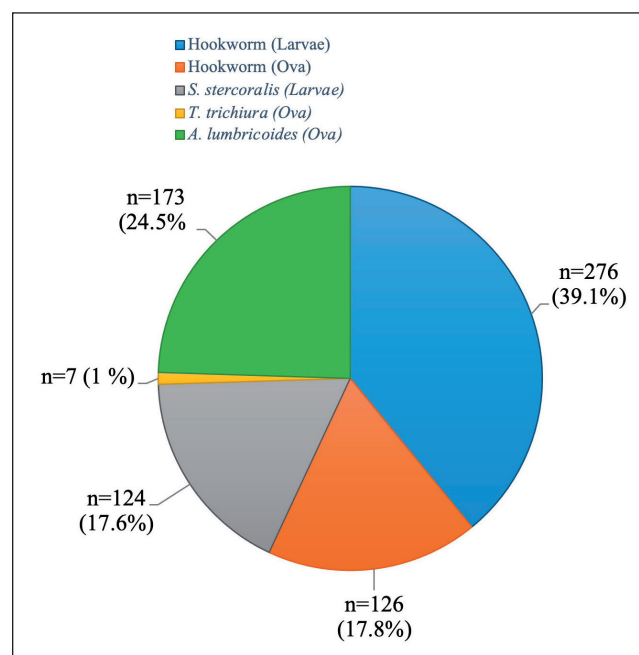
## RESULTS

### Occurrence and Distribution of Parasites Larvae and Ova in the Study Area

Out of the one hundred and ninety-two (192) soil samples from the sixteen schools, one hundred and fifty-two (152) (79.2%) were positive for the presence of parasites larvae and ova. Four (4) different geohelminths species were identified: Hookworm, *Strongyloides stercoralis*, *Ascaris lumbricoides* and *Trichuris trichiura*. Of all the species recovered, only hookworm had two developmental stages (ova and larvae) present in the soil. Seven hundred and six (706) parasites were recovered in total. Hookworm larvae showed the highest occurrence with 276 (39.1%), while *T. trichiura* was the least present with 7 (1%) (Figure 2).

### Soil Contamination Rate and Intensity of Parasites in the Schools

Table 1 shows the soil contamination rate and intensity of parasites in the selected schools. All sixteen primary schools recorded at least one species of soil-transmitted parasite. St. Anthony Primary School had the highest occurrence of parasites ( $n = 67$ ). There was no significant difference occurrence of parasites in all primary schools ( $p = 0.32$ ).



**Figure 2.** Occurrence and distribution of parasites larvae and ova in the Study Area.

**Table 1.** Soil contamination rate and intensity of parasites in the schools.

Schools	No of Samples Examined	No of Contaminated Samples	Hookworm (Larvae)	Hookworm (Ova)	Strongylodes stercoralis (Larvae)	Trichuris trichiura (Ova)	Ascaris lumbricoides (Ova)	Total
Josak	12	5	13	–	–	–	–	13
Intellectual	12	7	8	5	2	–	2	17
St. Peter	12	11	23	4	8	1	4	40
St. Micheal	12	12	15	10	7	–	10	42
Holad	12	8	28	13	18	–	5	64
Ademat	12	7	12	5	12	–	2	31
Apostolic	12	9	18	6	7	–	2	33
St. Andrew	12	8	23	6	11	–	1	41
Uncle Kay	12	10	20	9	10	1	21	61
Best Grade	12	11	15	10	14	–	17	56
St. John	12	12	16	12	4	–	40	72
St. Anthony	12	11	19	13	6	3	26	67
Morenikeji	12	12	20	5	9	1	7	42
Vessels of Honour	12	12	21	7	6	–	15	49
St. Paul	12	8	10	13	5	–	6	34
St. David	12	9	15	8	5	1	15	44
	192	152 (79.2)	276 (39.1)	126 (17.8)	124 (17.6)	7 (1)	173 (24.5)	706

There was no significant difference occurrence of parasites in all primary schools ( $p > 0.05$ )

### Soil Contamination Rate and Occurrence of Parasites in Relation to School Socio-Economic Status

Samples obtained from public primary schools were found to be more contaminated 80 (52.6%) with different parasite species than samples obtained from private primary schools 72 (47.4%). The frequencies of contaminated soil samples which were observed in both private and public schools were not significantly different ( $p = 0.15$ ) (Table 2).

### Soil Contamination Rate and Occurrence of Parasites in Relation to Collection Sites

Ninety-six (96) soil samples each were examined for both playground and toilet areas. The contamination rate of parasites in soil samples collected from the toilet area 86 (89.6%) was significantly higher ( $p = 0.00$ ) than that of the school playground 66 (68.8%). Hookworm larvae had the highest occurrence of parasite species in both collection sites (Table 3).

**Table 2.** Soil contamination rate and occurrence of parasites in relation to school socio-economic status.

Schools	No of Samples Examined	No of Contaminated Samples (%)	Hookworm (Larvae) (%)	Hookworm (Ova) (%)	Strongylodes stercoralis (Larvae) (%)	Trichuris trichiura (Ova) (%)	Ascaris lumbricoides (Ova) (%)	Total (%)
Private	96	72 (47.4)	137 (49.6)	54 (42.9)	71 (57.3)	2 (28.6)	69 (39.9)	333 (47.1)
Public	96	80 (52.6)	139 (50.4)	72 (57.1)	53 (42.7)	5 (71.4)	104 (60.1)	373 (52.9)
Total (%)	192	152 (79.2)	276 (39.1)	126 (17.8)	124 (17.6)	7 (1)	173 (24.5)	706

The frequencies of contaminated samples in both private and public schools were not significantly different from each other  $p = 0.15$  ( $\chi^2 = 2.02$ ; d.f = 1 and  $p > 0.05$ )

**Table 3.** Soil contamination rate and occurrence of parasites in relation to collection sites.

Site	No of Samples Examined	No of Contaminated Samples (%)	Hookworm (Larvae) (%)	Hookworm (Ova) (%)	Strongylodes stercoralis (Larvae) (%)	Trichuris trichiura (Ova) (%)	Ascaris lumbricoides (Ova) (%)	Total (%)
Playground	96	66 (68.8)	111 (40.2)	38 (31.2)	51 (41.1)	–	66 (38.2)	266 (37.7)
Toilet	96	86 (89.6)	165 (59.8)	88 (69.8)	73 (58.9)	7 (100)	107 (61.8)	440 (62.3)
Total (%)	192	152 (79.2)	276 (39.1)	126 (17.8)	124 (17.6)	7 (1)	173 (24.5)	706

The frequencies of contaminated samples in both private and public schools were not significantly different from each other  $p = 0.15$  ( $\chi^2 = 2.02$ ; d.f = 1 and  $p > 0.05$ )

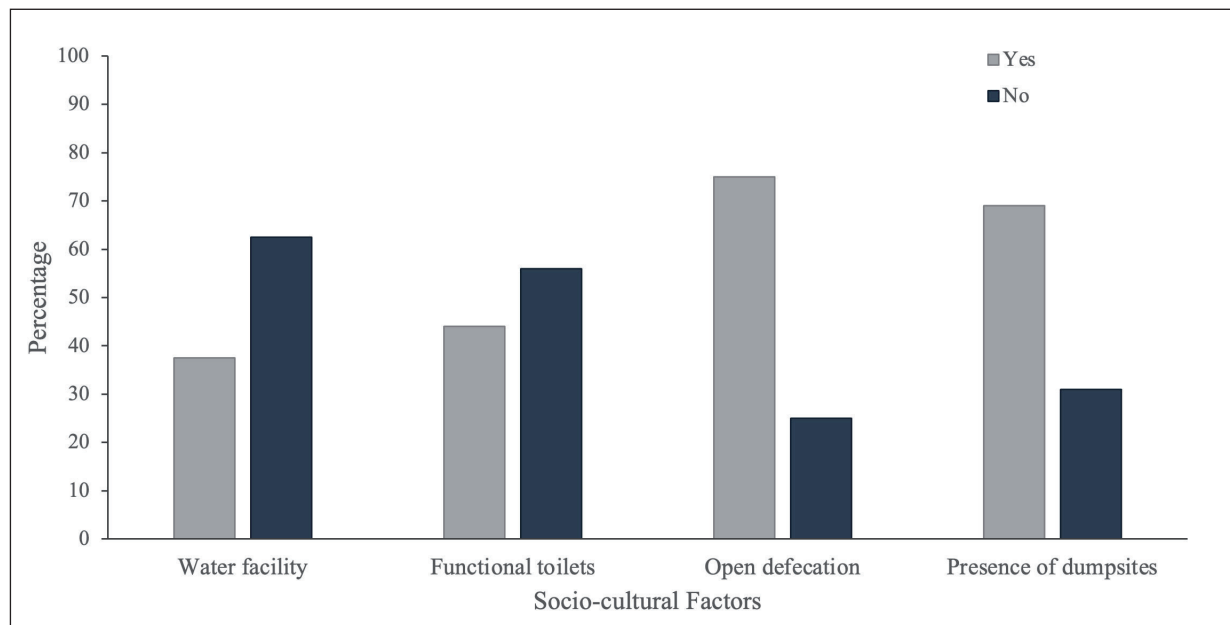


Figure 3. Socio-cultural factors associated with transmission of soil parasites.

### Socio-Cultural Factors Associated with the Transmission of Soil Parasites

The result obtained from the questionnaires showed that 62.5% of the schools had no stable water facility. There were no functioning toilets in 56% of the primary schools. There was also evidence of high rate of open defaecation (75%) and presence of dumpsites in most of the primary schools (69%) (Figure 3).

### DISCUSSION

As of 2018, it was estimated that 33.9 million school-aged children were infected with one or more soil-transmitted parasites in Africa<sup>15</sup>. Studies have demonstrated that children may acquire parasitic infections early in life which causes initial organ damage that can remain subclinical for years and manifest overtly only later in adulthood<sup>16</sup>. The result of the study showed that hookworm *larvae* was the highest occurring parasite in the examined soil samples. This is similar to previous reports in other parts of Nigeria<sup>9,17</sup>. *Trichuris trichiura* had the least occurrence in the soil, the low rate observed may be due to minimal dispersion of their *ova* into the environment, as a single female *Trichuris* liberates relatively less numbers of eggs (about 3,000 eggs per day) than other soil helminths. This may also be due to easy destruction of their embryonated eggs by desiccation<sup>18</sup>. The rate of soil contamination in public primary schools was higher than that of private schools. It was observed that the private schools put in more effort in ensuring that the school premises remained hygienic. The lack of perimeter fences in public schools could also have contributed to the higher contamination rate as children and even adults around the school environment had access to the school compound after school hours to engage in various activities and possibly defaecate on the soil thereby contaminating the school envi-

ronment with parasitic stages<sup>9</sup>. However, the substantial trend of the parasite distribution observed in the private schools showed that school-aged pupils in these schools are also equally at risk of soil-transmitted infections, as contamination may have more to do with behavioural and ecological factors rather than socio-economic status. In regard to collection sites, higher contamination rate was observed around the toilet area as compared with playgrounds. The presence of soil parasites around the playground is a potential source for massive outbreak of gastrointestinal infections among school-aged children.

Information obtained from the questionnaires suggests that socio-cultural practices like poor hygiene and sanitation influenced the abundance of soil-transmitted parasites in the soil. Intestinal helminth parasites in soil around refuse dumpsites have also been reported<sup>19</sup>. This could also explain the high contamination rate as a good number of the school toilets were situated very close to a dumpsite. There was visible evidence of faecal contamination of soil in most schools, suggesting that school pupils still engage in open defaecation around school premises. This is due fact that most of the primary schools lack functioning toilets. Open defaecation increases the rate of parasites dispersion into the environment.

### CONCLUSIONS

The high soil contamination rate observed in this study has revealed that school-aged children are at potential risk of geohelminthiasis irrespective of their socio-economic status. It can also be inferred that some socio-cultural factors played a significant role in the occurrence and abundance of geohelminths in the study area. Therefore, control by periodic school-based deworming programs, implementation of standard water, sanitation and hygiene (WASH) policy, sensitization campaigns are highly recommended.



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**AUTHORS' CONTRIBUTIONS:**

SIA and OOE contributed to the research design and involved in field and laboratory work. OOE carried out statistical analysis, interpreted the result of the study and wrote the first draft of the manuscript. SIA and OOE reviewed and approved the final manuscript.

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