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Wash Deployment and Geo-helminth Ova Dispersion in Primary Schools in Akure North and Owo Local Government Areas, Ondo State, Nigeria

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Abstract:
Soil-Transmitted Helminths (geo-helminths) are intestinal parasites causing human infections that are soil-borne. The study assessed the level of soil contamination with geo-helminths ova and also evaluated the level of compliance to WASH policies in some selected public and private schools in Akure North and Owo Local Government Areas of Ondo state, respectively. The study was conducted in the major districts of the two towns.
Methods
Soil samples were collected from three (3) different locations within each school premise: Toilet areas, classroom and playground. Assessment sheets were used to evaluate data on indicators of compliance to WASH interventions. Modified Baemann's culture technique was used in the extraction of geo-helminths larvae and sedimentation techniques were used in the concentration and isolation of geo-helminths eggs. The significant difference in soil contamination between public and private schools was obtained using statistical analysis.
Result
Of the 162 soil samples examined from each local government area, Akure North had the highest number of contaminated samples, n=116 (71.61%), while Owo local government had the least, n =88 (54.32%). Four (4) different geo-helminth species were identified; Hookworm, Ascaris lumbricoides, Strongyloides stercoralis, and Trichuris trichiura. The most occurring parasites seen in Akure North were hookworm larvae (67.83%), Strongyloides stercoralis (67.83%), hookworm ova (11.25%) and ova of Ascaris lumbricoides (7.56%). Likewise, Hookworm larvae had the highest level of occurrence (51.67%), while Trichuris trichiura was the least occurring (0.77%) in Owo local government area. Public schools had the higher parasite count 668/780 (85.64%), while private schools had the lesser parasite count, 112 /780 (14.36%).
Conclusion
The study revealed poor deployment of WASH in the schools, and children were predisposed to geo-helminths infections due to the high level of contamination, particularly in the public schools.

Keywords: *Geo-helminth, ova, dispersion, school children, WASH, LGA*

1. Background

Geo-helminthiases, also known as Soil Transmitted Helminth (STH) infections, are of major public health concern in low-income countries. About two billion individuals worldwide have been estimated to be infected globally, with school-aged children exhibiting the greatest morbidity (Adriko *et al*., 2018; WHO, 2020). The common causative agents of geo-helminthiases in Nigeria include *Ascaris lumbricoides, Trichuris trichiura, Strongyloides stercoralis* and hookworm (Oniya & Komolafe, 2013); the larvae and eggs are transmitted through the soil. Geo-helminth infections are part of the Neglected Tropical Diseases (NTDs) and the endemicity has been traced to poverty, underdevelopment, illiteracy and lack of personal hygiene. Prevalence is high in the poorest and most deprived communities of the world. Nigeria is endemic for geo-helminth infections due to trichuriasis, ascariasis and hookworm, with projected cases of 34 million, 55 million and 38 million, respectively (Omitola *et al*., 2016). Light infestation with STH is always asymptomatic. However, the adverse health and nutritional effect of severe worm infection cannot be neglected. Geo-helminth infections lead to iron deficiency

anaemia, stunting (a measure of chronic under-nutrition), wasting (a measure of acute under-nutrition), listlessness and abdominal pain (Van der Werf *et al.,* 2003; Bethony *et al*., 2006), and may negatively affect class-attentiveness of school children (Berhe *et al*., 2009). Chronic geo-helminthiasis induce T-cell hypo-responsiveness, which may also affect immune responses to other pathogens.

Most public schools in rural areas in Nigeria do not cater adequately to toilet facilities for the children, which promotes contamination of the environment with parasites. In most cases, the toilets are non-functional or non-existent, thereby leaving the children to relieve themselves in nearby bushes when the need arises to defaecate (Oniya, 2019). Eliminating soil-transmitted helminthiases is a problem in children because the eggs of geo-helminthiases may be ingested when they put dirty hands into their mouths without washing them while playing outside (WHO, 2021). Preventive chemotherapy is effective in the control of geo-helminth infections, but it often gives a short-term result since it does not stop reinfection after treatment. Long-term preventive solutions require deployment and improvement in Water, Sanitation and Hygiene (WASH). This study assessed Water Hygiene and Sanitation (WASH) deployment and soil contamination with geo-helminth ova in public and private primary schools in Akure North and Owo Local Government areas of Ondo State, Nigeria.

2. Materials and Methods

2.1. Study Area

The study was conducted in major towns in Akure North Local Government Area and Owo Local Government Area (LGA) of Ondo state. The vegetation type found in the study areas was typical rainforest, with Owo lying between 7°11' N and 5°35' E and Akure north (7°52'N; 5°18'E). The predominant occupational activities in the areas were farming and trading.

2.2. Study Sites and Sampling

Nine private and nine public primary schools from each LGA were randomly selected as study sites. Soil samples were collected from three (3) locations in each school; the toilet, playground and classroom. Each area has three replicate collections. Geo-referencing of sampled schools was done using a geographical positioning system device (Garmin eTrex 10 2.2 by Sudershan Measuring & Engineering Pvt Ltd, New Delhi).

2.3. Sample Collection

About 200g of soil samples were collected with a hand trowel at a depth of 3-5 cm. Soil samples were collected from 3 different locations within each school; the playground, classroom and toilet areas. Samples were collected from 3 different spots and stored in small clean and well-labelled polythene bags. Samples were collected between 10:00hrs and 12:00hrs. Soil samples were collected from eighteen primary schools between the months of December 2021 and February 2022. In all, a total of three hundred and twenty-four (324) soil samples were collected from public and private schools in Akure North LGA and Owo LGA. The samples were transported to the Parasitology and Public Health Laboratory at the Department of Biology, Federal University of Technology, Akure, for analysis. Soil samples that were not examined immediately after collection were refrigerated at 4°C until used.

2.4. Laboratory Analyses

Sedimentation technique was used in the isolation of geo-helminth ova. 5g of soil sample was weighed in a glass beaker and mixed thoroughly with 20 ml of distilled water. The suspension was then strained using a sieve of 150µm mesh size for the removal of coarse particles. The solution was then allowed to stand in a glass beaker for 2 hours. The solution was decanted and the sediment was re-suspended with 50 mL of distilled water. Thereafter the solution was poured into centrifuge tubes and centrifuged at 1500rpm for 5 minutes. The supernatant was discarded and the resulting sediment was pipetted onto a glass slide. The slide was carefully observed using a microscope at ×10 and ×40 objectives and examined for the presence of parasitic ova. Identification was made using standard morphological keys (CDC, 2014).
Modified Baermann method was used for the extraction of larvae from the soil as described by Collender *et al.* (2015). 20g of soil sample was weighed and placed on a white muslin cloth. A rubber band was used to tie the muslin cloth forming a pouch. After setting up the apparatus, the pouch containing the soil sample was then suspended in the funnel already filled with lukewarm water. The sample was then left to stand for 48-72 hours to allow active larvae present in the soil sample to settle at the bottom of the rubber tubing. The lower part of the suspension was collected into a universal bottle. Using a Pasteur pipette, 3 drops were placed on a clean slide and viewed under a microscope with ×10 objective lenses to check for the presence of parasitic larvae. Identification was made using standard morphological keys (CDC, 2014).

2.5. Data Analysis

The occurrence of geo-helminth ova was calculated and a comparison was made across public and private schools and between variables and indicators. The Pearson Chi-square test was used to establish significant differences between soil contaminations in private and public schools. A 95% confidence interval was used with a P-value of 0.05. Data obtained were imputed into the computer using Microsoft Excel 2015 version and analysis was carried out using Statistical Package for Social Sciences (SPSS for Windows) version 23.0.

3. Results

During the study, a total of 324 soil samples were collected from various locations in the surroundings of thirty-six primary schools. A total of 204 (56.04%) soil samples were contaminated with different parasitic stages. Table 1 shows that Public schools had the highest prevalence of 36.81% (n=134), while private schools had a prevalence of 19.23% (n=70)

School Category	Owo			Akure			Total No. of Infected (%)
	Number Examined	No. of Contamination (%)	Negative (%)	Number Examined	No. of Contamination (%)	Negative (%)	
Public	81	62 (76.54)	19(23.46)	81	72 (88.89)	9 (11.11)	134 (36.81)
Private	81	26 (32.10)	55(67.90)	81	44 (54.32)	37 (45.70)	70 (19.23)
Total	162	88(54.32)	74(45.68)	162	116 (71.60)	46 (39.66)	204(56.04)

Table 1: Prevalence of Parasitic Contamination of Soil Samples within the Study Areas

(a) $\chi^2 = 32.241$ *df 1= 1 P= 0.001*

(b) $\chi^2 = 10.866$, *df = 1, P = 0.012*

St. Thomas Anglican primary school, Isinigbo and Ilado Odudu community primary school, Ilado, had 100% contamination, while Leaders Path demonstration school, Oba- Ile, had no ova contamination. The school with the highest rate of soil contamination in Owo LGA was St John Nursery and primary school, Iyere, while Brainwave primary school, Isuada, was the least contaminated. The total parasitic count obtained from schools in Akure North was higher (1147) than those seen in Owo (780), as shown in tables 2 and 3. Four (4) different geo-helminth species were identified in this study (Figure 1), including Hookworm, *Ascaris lumbricoides, Strongyloides stercoralis, and Trichuris trichiura.* Of all the species recovered, only hookworm had two parasite stages (ova and larvae) present in the soil. The most occurring parasites in Akure north were hookworm larvae n= 778 (67.83%), *Strongyloides stercoralis* larvae n=153 (67.83%), hookworm ova n= 129 (11.25%) and ova of *Ascaris lumbricoides* n= 87 (7.56%). Ova of *Trichuris trichuria* was not observed in samples from Akure North. In Owo LGA, Hookworm larvae had the highest occurrence with n=403 (51.67%), *Strongyloides stercoralis* larvae n=217 (27.82%), *Ascaris lumbricoides* ova, n=87 (11.15%) Hookworm ova n=67 (8.59%) while *Trichuris trichiura* was the least occurring with n=6 (0.77%). The parasites common to both areas include Hookworm, *Ascaris lumbricoides,* and *Strongyloides stercoralis.* Comparison between WASH indicators and the rate of soil contamination in Akure North local government area and Owo LGA, as shown in table 4, in Akure North LGA, only 8/38 (21.05%) were functioning in public schools while 23/24 (95.83%) were functioning in private schools. Also, 5/9 (55.56%) of the private schools in Akure North had water in their toilets, and none of the public schools had water in the toilets. Only 3/9 (33.33%) of the public schools had hand washing facilities, while 2/9 (11.11%) of the private schools had hand washing facilities. Of all the schools in Akure North LGA, only 1/18 (5.56%) made provision for hand washing posters within their school premises. Public schools had the highest parasite count 753/1147 (65.67%), while private schools had 394/1147(34.35%). In Owo LGA, the provision of functional toilets was grossly deficient across all public schools, as only 9/41 (21.95%) were functioning, while 34/36 (94.44%) were functioning in private schools. Also, 7/9 (77.78%) of the private schools in Owo had water in their toilets, while only 1/9 (11.11%) of the public schools had water in the toilets. Furthermore, only 2/9 (22.22%) of the public schools had handwashing facilities, while 7/9 (77.8%) of the private schools had handwashing facilities. Public schools had the highest parasite count 668/780 (85.64)%, while private schools had a lesser 112/780 (14.36%).

Schools	Coordinates	Soil Sample		Total Parasite Count (%)
		Number Examined	Number Contaminated (%)	
Adetolase Nursery and primary school Itaogbolu	N 07° 19. 411; E 05° 14.325	9	5 (55.6)	117 (10.20)
Ambassador Nursery and primary school Igoba	N 07° 16.889; E 05° 13.693	9	0 (0.0)	58 (5.06)
Best Brain Nursery and primary school Bolorundo	N 07° 15.784; E 05° 20.751	9	8 (88.9)	41 (3.58)
Ilado Odudu community primary school, ILADO	N 07° 15.130; E 05° 20.490	9	9 (100.0)	84 (7.32)
L.A Primary School Itaogbolu	N 07° 18.429; E 05° 15.341	9	8 (88.9)	84 (7.32)
L.A Primary School Owode	N 07° 18.180; E 05° 14. 160	9	8 (88.9)	0
Leaders path Demonstration school Oba ile	N 07° 23.912; E 05° 15.774	9	0 (0.0)	31 (2.70)
New Day Nursery and primary school Ughele	N 07° 24.209; E 05° 15.940	9	8 (88.9)	72 (6.28)
Olusola Nursery and primary school Iju	N 07° 21.532; E 05° 14.984	9	5 (55.6)	97 (8.46)
Ondo state special primary school Oba ile	N 07° 21.569; E 05° 14.776	9	8 (88.9)	34 (2.96)
Seed of grace model Nursery and primary school Isinigbo	N 07° 19.006; E 05° 15. 474	9	7 (77.8)	133 (11.59)

Schools	Coordinates	Soil Sample		Total Parasite Count (%)
		Number Examined	Number Contaminated (%)	
St. Andrew Anglican primary school, Ayede	N 07° 18.725; E 05° 14.971	9	8 (88.9)	61 (5.32)
St. Luke C.A.C Primary School Bolorundo	N 07° 15.747; E 05° 14.342	9	7 (77.8)	31 (2.70)
St. Matthew Anglican Nursery and Primary School Igoba	N 07° 15.380; E 05° 15. 490	9	7 (77.8)	0
St. Michael United C & S Nursery and primary school Iju	N 07° 15.691; E 05° 22.163	9	8 (88.9)	75 (6.54)
St. Peter private global school Ogbese	N 07° 15.690 E005° 22.046	9	6 (66.7)	30 (2.62)
St. Thomas Anglican Nursery and primary school Isinigbo	N07° 16.110; E 05° 17.100	9	9 (100.0)	144 (10.56)
The New Rock of Ages Nursery and primary school Owode	N 07° 16.500; E 05° 16.510	9	5 (55.6)	55 (4.80)
Total		162	116	1147

Table 2: Rate of Soil Contamination and Total Parasite Count in Soil Samples from the Eighteen Primary Schools Studied in Akure North LGA

S/N	SCHOOLS	Coordinates	No. of Samples	No. of Contaminated Samples	Total Parasite Count
1	Adeolu Pubic Nursery and Primary School, Owo Town	7º12'8"N 5º34'14"E	9	7 (77.8%)	64 (8.21%)
2	Our Saviour Nursery and Primary School, Emure ile	7º14'34"N 5º30'38"E	9	6 (66.7%)	48 (6.15%)
3	Local Authority Nursery and Primary School, Isuada	7º13'37"N 5º35'5"E	9	7 (77.8%)	113 (14.49%)
4	Methodist Nursery and Primary School, Uso	No service	9	7 (77.8%)	106 (13.59%)
5	St. John Nursery and Primary School, Oke Ogun	7º11'41"N 5º34'26"E	9	6 (66.7%)	56 (7.18%)
6	Olagbegi Nursery and Primary School, Okedogbon	7º12'18"N 5º35'15"E	9	7 (77.8%)	82 (10.51%)
7	Idasen Nursery and Primary School, Idasen	7º11'0"N 5º35'3"E	9	7 (77.8%)	49 (6.28%)
8	St John Nursery and Primary School, Iyere	7º10'27"N 5º36'51"E	9	9 (100%)	128 (16.41%)
9	AUD Ipele Nursery and Primary School, Ipele	7º8'3"N 5º40'12"E	9	6 (66.7%)	22 (2.82%)
10	Adeolu Private Nursery and Primary School in Owo Town	7º12'9"N 5º34'15"E	9	2 (22.2%)	3 (0.38%)
11	Blessed Seeds Nursery and Primary School, Emure-ile	7º14'15"N 5º30'47"E	9	4 (44.4%)	15 (1.92%)
12	God's Own Nursery and Primary School, Oke Ogun	7º11'57"N 5º34'26"E	9	3 (3.33%)	10 (1.28%)
13	Graceland Nursery and Primary School, Okedogbon	7º12'17"N 5º35'12"E	9	2 (22.2%)	3 (0.38%)
14	Brainwave Nursery and Primary School, Isuada	7º13'43"N 5º35'10"E	9	1 (11.1%)	1 (0.13%)
15	Corpus Christi Nursery and Primary School, Iyere	7º10'27"N 5º36'51"E	9	3 (33.3%)	28 (3.59%)
16	Oasis Nursery and Primary School, Idasen	7º12'8"N 5º34'22"E	9	2 (22.2%)	2 (0.26%)
17	Ileri Iyanu Nursery and Primary School, Ipele	7º7'55"N 5º40'22"E	9	6 (66.7%)	36 (4.62%)
18	Prince of Peace Nursery and Primary School, Uso	7º11'53"N 5º34'52"E	9	3 (33.3%)	14 (1.79%)
	Total		162	88	780

Table 3: Rate of Soil Contamination and Total Parasite Count in Soil Samples from the Eighteen Primary Schools Studied in Owo LGA

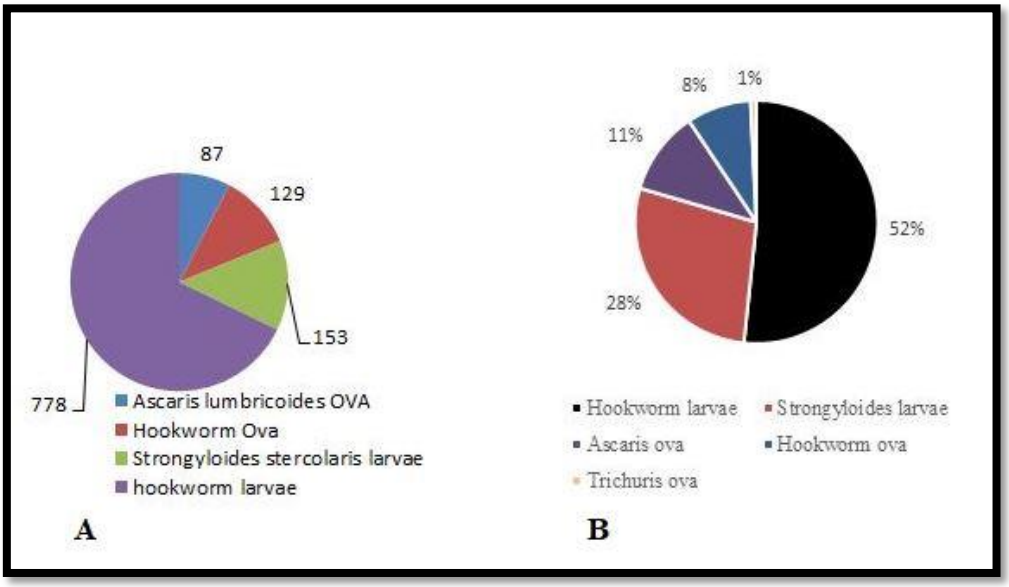

Figure 1: Occurrence and Diversity of Geo-helminth Recovered from (A) Akure North LGA and (B) Owo Local Government

		Owo LGA			Akure North LGA		
S/N	**WASH Indicator**	**Public Schools %**	**Private Schools %**	**Total %**	**Public Schools %**	**Private Schools %**	**Total %**
1	Functioning toilets	9/41 (21.95%)	34/36 (94.44%)	43/77 (55.84%)	8/38(21.05%)	23/24 (95.83%)	31/62 (50%)
2	Water on site	5/9 (55.56%)	6/9 (66.67%)	11/18 (61.11%)	3/9 (33.33%)	5/9 (55.56%)	8/18 (44.44%)
3	Water in the Toilets	1/9 (11.11%)	7/9 (77.78%)	8/18 (44.44%)	0/9 (0%)	4/9 (44.44%)	4/18 (22.22%)
4	Water is drinkable	1/9 (11.11%)	7/9 (77.78%)	8/18 (44.44%)	4/9 (44.44%)	7/9 (77.78%)	11/28 (61.11%)
5	Hand washing facilities	2/9 (22.22%)	7/9 (77.8%)	9/18 (50%)	3/9 (33.33%)	2/9 (11.11%)	5/18 (27.78%)
6	Presence of handwashing posters	0/9 (0%)	1/9 (11.11%)	1/18 (5%)	0/9 (0%)	1/9 (11.11%)	1/18 (5.56%)
7	Parasite count	668/780 (85.64)	112/780 (14.36%)	780 (100%)	753/1147 (65.67%)	394/1147 -34.35%	1147 (100%)

Table 4: WASH Indicators and Environmental Contamination between Public and Private in Owo Local Government Area and Akure North Local Government Area

4. Discussion

It has been reported that over 1.5 billion people worldwide are infected with geo-helminth (Ogbe *et al*., 2002). This is mostly associated with children from rural and poor areas because of their constant exposure to soil, especially contaminated silt, and poor hygiene practices (WHO, 2020). Anywhere suitable water and good sanitation are lacking, soil contamination by the infective stages of intestinal parasites is the most significant risk factor of infection for both humans and animals. These parasites have been recognized as an important public health problem, particularly in developing countries (Mordi, 2009). Different studies have been conducted in several locations all over the world, with results revealing the varied prevalence of soil contamination with different parasites (Nkouayep *et al.*, 2017). The distribution of STH in soil samples differed from those obtained from faecal samples. Hookworm larvae were the most prevalent in the study areas, which is similar to the findings of Oniya (2019). The high prevalence of Hookworm and *Strongyloides stercoralis* larvae in this study might be because they burrow into the soil, which makes their larva protected. The findings of this report clearly indicate that there is a high level of contamination in the study area and classify the community as a high-risk area according to WHO standards (WHO, 2012). This situation is worrisome because school-aged children are the most susceptible to STH infections, and they are often predisposed to contaminated soil through the practice of open defaecation, children walking barefoot, and geophagy. From all the collection sites, the students were prone to infection, especially in the public schools, as they could contract infections because of the lack/of non-functional toilets in a good number of the schools. The playground, though expected to have no parasitic stage, was also a risk to the children because

most of the schools' playgrounds were close to dumping sites, and the children tended to play barefoot. This practice is comfortable for children with consequent exposure to infection and reinfection of hookworm. Most of the schools had hand washing stations and toilet buildings. Unfortunately, some of the public schools had their toilets locked, thereby leaving the children to open defaecation. A number of toilet environments were noticed to be bushy and lacked running water which might also lead to the extra task of fetching water which might discourage the children from using the toilets.

5. Conclusion

The result from this study showed that if WASH practices were adhered to, the rate of soil contamination with geo-helminth would be reduced. There was a significant difference between the total parasitic count in public and private schools, and this is due to WASH compliance by most private schools. The teachers should educate the children on the importance of good sanitation practices and also ensure that open defaecation is abolished. In addition to providing enough sanitation facilities in schools, behavioural change models, deworming programmes, and preventive chemotherapy need to be implemented in schools. School authorities can also design behavioural change models and health talks in Parent Teachers Association Meetings to implement WASH practices at home and ensure the children wear footwear at all times. Schools should be encouraged to employ cleaners who will keep the facilities clean and ensure they are used adequately (Mogaji *et al*., 2017).

6. Declarations

6.1. Ethical Approval and Consent to Participate

Before the commencement of the research work, advocacy visits were paid to Heads of the schools where soil samples were collected for official introduction, seeking consent and familiarity before the commencement of the research work. Approval was easily given since the research work does not involve any body parts, and it is non-invasive in any way.

7. Authors' Contributions

OMO, DTI and OOI developed and executed the research work, reviewed the literature, and wrote the manuscript. OMO, DTI and OOI followed up on field assessments and collection of data, Laboratory executions and data analysis. Supervisions, feedback and review of the final manuscript were done by OMO, SIA and OEO. The author(s) read and approved the final manuscript at submission.

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