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Knowledge, attitude and practice with respect to soil contamination by Soil-Transmitted Helminths in Ibadan, Southwestern Nigeria

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ABSTRACT

Ancylostoma duodenale, *Necator americanus*, *Ascaris lumbricoides* and *Trichuris trichiura*, the four major Soil-transmitted helminths (STHs) and also *Strongyloides stercoralis* infect humans worldwide. Most studies on Soil-transmitted helminths (STHs) carried out in Ibadan were faecal examination based while relatively few soil examination based studies were carried out mostly around school premises using limited number of sampling locations. This study was therefore designed to assess the level of soil contamination with STH and associated risk factors in the eleven local government areas of Ibadan. A total of 1980 soil samples were purposively collected monthly, between January and December 2017, from toilet areas, refuse dump sites, house vicinities, playgrounds, roadsides/walk ways, and examined for the presence of parasite eggs or larvae using automated analysis of light microscopy images by computer. Well-structured questionnaires were administered to 620 consenting participants to obtain information on the Knowledge of STH infections, Attitudes and Practices towards the infections. Data were analyzed using SPSS version 21, Chi-square and ANOVA were used in the analysis at $p < 0.05$. Out of soil samples examined, 1087 (54.9%) had at least one species of parasite. The prevalence of hookworm was 74.5% followed by 50.2% and 37.2% for *Strongyloides* species larvae and adult respectively, and 25.1% for *Ascaris* species. The highest prevalence was observed in the refuse dump (74.2%) followed by toilet area (36.5%) while the lowest was at house vicinities (1.6%). Fifty-seven percent of the respondents use pit latrine while 20.6% still practice open defecation. A high transmission risk was observed as large percentage (66.8%) of the respondents showed inadequate knowledge of how to avoid STH infections. Moreover, 64.0% and 25.2% reported that they often walk barefooted and suck fingers respectively. The high prevalence of parasitic contamination of soil observed in the present study and the high proportion of respondent with inadequate knowledge of how to prevent transmission of STH pose a high risk of re-infections in the study area even after treatment. Therefore there is a need for proper education on parasite transmission in the area.

1. Introduction

Soil-Transmitted Helminth (STH) infections are among the most prevalent Neglected Tropical Diseases (NTDs) which persist absolutely in the poorest populations (Hotez et al., 2009; Njiru et al., 2016). Diseases caused by the four main species of STH

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(*Necator americanus* and *Ancylostoma duodenale* also referred to as the hookworms, *Ascaris lumbricoides*, and *Trichuris trichiura*) are the most widespread NTDs, but broad geographical analyses are scarce (Karagiannis-Voules et al., 2015).

In Nigeria, intestinal helminth infections with *A. lumbricoides*, *T. trichiura* and the hookworms remained prevalent according to Oluwole et al. (2015), with the highest number of infected people in sub-Saharan Africa (Hotez and Kamath, 2009; Federal Ministry of Health, 2013). The majority of those affected are young children between the ages of 5 and 14 years living in rural areas and urban slums (Ekundayo et al., 2011). Most studies carried out were based on enrollment of school-aged children because of the high prevalence rate among children and accessibility to these school children.

The prevalence of soil transmitted helminthiasis in Nigeria differs from region to region (Odinaka et al., 2015). Although several studies (Olaniyi et al., 2007; Adefioye et al., 2011) have been conducted on the prevalence of intestinal helminthiasis in Nigeria, there are still localities for which epidemiological information is not available (Odinaka et al., 2015). A recent study carried out by Hassan et al. (2017) in five Local Government Areas in Ibadan metropolis (Ibadan North West, Ibadan South East, Ibadan North, Ibadan North East, and Akinyele), showed that out of 720 soil samples collected in the study, 483 (67.1%) had at least one species of Soil-transmitted helminth. The most frequently observed STH in this study was hookworm (58.6%) followed by *Strongyloides* species (39.7%), *Ascaris* (16.0%) and the least occurring species (0.3%) was *Trichuris*. This observation placed Ibadan as a major endemic location for Soil-transmitted helminth infection.

Despite the increased emphasis on the role of good sanitation and hygiene in the control of soil-transmitted helminths (WHO, 2017), huge number of the population still do not understand the relationship between the two, particularly in rural villages and the slums. There have been relatively few studies designed with the aim of evaluating soil contamination by soil transmitted parasites in different regions of Nigeria, where access to and use of Water, Sanitation and Hygiene (WASH) program is absent or inadequate. Improvements in personal and environmental hygiene as well as the provision of potable water improvement in socioeconomic status and health education (WHO, 2002; Ulukanligil et al., 2001) can help in effective prevention of the parasites. Hence this study was carried out in all the eleven Local Government Areas (LGAs) in Oyo State to determine the rate and intensity of soil contamination with STH and investigate the influence of extrinsic factors such as personal hygiene and socioeconomic background of the people on the status of STH infection, and furthermore, assess the level of knowledge and awareness of STH transmission.

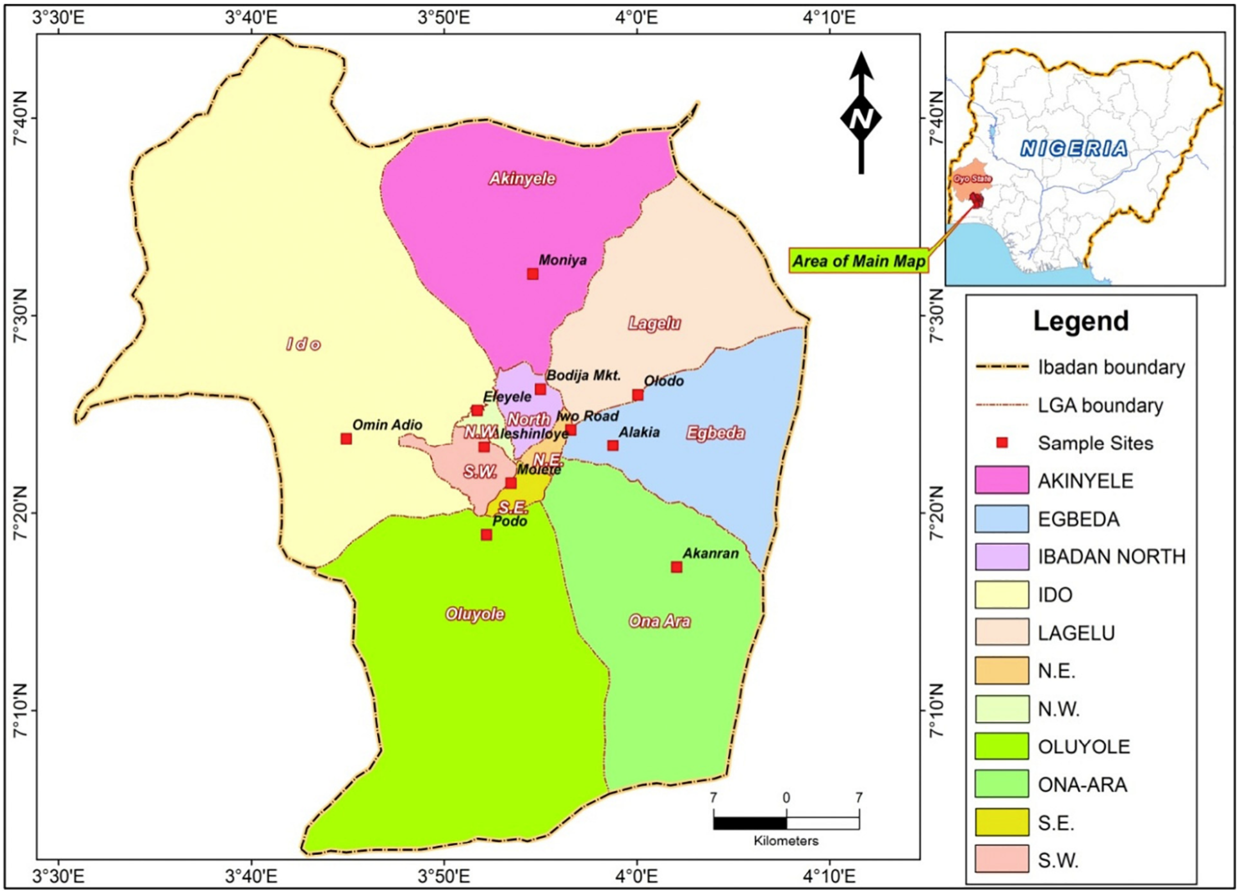

Fig. 1. Map of Ibadan showing the study locations.

2. Materials and methods

2.1. Study location and sampling sites

Ibadan is located in the south-western part of Nigeria, 128 km inland northeast of Lagos and 530 km southwest of Abuja, the Federal Capital. It is located in the south-eastern part of Oyo State about 120 km east of the border with the Republic of Benin in the forest zone close to the boundary between the forest and the savanna. The study was undertaken in eleven local government areas in Ibadan, Oyo state southwestern part of Nigeria. Study locations at each local government included; Molete (Ibadan South East LGA), Aleshinloye (South West LGA), Iwo road (North East LGA), Eleyele (North West LGA), Bodija (Ibadan North LGA), Moniya (Akinyele LGA), Akanran (Ona Ara LGA), Olodo (Lagelu LGA), Podo (Oluyole LGA), Alakia (Egbeda LGA) and Omi Adio (Ido LGA) (Fig. 1). Samples were collected from the following sites; toilet areas, refuse dumps, house vicinities, play grounds, road sides/walk paths.

2.2. Study design and sample size

The study was designed as a cross-sectional survey. A monthly soil sampling was conducted between January 2017 and December 2018. Soil sampling was carried out in the early hours of the day between 6.00 and 11.00 am, when the infective stages are still present and fresh in the topsoil (Nwoke et al., 2013). Purposive random sampling methods were carried out in areas where STHs would likely survive, or where human exposures would probably occurred (Collender et al., 2015).

A minimum of 320 soil samples for each sample site was calculated using the formula for a cross-sectional study as recommended by Alelign et al. (2015); $n = \frac{Z2P(1-P)}{d2}$ where n = sample size, Z = standard normal variate, P = expected proportion in the population, and d = absolute error or precision. A recent expected proportion of STH in soil environments in Ibadan (P), 70.8%, was reported by Hassan and Oyebamiji (2018). The standard normal variate at 5% type one error (Z) is 1.96, while the absolute error or precision (d) is 5%. An approximate minimum sample size of 320 was therefore estimated.

2.3. Ethical approval and considerations

Ethical approval was collected from the Oyo State Ministry of Health. There were pre-survey visits to the study areas and informed consent obtained from the authorities in charge to undertake the study. Permission to carry out the study was obtained from the Local Government Areas and the communities' heads. Voluntary participation and withdrawal from the study at any time without repercussion was ensured. All data/information from the completed questionnaire were kept confidential to prevent undue access by third party to information provided by study participants.

2.4. Inclusion criteria

Volunteers of different ages who reside in the LGA and signed informed consent form were included in the study.

2.5. Exclusion criteria

People that do not volunteer and refused to sign a written consent form were excluded from the study.

2.6. Questionnaire administration

A close ended questionnaire following recommendations by Ojurongbe et al. (2010) was pretested in a non-target sampling area. The questionnaires interpreted in yoruba language for use when necessary and translated back to English for data entry and analysis. Questionnaires were administered to consenting participants enrolled to obtain information such as age, sex, dietary habits, education and socioeconomic status, knowledge and perception about parasitic infections. Where necessary, participants were assisted in completing the questionnaire for better understanding.

2.7. Sample collection

Approximately 100 g of soil was randomly collected at a depth of 2–3 cm (Odikamnoro et al., 2013; Hassan et al., 2017; Hassan and Oyebamiji, 2018) from different points within the five sampling sites. Each of the 396 soil samples from each location was stored in properly labeled polythene bag until required for laboratory analysis.

2.8. Recovery of STHs

Concentration of parasites eggs or larvae from soil: About 5 g each of the soil sample were mixed thoroughly with distilled water. The suspension was strained through a sieve mesh size 200 μm to remove coarse particles. The filtrate was centrifuged at 1000 RPM for 3 min and the supernatant decanted. The resulting sediment was further broken up by shaking and tapping the tube. The sediment was mixed with zinc sulphate solution (specific gravity 1.2), added up to the brim of the test tube and allowed to stand for a few minutes with a cover slip on the tube to collect any floating egg. The cover slip was removed and examined under the microscope at ×10 and ×40 objectives (Auta et al., 2014; Hassan et al., 2017).

Soil Nematode Extraction: Modified Baermann method was used for extraction of Hookworm and *Strongyloides* larvae from the soil as described by Collender et al. (2015). The apparatus consists of a modified funnel with a short piece of rubber tubing attached to the stem and a clamp closure. The funnel was supported in an upright position and filled with water. 20 g of soil was placed on top of a two-layered paper napkin on top of a wire screen. The 'enveloped' soil sample was placed in the Baermann funnel (filled with distilled water). The larvae migrated through the paper napkin and screen into the water in the funnel, settled at the bottom of the funnel by gravity and were collected after 48–72 h. The lower 5 ml of the suspension was viewed under the microscope for the presence of nematodes.

2.9. Identification of larvae and ova of STHs and parasite counts

Following the recovery of eggs and/or larvae from the soil sample, identification was done using standard methods (Chiodini et al., 2003; Otubanjo, 2013; Hassan et al., 2017) and quantified using automated analysis of light microscopy images by computer (Pallar and de Chavez, 2014; Collender et al., 2015).

The prevalence was determined using the formula below:

$$\text{Prevalence} = \frac{\text{Number of contaminated soil samples}}{\text{Total number of soil samples examined}} \times 100$$

2.10. Statistical analysis

Data obtained were entered into the computer using Microsoft excel 2007 version, entry errors were checked and analysis was carried out using SPSS for windows version 21 (SPSS Inc., Chicago, IL, USA). Categorical variables like the demographic characteristics of the respondents were presented as frequencies and percentages, and analyzed in relation to risk parameters using the Chi-square test. The significant associations were identified based on $p < 0.05$ (Hassan et al., 2017). Cross tabulations of important variables of the questionnaire were done and the statistical significance of variables was estimated using Chi-square test. One-way ANOVA was used to test means of parasite load in different sites.

3. Results

3.1. Overall prevalence of STH

Out of the 1980 soil samples collected, 1087 (54.9%) had at least one species of parasite. The most frequently observed STH in this study was hookworm (74.5%) followed by *Strongyloides* larvae (50.2%), *Strongyloides* adult (37.2%) and *Ascaris* (25.1%). The prevalence of parasites in relation to sampling sites during the sampling period varied significantly, $p < 0.05$.

3.2. Distribution pattern of Soil-transmitted helminths

The level of hookworm contamination in soil was highest, followed by the level of *Strongyloides* species larvae and the lowest load was recorded for *Ascaris* species (Fig. 2).

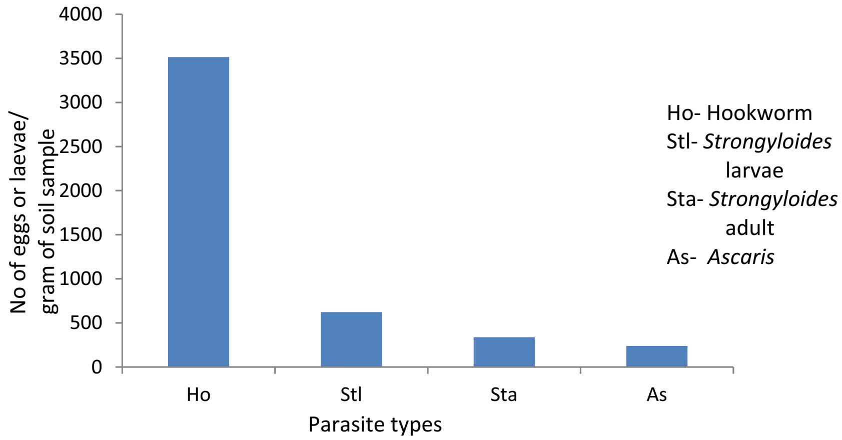

Fig. 2. Level of soil-transmitted helmiths in soil samples.

3.3. Soil contamination with STH in the Various Sampling Sites

The range of parasite load was from 2370 per gram of soil around refuse dump to 20 per gram of soil at house vicinities (Fig. 3). The observed variation was highly significant, $p > 0.05$.

3.4. Demographic characteristics of respondents

Table 1 shows the demographic distribution of respondents. More males (61.8%) than Females (38.8%) were enrolled into the study. The highest (27.1%) and lowest (2.3%) proportion of respondents were within the age range of 31–40 years and 61–70 years respectively. Approximately 7.0% had no education, 7% also had National Diploma or National Certificate (ND/NCE), while the largest percentage (43.0%) of the respondents had Senior School Certificate (SSC). In addition, the higher proportions (29.4%) of the respondents were traders, while the lower proportions (14.0%) were civil servants.

3.5. Knowledge of STH infection and attitude towards infection

Fig. 4 shows level of awareness of STH among respondents. Majority of the participants (62.6%) have knowledge of parasitic worms, however, 88.4% do not actually know how to avoid getting infected with worms. Analysis showed that a significantly lower proportion of respondents (11.6%) reported that clean water and clean environment could prevent transmission of STH ($p < 0.05$).

3.6. Risk of STH infection among study participants

A large proportion of the respondents (85.5%) indicated that the health center can be assessed in few minutes by mobile transportation. Approximately 58.4% of the respondents did not remember the last time they were dewormed. A total of 396 (64.0%) walk barefooted while 57.5% of the respondents kept goat as pet animals (Table 2). The main source of drinking water was well (46.7%) followed by tap (35.5%), only a few had access to water from trucking commercial supplier (8.4%). Most of the respondents used pit latrine (57%) and also a large percentage of respondents (68.7%) washed hands with water only, no soap. Most of the respondents do not bite or suck their nails (72.9%).

4. Discussion

The presence of parasitic helminths eggs and larvae in soil is of great epidemiological significance and a serious public health concern. Hookworm's larvae, *S. stercoralis* larvae and adult, and *Ascaris* eggs observed in soils around Ibadan in the present study were the most common Soil-transmitted helminth species in Ibadan and this finding is in line with previously reported observation by Hassan et al. (2017). The high level of soil contamination with STH confirmed the endemic status and evidence of a high risk exposure of people to STH around Ibadan. Soil contamination with STH serves as a continuous source of human infection according to Ogbolu et al. (2011).

The highest level of soil contamination with parasites during the study period was at sites dump sites, and similar observation was recorded by Ogbolu et al. (2011), Adekeye et al. (2016), Hassan et al. (2017) and Hassan and Oyebamiji (2018). This situation not only provides a continuous/reserved source of infection in the communities particularly among the male, those in age group 31–40 years, the educated and traders, who probably were in the majority among the inhabitants. A risk of spread of STH

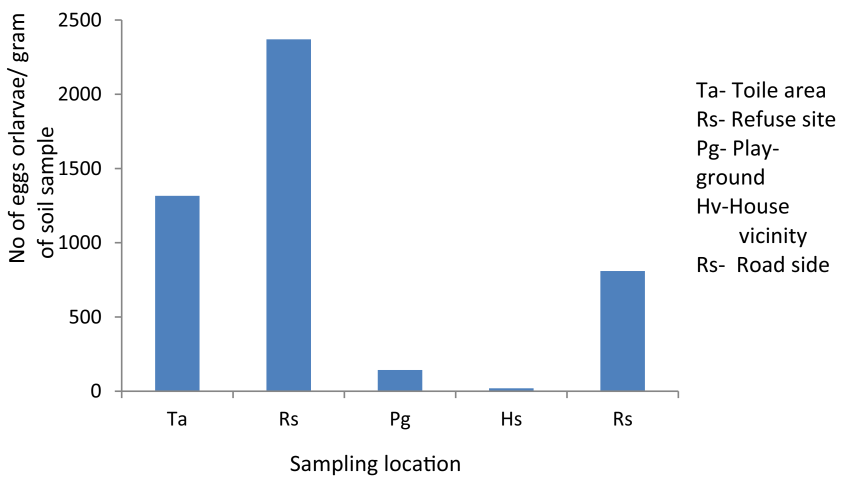

Fig. 3. STHs count in relation to sampling locations.

Table 1
Demographic characteristics of respondent.

Characters	Variables	Freq. (%)
Sex	Male	379 (61.1)
	Female	241 (38.9)
Age	0–10	87 (14.0)
	11–20	55 (8.90)
	21–30	70 (11.3)
	31–40	168 (27.1)
	41–50	119 (19.2)
	51–60	107 (17.5)
	61–70	14 (2.3)
Educational status	No education	43 (7.0)
	Pry school	214 (34.6)
	SSC	267 (43.0)
	ND/NC	44 (7.0)
	HND/BSC	52 (8.4)
Occupation	Unemployment	142 (22.9)
	Farmer	119 (19.2)
	Trader	182 (29.4)
	Civil servant	87 (14.0)
	Motorcycle	90 (14.5)

N = 620.

following heavy or moderate rainfall is eminent as most of the inhabitants defecate in open bushes beside the dump sites, while others defecate in polythene bags and dispose the waste at the dump site. This sanitary status is significant to the fact that the current declaration of Open Defecation Free (ODF) community announced by WHO may not be feasible in the nearest future (UNICEF, 2017). The high prevalence recorded in the river bank may be attributed to free ranging animals that also defecate all around particularly at dumpsite as they go to feed. These evidences, however, suggest a high level of environmental risk of parasites transmission. Children recreating at the playground are exposed to continuous infection since they are prone to habits like walking barefooted (especially while playing), picking up dropped foods from the ground, and sucking or biting their nails. According to WHO, children are the most vulnerable population to STH infection (Welch et al., 2016).

The contamination with STH at the toilet areas could be attributed to the fact that most of the inhabitants with pit latrines even when housed in small buildings, still preferred to defecate around toilet areas. A study carried out by Ziegelbauer et al. (2012) showed that sanitation facilities protected against Soil-transmitted helminth infections as children from schools with toilet facilities had lower prevalence of STH compared to children from schools without toilets. The low level of contamination in households' vicinities when compared to other sites could be explained by the fact that house premises were swept regularly and being utilized minimally as defecation sites because of reduced privacy, moreover, the contamination observed could be attributed to run-offs from nearby dump sites during rainfall. Another risk factor is the type of floor in the home. Concrete floors have been reported to reduce the prevalence of STH infection when combined with deworming medications (Benjamin-Chung et al., 2015; Worrell et al., 2016). Worrell et al. (2016) reported increased prevalence of STH infection among children living in households with unfinished floors. While unfinished floors have been associated with hookworm infection (Pullan et al., 2010; Soares Magalhães et al., 2011), there is less evidence to support any association in *A. lumbricoides* and *T. triciura* infections (Basualdo et al., 2007; Forrester et al., 1990). Consequently, the plausible explanation could be the ease of contaminating bare floor with contaminated barefoot and the provision of suitable of STH transmission. Furthermore, a large percentage of the respondents

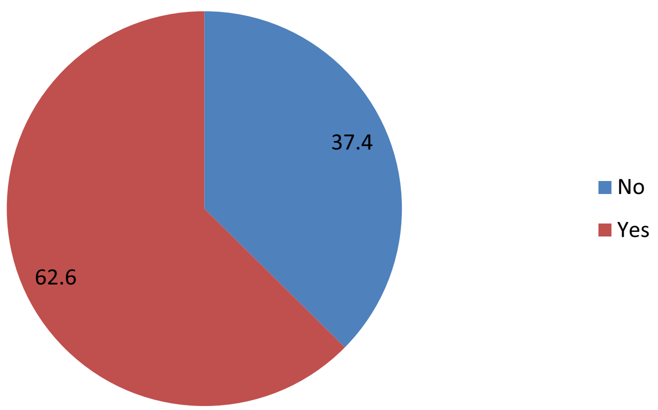

Fig. 4. Awareness status of STH among respondents.

Table 2
Attitude and practice of respondent towards STH infection.

Variables	Freq. (%)	*p*-Value
Hospital distance		
An hour drive	40 (6.5)	$\chi^2 = 262.27, p < 0.05$
Walking distance	50 (8.1)	
Few minutes by car	530 (85.5)	
Total	620 (100)	
History of deworming		
Months ago	64 (10.3)	$\chi^2 = 129.29, p < 0.05$
Years ago	104 (16.8)	
Don't know	362 (58.4)	
Never	90 (14.5)	
Total	620 (100)	
Walking barefooted		
Never	215 (34.6)	$\chi^2 = 126.01, p < 0.05$
Sometimes	9 (1.4)	
Always	396 (64)	
Total	620 (100)	
Ownership of pets/animals		
Yes	357 (57.5)	$\chi^2 = 4.79, p < 0.05$
No	263 (42.5)	
Total	620 (100)	
Source of drinking water		
Tap	220 (35.5)	$\chi^2 = 94.41, p < 0.05$
Well	290 (46.7)	
Sachet/bottle water	58 (9.3)	
Water truck	52 (8.4)	
Total	620 (100)	
Type of toilet available		
Water closet	139 (22.4)	$\chi^2 = 54.09, p < 0.05$
Pit latrine	353 (57.0)	
Bush	128 (20.6)	
Total	620 (100)	
Hand washing after defecating/before eating		
Never	61 (9.8)	$\chi^2 = 124.28, p < 0.05$
With water only	426 (68.7)	
With soap and water	133 (21.5)	
Total	620 (100)	
Nail biting/finger sucking habits		
Never	452 (72.9)	$\chi^2 = 168.26, p < 0.05$
Sometimes	12 (1.9)	
Always	156(25.2)	
Total	620 (100)	

said they had pets such as dogs and cats at home, while others said they had animals such as turkey, hen, and goat around the house. This could lead to zoonotic transmission of STH to those leaving with the animals.

In addition, various studies on STH infection concluded that toilet habits had influence on infection rate (Asaolu et al., 2002; Blaszkowska et al., 2011; Gyawali et al., 2013; Adekeye et al., 2016; Hassan et al., 2017). However, considering the high level of soil contamination, the low percentage of people who defecate in the bush cannot be explained outside the fact people are often ashamed to admit they practice open defecation. The highest proportions that practice OD (bush attack) reported in the present study were mostly children. After defecating in the bush, most do not remember to wash their hands when they get home, neither do they go to the bush with water or tissue paper to clean up after defecating. These children explained that nearby waste papers or leaves were often used, thereby increasing chances of contaminating fingers which they end up sucking or biting the nails. However, a large percentage of the respondents stated that they cleaned up with tissue paper/water every time they visited the toilet, while only a small percentage said they had never made use of tissue/water after defecating thus suggesting the use of paper or leaves as only choice. Ziegelbauer et al. (2012) reported that people who either had or used a latrine were half as likely to be infected with a soil-transmitted helminth as people who neither had nor used a latrine. Providing access to, and promoting the use of, standard sanitation facilities would be an effective control measure for soil-transmitted helminthiasis (Ziegelbauer et al., 2012). In the present study communities, there is a need for more emphasis on improving access to adequate sanitation in control strategies for soil-transmitted helminths. Combining adequate sanitation facilities with preventive chemotherapy and health education on helminthiasis as recommended by WHO (2017) would go a long way in controlling STH infections in these areas and put a stop to open defecation completely. Apparently, it could be implied also that because a larger percentage of respondents do not know how to prevent STH infection, this low level of knowledge of STH transmission showed that this level of ignorance could place them at a high risk of being infected. This risk picture is in line with previous reports by Onuoha (2009) and Adekeye et al. (2016).

The history of deworming and the proximity of the health center to people in the study areas could have influence on the rate of infection with STH as explained by Clarke et al. (2017) and WHO (2017). The findings of the present study confirmed the need for proper documentation to enhance the use of Preventive Chemotherapy (PC) in the area. Most of the respondents do not know when last they were dewormed, a large percentage claimed they never used any anthelminthic drug, while a small proportion admitted that they had recently been dewormed (few months back). Most of those respondents that claimed to have been dewormed few months or years back could not ascertain the type of drugs used, but some mentioned paracetamol, anti-malarial drugs, and the local herb known as 'Agbo Jedi'. Hence, it is possible that the drugs recommended by WHO for treating soil-transmitted helminthiasis (albendazole 400 mg, mebendazole 500 mg, pyrantel 10 mg/kg, and levamisole 2.5 mg/kg) are not popular among study population. The herbal concoction (Agbo Jedi) on the other hand is a variety of herbs used by most Nigerians, especially among the natives in the communities. Most of the respondents indicated that they used this herb to de-worm, however, there is no documented evidence of the effectiveness of 'Agbo Jedi' in deworming. According to WHO, 80% of Africans use traditional medicine for primary health care, mostly because they believe it works faster than the conventional medicines, and because it is cheaper (WHO, 2017).

The high proportion of respondents who relied on well water as a source for drinking calls for the need to educate people in the present study area about proper water treatment and management of drinking water. These communities however are at a high risk of infection since most of the open wells were not standard constructions and rains could easily wash off parasites into these wells because open defecation is a regular practice. Onuoha (2009) also recorded that those who drank well water during the rainy season had the highest prevalence of STH infection compared to those who drank sachet or bottled water. Moreover, the fetchers used to draw water from the wells are usually left on the ground around the well. From the ground, it is lowered again into the well without being washed and there could have been possible contamination of the entire well water thereby serving as a source of infection for the whole community (Mbae et al., 2013). Furthermore, the intensity of *Ascaris* species infection has been found to increase with increased downhill runoff and draining after rainfall (Onuoha, 2009; Campbell et al., 2014). It is possible that *Ascaris* eggs that are washed downhill may be washed into rivers, streams or open and poorly structured wells (Brooker and Michael, 2000, Adekeye et al., 2016). It is therefore a point of concern that most of the respondents admitted to drinking well water. Anthelmintics alone will not be sufficient in controlling STH in this community, as the absence of good drinking water will only increase the rate of re-infection after treatment (Hotez et al., 2009; Echazú et al., 2017).

5. Conclusion

The high prevalence of parasitic contamination of soil observed in the present study and the high proportion of respondents with inadequate knowledge of how to prevent transmission of STH pose a high risk of STH transmission in the study area, therefore there is a need for proper education on parasite transmission in the area. Moreover, the high number of people that still practice open defecation call for concern because of the year 2025 zero targets for open defecation. The low access to standard water and sanitation explains the very high level of soil contamination with soil-transmitted helminths in this study. Improvement in the access to WASH program in these communities characterized with open defecation practice and high level of soil contamination is highly recommended. Furthermore, it is clear that high rainfall combined with low level of awareness, hygiene, and the known hardy nature of STH eggs and larvae provides a fertile environment for STH transmission in this city. In order to differentiate between human and animal helminthes, molecular study needs to be carried out in the area.

Declarations

We declare that this is an original work, it has not been previously published or accepted for publication in any journal and has not been submitted to any other journal for consideration and publication.

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Author's contributions

Adesola A. Hassan and David A. Oyebamiji, designed the experiment, wrote and proofread the manuscript for publication. David A. Oyebamiji, Amarachi N. Ebisike and Jennifer O. Egede went to the field and did the data analysis.

Conflict interests

None.

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