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Soil transmitted helminths infections in a rural community

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ABSTRACT

Objectives: Soil-transmitted helminths (STHs) are a type of neglected tropical disease that are responsible for the majority of infections worldwide. The most common STHs are *Ascaris lumbricoides*, hookworm, *S. stercoralis,* and *Trichuris trichiura*.The aim of the study was to determine the prevalence of STHs in the Agbeyangi community and its associated risk factors.

Material and Methods: The study is a cross-sectional, community-based descriptive study. Total sampling of consenting participants was done in the community. The research was carried out between June to August of 2023. A validated self-administered questionnaire was used to capture information on socio-demographics. A fecal sample was collected in a test tube after obtaining consent from the parents/guardians, and samples were de-identified and coded. The coded samples were taken to the laboratory on the same day. Helminthes ova were quantitatively determined on slides per sample using the number of eggs per gram (epg) of feces. In order to calculate the amount of epg of feces, the number of helminth eggs was counted and multiplied by 24. Of these, 20% were chosen at random and read once more as a quality control measure and to verify the consistency of the outcome.

Results: Of the 500 respondents, those in the age range of 18-23 years had the highest response (161, 32.2%), followed by children between the ages 0-5 (137, 27.4%). Males were more prevalent (255, 51.0%) than females (245, 49.0%). The prevalence of STH was 13.2%. Hookworm (27, 40.91%) was the most prevalent species, followed by *Entamoeba histolytica* (19, 28.79%), the least being *S. stercoralis* (8, 12.12%). Risk factors for STH infection included the age range of 12-17 years, not wearing shoes, lack of awareness, lack of hand washing, and sources of drinking water ($p<0.05$).

Conclusion: Hookworm was the most common helminth infection in the community. However, STH was deemed to be low in the study area. Infection rates were considerably influenced by elements like age group, footwear use, awareness, and handwashing practices.

Keywords: *Entamoeba histolytica,* Eggs per gram, Hookworm, Neglected tropical diseases, Soil-transmitted helminths

INTRODUCTION

The World Health Organization (WHO) estimates that 568 million school-age children (SAC) reside in locations where soil transmitted helminths (STH) are widely transmitted[1] and over two billion people are afflicted with one or more STHs, the most common of which are *Ascaris lumbricoides*, hookworm, and *Trichuris trichiura.*[2] School-aged children are more likely to become infected with STH.[1] STHs are a type of neglected tropical disease responsible for the majority of infections worldwide, primarily affecting disadvantaged populations in low- and middle-income nations[3] in tropical regions in Africa, Asia, and Latin America.[1] *Ascaris lumbricoides* infects around 1.2 billion individuals, followed by *Trichuris trichiura* infecting around 795 million people and Hookworm (*Ancylostoma duodenale* and *Necator americanus*) infecting around 740 million people globally.[4,5] *Ascaris* and *Trichuris* primarily affect school-aged children,[4] possibly because children are more exposed to contaminated soil when they play, walk barefoot, consume soil, and do not practice basic personal hygiene.[1] However, hookworm affects both children and young adults. It causes iron deficiency anemia, protein energy malnutrition, and growth retardation.[4]

The prevalence of helminthic infection in school-aged children makes this subgroup a strong target for helminth control programs in the general population, and schools provide good possibilities for control program implementation.[6] While Odinaka *et al.*[7] identified inadequate hand washing and male gender as risk factors for being infected with STH. Onah, 2023[3] identified children who played with sand and those who didn't wash their fruits before eating as a risk factor for being infected.

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The prevalence of STH varies in Nigeria, between 30.3%[7] to 52.0%.[8] Despite various studies on the prevalence of intestinal helminthiasis in Nigeria, there are still areas, like our study area, where epidemiological data is lacking. The aim of the study was to determine the prevalence of STH and its associated risk factors. This will serve as a baseline for any future study of proposed regular deworming programs at local communities throughout the state.

MATERIAL AND METHODS

Study area: The study was conducted in the Agbeyangi community, which is the headquarters of the Agbeyangi/Gbadamu/Oshin political ward of the Ilorin East local government area. Ilorin East is a Local Government Area in the Nigerian state of Kwara. Its headquarters are located in Oke Oyi.

It has a land area of 486 km^2 and a population of 204,310 people, according to the 2006 census.[9] The population of Agbeyangi consists primarily of farmers, while some work in other businesses such as driving, trade, and weaving cotton for local lamps, among others. Their major sources of water are the well and stream.

Study design: The study is a cross-sectional, community-based descriptive study. Total sampling of consenting participants[10] was done in the community. The research was carried out between June to August, 2023

Study populations: The study population comprises infants, children, adolescents, and young adults in the community

Ethical approval: Ethical approval was obtained from the Kwara state Ministry of health, Ilorin, Kwara State, with Ethical No: ERC/MOH/2023/06/124. Signed consent was obtained from all participants, and in children assent was obtained from the parents or guardian.

Inclusion Criteria

1. Those who gave their Consent
2. Children, infants, and young adults
3. Participants who reside in the Agbeyangi community

Sample collection: One stool sample was collected from each person in a sterile, leak-proof, transparent, wide-mouth container, pre-labeled with identification numbers. They were told not to contaminate the sample with disinfectant or urine while it was being collected, and the sample was sent to the laboratory on the same day. Samples were de-identified and coded. Each feces sample was first thoroughly inspected for the presence of blood, mucous, and mature worms. The samples were further analyzed microscopically for the presence of eggs.

Laboratory procedure: In the Para Tube, 1 g of fresh or formalinized feces were suspended in 10 mL formalin (10%) and centrifuged at 500 g for 1 minute. The inner tube with the filtered debris was discarded after centrifugation. The cone-bottomed tube was then filled with 3 mL of ethyl acetate. After centrifuging the tube at 500 g for 10 minutes, the supernatant was decanted, and the top plug of debris was rimmed with an applicator stick. The residual silt was diluted in a few drops of 10% formalin, and 20 L was deposited onto a slide to be checked for parasites.[11]

Detection and quantification of intestinal helminthes: Helminthes ova were quantitatively determined on slides per sample using the number of eggs per gram (epg) of feces to measure the infection's severity. In order to calculate the amount of epg of feces, the number of helminth eggs was counted and multiplied by 24. Of the slides, 20% were chosen at random and read once more as a quality control measure and to verify the consistency of the outcome. The WHO categorized the epg as light infection (epg 100), moderate infection (epg 100-399), and heavy infection (epg 400).[12]

Data analysis: The Statistical Package for Social Sciences (SPSS) version 20.00 was used for data entry and data analyses. Percentages and Tables were used to present summarized data. For categorical measurements, the frequencies were computed. Comparative analysis involving two categorical variables was done using the chi-square test and logistic regression with the level of significance set at $p<0.05$.

RESULTS

Socio-demographic characteristics of the study population

Of the respondents, those in the age range of 18-23 years had the highest response (161, 32.2%), followed by children between the ages 0-5 (137, 27.4%). Males were more prevalent (255, 51.0%) than females (245, 49.0%) [Table 1].

Risk factors for soil transmitted helminthes

Table 2 shows that risk factor for STH infection include ages 12-17 years, not wearing shoes, lack of awareness, lack of hand washing, and sources of drinking water ($p<0.05$).

Prevalence of soil transmitted helminth among respondents

Table 3 shows the prevalence of STH as 13.2%. Hookworm (27, 40.91%) was the most prevalent STH, followed by *Entamoeba histolytica* (19, 28.79%) and *S. stercoralis* (8, 12.12%).

Table 1: Socio-demographic characteristics of the study population

Characteristics	Frequency (n)	Percentage (%)
Age group (years)		
0-5	137	27.4
6-11	66	13.2
12-17	133	26.6
18-23	164	32.8
Gender		
Male	255	51.0
Female	245	49.0

A logistic regression analysis was performed to examine the influence of age and other risk factors on the risks of being infected (coefficient of the variable *AGE* is b = 0.05, which is positive) showed an increase in age, not wearing footwear, lack of awareness and the source of drinking water are associated with an increase in the probability of being infected (OR= 0.1, 95% CI- 0.06 - 0.17, p value <0.001; OR= 0.02, 95% CI- 0.01 – 0.05, p value <0.001; OR= 1.05, 95% CI- 1.01-1.08, p value- 0.014; OR= 1.02, 95% CI- 0.45 – 0.51, p value <0.001) Respectively [Table 4].

Table 2: Risk factors for soil transmitted helminthes

Risk factors	Helminth status		Total (n%)	X^2	p-value
	Infected (n%)	Non-infected (n%)			
Age (years)				38.508	0.000
0-5	7(5.11)	130 (94.87)	137 (100)		
6-11	3 (4.55)	63 (95.45)	66 (100)		
12-17	38 (27.94)	98 (72.06)	136 (100)		
18-23	18 (11.18)	143 (88.82)	161 (100)		
Total	66 (13.2)	434 (86.8)	500 (100)		
Foot ware				5.893	0.015
Yes	31 (7.3)	393 (92.7)	424 (100)		
No	12 (15.8)	64 (84.2)	76 (100)		
Total	43 (8.6)	457 (91.4)	500 (100)		
Sewage disposal				2.516	0.284
Open defecation	0	0	0		
Wc*	16 (7.1)	209 (92.9)	225 (100)		
Pit	31 (11.3)	244 (88.7)	275 (100)		
Total	47 (9.4)	453 (90.6)	500 (100)		
Awareness				7.091	0.008
Yes	27 (9.5)	257 (90.5)	284 (100)		
No	38 (17.6)	178 (82.4)	216 (100)		
Total	65 (13)	435 (87)	500 (100)		
Gender				1.316	0.251
Male	38 (14.9)	217 (85.1)	255 (100)		
Female	28 (11.4)	217 (88.6)	245 (100)		
Total	66 (13.2)	434 (86.8)	500 (100)		
Hand washing				18.430	0.000
Always	25 (8.09)	284 (91.91)	309 (100)		
Occasional	41 (21.47)	150 (78.53)	191 (100)		
Total	66 (13.2)	434 (86.8)	500 (100)		
Source of drinking water				51.593	0.000
Well	47 (28.83)	116 (71.17)	163 (100)		
Borehole	19 (5.64)	318 (94.36)	337 (100)		
Total	66 (13.2)	434 (86.8)	500 (100)		

*Wc: Water closet, p-value <0.05 is statistically significant

Table 3: Prevalence of soil-transmitted helminths among respondents

Total populations	**Total infected (N)**	**Prevalence (%)**
500	66	13.2
Specie	Frequency (N)	Percentage (%)
Hookworm	27	40.91
Entamoeba histolytica	19	28.79
Lumbricoides	12	18.18
S. stercoralis	8	12.12
Total	66	100

DISCUSSIONS

Socio-demographics of the respondents show that out of 500 respondents, 51.0% (255) were males while 49.0% (245) were females. This was lower than that recorded by Onah (2023), which showed the male prevalence to be 57.3% and female prevalence to be 42.7%.[3] Furthermore, in the study by Onah (2023), respondents fell into three age groups- 5-8, 9-12, 13-16, and 17-20 years, with group 9-12 having the highest number of participants (159, 46.5%).[3] However, our study included infants in the community and fell into five groups 0-5, 6-11, 12-16, and 17-23 years, with group 18-25 having the highest number of participants (164, 32.8%). Adefioye *et al.* (2011) recorded ages 11-15 years as having the highest number of participants.[13] The difference could be that our study was a community-based research, while Onah's (2023) research was carried out in a school.[3] Not wearing footwear, lack of awareness/knowledge on STH, not washing hands, and contaminated sources of drinking water were identified as risk factors for STH infestations ($p<0.05$) in our study in North Central Nigeria. In this study, logistic regression showed that as age increases, the risk of infection also increases (OR= 0.1, 95% CI- 0.06 - 0.17, p value <0.001). Also, not wearing footwear, lack of awareness and the source of drinking water were associated with an increase in the probability of being infected (OR= 0.02, 95% CI- 0.01 – 0.05, p value <0.001; OR= 1.05, 95% CI- 1.01-1.08, p value- 0.014; OR= 1.02, 95% CI- 0.51 – 0.45, p value <0.001), respectively. Odinaka *et al.* (2015) in South eastern Nigeria identified the male gender as a risk factor.[7] Adefioye *et al.* (2011) in their study in South western Nigeria identified use of pit latrines, drinking of stream water, and not treating water before drinking as risks factors.[13] Aribodor and colleagues (2023) identified lack of awareness as a risk factor for being infected with STH (OR = 0.60, 95% CI: 0.42 - 0.86, p = 0.008).[14] Ekundayo *et al.* (2007) noted that in the 1980s, most authors noted on the unsanitary and common behavior of people defecating or dumping feces at garbage depots, neighbouring bushes, below bridges, along bush tracks, motor roads, river sides, and even on open fields. Minimal success was recorded in introducing latrines into rural Nigeria as many dwellings lack latrines, and public latrines are limited.[8] However, we noted that there may be a down trend to open defecation as respondents use both pit and water closet.

The prevalence of STH in our study was 13.2% and was highest among the age group 12-17 years, as shown in our study (38, 27.94%). Hookworm was the most prevalent specie (27, 40.91%) followed by *Entamoeba histolytica* (19, 28.79%) and the least prevalent was *S. stercoralis* (8,12.12%). Infections with hookworm are common in Nigeria, particularly in children, depriving them of the essential nutrients needed for growth and development.[15] Odinaka *et al.* (2015) showed 30.3% STH prevalence and similarly observed hookworm as the most prevalent specie (81, 94.2%), with the least common being *A. lumbricoides* (2, 2.3%).[7] Adefioye *et al.* (2011) had a higher prevalence of 52.0%, highest among the age group ≥15 years, but in contrast recorded *A. lumbricoides* as the most prevalent (36.2%) followed by hookworm (10.5%).[13] Ibidapo *et al.* (2008) recorded an overall prevalence of 83.3% with *Ascaris lumbricoides* (67.7%) being the most prevalent followed by hookworm (45.0%), *Trichuris trichiuria* (31.3%), and the least prevalent being *S. stercoralis* (18.0%).[15] One of the main ways that ascariasis spreads among schoolchildren is through dirty hands. Due to their unclean play environment and frequent dipping of contaminated hands in their mouths, toddlers have also shown high positive rates for STHs.[15] In

Table 4: Correlation between the risk of STH infection and the risk factor using logistic regression

Variables	**Coefficient B**	**Standard error**	**z**	**p**	**Odds ratio**	**95% confidence interval**
Constant	-2.32	0.28	8.13	<0.001	0.1	0.06 - 0.17
Age	0.05	0.02	2.47	0.014	1.05	1.01 - 1.08
Gender	0.04	0.25	0.17	0.863	1.04	0.64 – 1.70
Footwear	-3.75	0.37	10.05	<.001	0.02	0.01 – 0.05
Awareness	0.05	0.02	2.47	0.014	1.05	1.01-1.08
Source of drinking water	-3.75	0.37	10.05	<0.001	1.02	0.45 – 0.51

STHs: Soil-transmitted helminths. p-value <0.05 is statistically significant. Observed value above mean: Positive z score, Observed value below the mean: Negative z score.

our study the sources of drinking water played a significant role in STH transmission ($p<0.05$), even in cases where there is no increase in the availability of clean water or sanitation, it is recommended that Nigeria treat SAC on a regular basis, as well as other vulnerable populations like pregnant women, pre-schoolers, and people in particular occupation groups, in order to help prevent the worst consequences of infection.[15]

Low positive rates for *S. stercoralis* may have resulted from the dry environmental conditions experienced between July and December, as these parasites' ova are known to be susceptible to destruction.[13] The variation in prevalence could also be related to differences in survey timing and season, environmental conditions, and other geographical characteristics in the studied sites. Furthermore, the most popular diagnostic techniques for detecting STH, like Kato-Katz and direct fecal smear, have poor sensitivity for *S. stercoralis* and occasionally may not detect it at all. Under diagnosis of threadworm might result from these diagnostic challenges, which are frequently caused by the irregular excretion of parasite larvae.[16]

The lower prevalence may also be due to regular deworming in the community. Hence, it is imperative to constantly evaluate the prevalence of intestinal helminths among children and young adults, owing to the ill-effects posed by these parasites among the vulnerable groups.

Because intestinal helminthiasis is linked to socioeconomic status in most African countries and has a negative impact on schoolchildren's academic performance, a comprehensive investigation of intestinal helminth infection should not be limited to children alone but should also include their parents and other communities within the local government area for effective control. Mass deworming of schoolchildren with anti-helminthic medications such albendazole or combination therapy with praziquantel should be done at least twice a year. This would substantially lower the prevalence and severity of infections. Personal cleanliness must also be promoted.

Limitation

This study is limited by its small sample size and short duration of study. Future research should involve a randomized control with a longer duration of study.

CONCLUSION

The prevalence of STH was low in our study site (13.2%), and risk factors associated with STH infestation include not wearing footwear, lack of awareness/knowledge of STH, lack of hand washing, and contaminated sources of drinking water.

Ethical approval: The research/study approved by the Institutional Review Board at Kwara State Ministry of Health, Ilorin, number ERC/MOH/2023/06/124, dated 22nd June 2023.
Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent.
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