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Prevalence of Soil-Transmitted Helminths among Asymptomatic School Children in Selected Rural and Urban Communities in North-Central Nigeria

Amase Nyamngee*, Idiat Modupe Sanda, Kehinde Mariam Sulaiman

Department of Medical Microbiology and Parasitology, Faulty of Basic Clinical Science, College of Health Sciences, University of Ilorin, Nigeria.

***Corresponding Author:** Email: anyamngee2010@yahoo.com; Tel: +2348032110682; +2348128285031

ABSTRACT

Soil-Transmitted Helminths (STHs) are a group of intestinal parasitic nematodes causing diseases in humans when exposed to their infective stages (eggs or larvae) thriving in warm and moist soil. This study ascertains the prevalence of STHs among school children in urban and rural communities in North-Central Nigeria. A cross-sectional study involving 1,372 randomly selected school children, aged 4 to 12 years from twelve public primary schools was conducted between November 2023 and May 2024. Stool specimens were collected from 686 pupils from Rural schools and 686 from Urban schools and examined using the direct wet mount and formal-ethyl acetate concentration techniques. Of the 1,372 stool specimens examined, 231(16.8%) were infected with at least one type of STHs comprising 18.3% and 15.3% prevalence in rural and urban communities respectively. Parasites identified were eggs of *Ascaris lumbricoides, Trichuris trichiura, Ancylostoma duodenale* and larvae of *Strongyloides stercoralis*. The age group 7–9 years had the highest prevalence of 23.4%, but no significant difference seen in prevalence across age groups. Males (19.1%) had significantly higher infection than females (13.8%) in both rural and urban communities (p=0.036). The high prevalence of STHs infections in this study underscores the need for regular health education programs among pupils to further inculcate the practice of proper hygiene and the provision of social amenities in primary schools by concerned government agencies. Additionally, regular deworming of pupils is essential to reduce the disease burden.

Key Words: prevalence, soil-transmitted, helminths, asymptomatic, school children.

INTRODUCTION

Soil transmitted helminths are intestinal worms that are transmitted to humans through contaminated soil. They are the most common infection worldwide affecting poor and deprived communities especially in tropical and subtropical countries [1]. They consist of mainly Roundworm (*Ascaris lumbricoides*), Whipworm (*Trichuris trichiura*), Hookworm (*Necator americanus and Ancylostoma duodenale*) and *Strongyloides stercoralis*. Generally, more than 1.5 billion people or over 24% of world population are infected with the highest prevalence reported from Sub-saharan Africa, China, South America, and Asia [2]. According to the WHO, over 270 million preschool-age children and 600 million school-age children are living in the area where these parasites are intensively transmitted [3]. However, the age group of 4–10 years are at greater risk of acquiring infections [4] as they are highly active with frequent soil contact during play hours both at home and in school [5].

Nigeria is endemic for helminths infections, in which *Ascaris spp, Trichuris spp,* and Hookworm were incriminated as the major cause, with estimated cases of 55 million, 34 million, and 38 million, respectively [6]. According to the Center for Diseases Control, soil transmitted helminths are considered Neglected Tropical diseases

(NTDs) because they inflict tremendous disability and suffering yet can be controlled or eliminated [7]. They rank among the most prevalent and harmful organisms affecting humans, contributing significantly to illness and death in underdeveloped regions worldwide [6,7].

Transmission occurs when their eggs are passed out in human feces, subsequently contaminating the soil in regions lacking adequate sanitation systems. This contamination leads to human infection through the ingestion of eggs in tainted food or the entry of *Ancylostoma spp* larvae into the skin particularly, when individuals walk barefoot on contaminated soil or consume poorly washed fruits and vegetables, these behaviors occur often among children and facilitate the spread of helminthic infections [8]. Moreover, the viability of soil transmitted helminths (STHs) eggs and larvae in the environment is contingent upon warm temperatures and sufficient moisture for hatching and embryonation [9]. They can reside within the digestive system of both humans and domesticated animals and can be located in various sections of the gastrointestinal tract, including the duodenum, jejunum, colon, appendix, and rectum. Additionally, they may be present in unexpected locations outside the gastrointestinal tract, such as the liver, kidney, heart, and lungs [10].

Epidemiological surveys have demonstrated that factors contributing to human infection are poverty, overcrowding, insufficient personal hygiene, poor sanitary conditions such as open defecation and fecal contamination of water bodies which leads to intestinal worm infestation while the spread is due to poor personal hygiene [11].

Although, in Nigeria, STHs studies have been focused mostly in rural than urban areas, in typical rural communities and urban slums, children can be infected soon after weaning, and be infected and re-infected constantly for the rest of their life due to the socio-economic activities and living habit, poor hygiene practices, access to potable drinking water, which makes good hygiene practices like hand washing and personal cleanliness paramount for elimination [12]. Therefore, evaluating and comparing the prevalence of STHs in rural and urban communities in Kwara State will contribute to the existing data, permit targeted interventions, and improve prevention strategies which will in turn contribute to the overall goal of reducing the burden of the STHs among school children in both rural and urban settings.

The global view shows that over one billion people are infected by at least one of the commonest species of Soil Transmitted Helminths [13]. It was reported that *Ascaris lumbricoides* infects over one billion people, *Trichuris trichiura* 795 million, hookworm 740 million and *Strongyloides stercoralis* 600 million people contributing significantly to illnesses and death in underdeveloped regions worldwide. Studies have shown that Soil transmitted helminths is the leading cause of mortality among children above six years in Africa and may account for up to 12% of total disease burden among children in resource poor countries with more than 10,000-135,000 deaths annually [14].

In Nigeria, Soil transmitted helminths infections are major health concern especially in rural and urban slums and this is as a result of factors such as population density, poor socioeconomic status, lack of basic amenities such as pipe borne water and other sanitary facilities which influence transmission and burden of these infection [15].

Although STHs can frequently evolve in a relative host–parasite balance, infections with a high parasitic burden can cause acute and life-threatening complications, including intestinal obstruction and perforation by *A. lumbricoides*, dysentery and rectal prolapsed by *T. trichiura*, and severe anaemia caused by hookworms [16]. High worm burdens are associated with re-infections due to constant exposure to environments contaminated with eggs (*A. lumbricoides* and *T. trichiura*) or larvae (hookworms) [17].

These infections have been shown to impact negatively on the fitness and cognitive development performance of the pupils, malnutrition, dysentery, fever, dehydration, vomiting, and colitis are among the complications associated with soil transmitted infections others include eosinophilia, intestinal ulcers, and appendicitis in case of high infection. It is recognized as a major contributor to high rates of absenteeism and the loss of disability-adjusted life years, ultimately leading to learning defects of children in vulnerable communities [18].

MATERIALS AND METHODS

The study area: This study was carried out in 6 selected public primary schools from rural and urban settings in Kwara state, North-Central Nigeria with relatively good representation of urban and rural communities [19], with a total number of 197 Public schools located in rural and urban areas and is located between Latitudes 80° and 150°N and Longitudes 40° and 50°E, and an area of 33,433 km² with a population over 4,204,310 as at the 2006 population census with the growth projection rate [20, 21].

Study Design: This study utilized a cross-sectional design to assess the prevalence of soil-transmitted helminths among primary school children aged between 4-12 years in urban and rural communities in Kwara State, North-Central Nigeria.

Inclusion criteria: Participants are Pupils of both gender within the age group of 4-12 years who attend Public primary schools in urban and rural areas and only Children whose parents give consent were recruited.

Sample size determination: The sample size was determined using the formula described by Araoye [22]. Therefore, a total sample size is 1,372 was recruited for the study.

Ethical consideration: Ethical approval was sought and obtained from research ethics committee of Kwara State Ministry of Health, with reference number ERC/ MOH/ 2023/12/ 171. Approval was also gotten from Kwara State Universal Basic Education (SUBEB) with reference number KWSUBEB/SUB/1400/VOL.I/43 and Informed consent was obtained from parents or guardians of the participating Pupils. Confidentiality of the collected data was ensured, and appropriate measures were taken to protect the privacy and rights of the participants.

Sampling Technique: For this study, simple random technique using the balloting method for school selection was used to select three (3) schools each from the urban and rural areas across the state and in each selected school, random sampling of children within the target age group of 4-12 years was performed.

Samples Collection: As described by the WHO guidelines on stool sample collection, samples were collected in 3mm wide clean screw-top sterile bottles bearing a tag where the children's name, age, number and date was recorded and issued to the children [23]. Samples were properly kept in a cold chamber immediately after collection and were transported to the Department of Medical Microbiology and Parasitology laboratory, University of Ilorin, Ilorin in a leak proof bag for further processing.

Data Collection using Questionnaires: A well-structured questionnaire was administered to the pupils with the help of class teachers who assisted in collection of data such as socio-demographic information, knowledge, attitudes, and practices related to hygiene and sanitation.

Laboratory Analysis of the Samples

Macroscopic Examination: The samples were examined visually to assess attributes such as color, consistency, presence of mucus and blood. Adult worms like *Ascaris spp,* Hookworm and *Trichuris spp,* were examined with the aid of a hand lens.

Microscopic Examination

Wet Mount technique: A drop of normal saline/ iodine solution was placed on a clean grease grease-free slide. A pea size of the fecal sample was emulsified thoroughly and covered with a cover slip. It was viewed under the x10 and x40 objective lens of the microscope [24]. Expected Results: ova of *Ascaris lumbricoides, Trichuris trichiura, Ancylostoma spp, Strongyloides stercoralis*

Concentration Method

Formalin Ethylacetate Concentration Method: 1 g of fecal sample was added to 4 ml of 10% formal saline. 3-4 ml of 10% formalin was further added and it was sieved into a clean centrifuge tube. 3-4 ml diethyl acetate was then added to the suspension. It was mixed thoroughly and centrifuged at 3000 rpm for 1 min. The supernatant was discarded and the sediment was examined by placing a drop on a clean glass slide and covering it with a coverslip. It was viewed under the x10 or x40 objective lens of the microscope. Expected Results: Characteristic ova

of *Ascaris lumbricoides, Trichuris trichiura, Ancylostoma spp, Stongyloides stercoralis*

Statistical analysis: Data obtained from questionnaires and laboratory analysis were inputted into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS, version 24.00). Results were presented in descriptive and inferential statistics. Comparative analysis of data was conducted using chi square for categorical data and student's T test for continuous variables for association testing. Significance level was set at P-value of 5% (0.05) [25].

RESULTS

Of the 1,372 pupils examined, 231(16.8%) were confirmed positive for soil-transmitted helminthes. Further analysis indicated the prevalence of 126 (18.4%) to be from pupils in schools located in rural communities and 105 (15.3%) for schools in urban communities, indicating that prevalence of soil transmitted helminths higher among pupils in schools located in rural communities compared to infection rate among pupils in schools in urban areas. However, there was no statistical significant difference in the infection rates among the pupils in rural and urban schools (p = 0.227), (Table1).

Table 1: Prevalence of Soil Transmitted Helminths among School Children in Rural and Urban Communities of Ilorin East Local Government Area

	Rural	**Urban**	**Total**
Number examined (%)	686 (50.0)	686 (50.0)	1,372 (100.0)
Number infected (%)	126 (18.4)	105 (15.3)	231 (16.8)
(Chi-square) p-value	**0.227**		

Numbers in parenthesis are expressed in percentages (%)

The prevalence of STHs among the different age groups indicated a higher prevalence (23.4%) of soil-transmitted helminths, within the age group of 7-9 years in rural communities, whereas the lowest prevalence (10.2%) was observed among age 10-12 in urban communities. Nevertheless, the age group of 7-9 years displays the highest prevalence in both rural and urban settings (22.8%). Furthermore, it was noted that there is no statistical disparity in the age distribution of pupils between rural and urban communities (P=0.960), (Table 2).

Table 2: Prevalence of Soil Transmitted Helminths among school pupils by Age Groups of the Pupils

Locations	Rural			Urban			Total		
Age groups (yrs)	**4 – 6**	**7 – 9**	**10-12**	**4 – 6**	**7 – 9**	**10-12**	**4 – 6**	**7 – 9**	**10-12**
No. Examined	202	264	220	212	258	216	414	522	436
No. (%) Infected	28(13.9)	67(23.4)	31(14.1)	31(14.6)	52(20.2)	22(10.2)	59(14.3)	119(22.8)	53(12.2)
Ancylostoma duodenale	12(42.8)	25(37.3)	15(48.4)	7(22.6)	9(17.3)	0(0.0)	19(32.2)	34(28.6)	15(28.3)
Ascaris lumbricoides	8(28.6)	21(31.4)	10(32.2)	19(61.3)	25(48.2)	14(63.6)	27(45.8)	46(38.7)	24(45.3)
Stongyloides stercoralis	4(14.3)	8(11.9)	3(9.7)	3(9.6)	4(7.7)	0(0.0)	7(11.8)	12(10.1)	3(5.7)
Trichuris trichiura	0(0.0)	9(13.4)	3(9.7)	0(0.0)	6(11.5)	4(18.2)	0(0.0)	15(12.6)	7(13.2)
Ancylostoma duodenale &Ascaris lumbricoides	4(14.3)	4(6.0)	0(0.0)	0(0.0)	6(11.5)	4(18.2)	4(6.8)	10(8.4)	4(7.5)
Ascaris lumbricoides & Strongyloides stercoralis	0(0.0)	0(0.0)	0(0.0)	2(6.5)	2(3.8)	0(0.0)	2(3.4)	2(1.6)	0(0.0)
(T-test) p-value	0.612			0.960					

Numbers in parenthesis with one decimal point indicate percentages (%)

The prevalence by gender showed males with a higher prevalence (19.1%) compared to females (13.8%). A chi-square test reveals that the overall difference in STHS prevalence between males and females was significant (p = 0.036) Whereas males in both rural (19.2%) and urban (19.0%) communities show a similar prevalence, there was a difference in females of Rural (17.2%) and Urban (10.5%) communities but this difference was not significant (P = 0.651) (Table 3).

Table 3: Prevalence of Soil Transmitted Helminths among school pupils by Gender of the Pupils

Location	Rural		Urban		Total	
Gender	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
No. Examined	396	290	390	296	786	586
No. (%) Infected	76(19.2)	50(17.2)	74(19.0)	31(10.5)	150(19.1)	81(13.8)
A. duodenale	28(36.8)	24(48.0)	11(14.9)	5(16.1)	39(26.0)	29(35.9)
A. lumbricoides	27(35.5)	12(24.0)	43(58.1)	15(48.3)	70(46.7)	27(33.3)
S. stercoralis	12(15.8)	3(6.0)	3(4.1)	4(12.9)	15(10.0)	7(8.6)
T. trichiura	5(6.6)	7(14.0)	8(10.8)	2(6.5)	13(8.7)	9(11.1)
A. duodenale & A. lumbricoides	4(5.3)	4(8.0)	7(9.4)	3(9.7)	11(7.3)	7(8.6)
A. lumbricoides & S. Stercoralis	0(0.0)	0(0.0)	2(2.7)	2(6.5)	2(1.3)	2(2.5)
p-value 0.036*						

*Implies significance at $p<0.05$ level
Numbers in parenthesis with one decimal point indicate percentages (%)

The prevalence and distribution of soil-transmitted helminths with respect to the educational attainment of parents was presented. It was observed that children of parents with no formal education exhibit the highest overall prevalence of 13.2%, those of the same category in the rural communities had a higher prevalence (9.1%) compared with those in the urban communities (4.0%). Conversely, while the trend in prevalence decreases among children whose parents had formal education from primary to tertiary in in rural communities, there was a slightly a different scenario in urban settings where school children whose parent had secondary education (4.3%) show a slightly higher prevalence compared to those whose parents had primary education (4.6%). Interestingly in all these differences, there was no statistical significant difference (Table 4).

Table 4: Prevalence of Soil Transmitted Helminths among school pupils by Parent's Level of Education

Location	Rural				Urban				Total			
Education	1	2	3	4	1	2	3	4	1	2	3	4
No. Examined	201	192	156	137	194	199	171	122	395	391	327	269
No. (%) Infected	64(9.1)	31(5.6)	20(2.2)	11(1.3)	23(4.0)	26(4.3)	37(4.6)	19(2.4)	87(13.2)	57(9.9)	57(6.7)	30(3.8)
Ancylostomaduodenale	28(43.8)	10(32.3)	9(45.0)	5(45.5)	5(21.7)	3(11.5)	8(21.6)	0(0.0)	33(37.9)	13(22.8)	17(29.8)	5(16.7)
Ascaris lumbricoides	24(37.5)	5(16.1)	6(30,0)	4(36.4)	12(52.2)	7(26.9)	26(70.3)	13(68.4)	36(41.4)	12(21.1)	32(56.2)	17(56.6)
Stongyloidesstercoralis	3(4.6)	7(22.6)	5(25.0)	0(0.0)	0(0.0)	5(19.3)	0(0.0)	2(10.5)	3(3.5)	12(21.1)	5(8.8)	2(6.7)
Trichuris trichiura	5(7.8)	5(16.1)	0(0.0)	2(18.1)	0(0.0)	3(11.5)	3(8.1)	4(21.1)	5(5.7)	8(14.0..)	3(5.2)	6(20.0)
A.duodenale & A.lumbricoides	4(6.3)	4(12.9)	0(0.0)	0(0.0)	6(26.1)	4(15.4)	0(0.0)	0(0.0)	10(11.5)	8(14.0)	0(0.0)	0(0.0)
A.lumbricoides& S.stercoralis	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	4(15.4)	0(0.0)	0(0.0)	0(0.0)	4(7.0)	0(0.0)	0(0.0)
p-value	0.727											

1–none, 2–primary, 3–secondary, 4–tertiary

DISCUSSION

Overall prevalence of soil transmitted helminths

Out of the 1, 372 primary school children from rural and urban communities in North-central Nigeria who participated voluntarily in this study, 786 were males and 586 females. The overall prevalence of soil-transmitted helminth infections of 16.8% observed was high in this population. This infection rate differs among different groups of people and is affected by multiple factors, particularly environmental conditions, characteristics of the parasite, and factors related to the host [25, 26]. In this research, the microscopic examination carried out to diagnose and determine the prevalence of soil-transmitted helminths among public primary schools in the rural and urban communities in North-central Nigeria showed that STHS is prevalent among these communities. Consequently, this population remains at risk of these infections which has been targeted by WHO for global control/eradication.

From this population and in this study, findings revealed a considerable prevalence of STHs among pupils in both rural (18.4%) and urban (13.3%) public schools underscoring the believe shared by many other authors [27,28] of the cosmopolitan nature of STIs globally. While a good number of pupils schooling in urban communities were infected with one STHs or the other, indicating that the prevalence of soil transmitted helminths is high among pupils in urban settings, a high prevalence was seen among the same category of pupils matched with age in schools in the rural areas when compared to infection rates among pupils in urban areas, even though infections among the pupils in both rural and urban areas were not statistically significant. Therefore, the total prevalence of soil transmitted helminths among pupils in public primary schools in North-central Nigeria remains a public health concern among school pupils in both urban and rural communities and by extension among all children in this region. According to WHO standards [29], diseases spreading among 5% of a population are considered high risk, thus, the 16.8% prevalence spread of soil transmitted helminths among pupils in North-central Nigeria is high and has put this population at high risk of soil-transmitted infections (STIs). This could be attributed largely to the lack of basic amenities in these schools that will enhance proper sanitation and hygienic behaviors and is compounded by ignorant about the modes of infection of these infectious agents among pupils both at home and in school. In all the selected schools and environs even among those in the urban settings, it was observed that there were limited toilet facilities and even where they do exist, they were not properly functional, and there was no adequate water supply. The pupils mostly defecated in open fields and at school, indicating serious public health issues that require intervention. Similarly, Chelkeba *et al*. [9] found a very high prevalence (33.4%) of STIs among school-aged children in Ethiopia. Again, a slightly higher prevalence of 40.6% was reported by Taiwo [27] among pupils in the Southern region of Nigeria and 41.6% prevalence was reported by Babatunde *et al* [29] among pupils in South-western part of Nigeria. By findings in this study and others across Nigeria, it is eminent that soil-transmitted helminths present a considerable threat to school-age children in Nigeria. This situation demands serious attention and intervention from the relevant authorities, given its potential impact on their growth and cognitive health, as outlined in a prior study by Salawu & Ughele [5].

Prevalence of soil transmitted helminths by age group

According to WHO, priority should be given to school-age children aged 5-10 years in communities endemic to soil-transmitted helminths [2]. As indicated in this study also, categories of children in the age groups 4-6, 7-9, and 10-12 have shown a considerable prevalence of soil transmitted infections (STIs). It was found that the 7-9 age group had the highest prevalence in both rural and urban communities, which is in line with research conducted by Chelkeba *et al* [9]; this finding was slightly lower than that reported by Awasthsi *et al* [12], which identified a lower prevalence among 6-10-year-old children. Younger children were more infected with intestinal parasites, and perhaps children in these age groups are more engaged in outdoor activities, resulting in greater exposure to the STHS parasitic infections [26, 27, 29]. Furthermore, no statistical disparity was noted in the age distribution of pupils between rural (0.612) and urban communities (0.960).

Prevalence of soil transmitted helminths by gender of the pupils

Out of a total of total number of males and females who participated voluntarily in this study, there was a statistical significant difference in the prevalence of infection among males and females, with the males having a prevalence of 19.1% compared to the 13.8 observed in the females. Even though more males were infected than their female counterpart from schools in both the rural and urban communities, the difference in the prevalence of infection between pupils in the rural and those from the school in the urban communities was not statistically significant. Expectedly more males were infected with these STIs than the females in both the rural and the urban settings similar to other studies conducted under similar conditions in other places [22,23,24,26]. Another point of note from this study is that *Ancylostoma duodenale* and *Ascaris lumbricoides* remain the dominant types of STIs in all the gender from our findings. These findings agree with a study conducted by Chidi *et al* [18] and other previous findings in similar environment conducted by Ikpe *et al* [26] and Taiwo *et al* [27] that males actually have a higher prevalence of STIs than their female counterparts. Also, the higher prevalence found in the rural communities among the males compared with the prevalence found in females, is similar to researches conducted by other researchers [11, 14, 18]. Consequently, the distribution of STIs across genders significantly differs among male and female pupils in both rural and urban communities. Nonetheless, female pupils tested positive for *Ascaris lumbricoides* and *Ancylostoma duodenale* in all cases. Additionally, prevalence among males and females and its significance may be attributed to the general hygienic and sanitary conditions of the environment owing to lack of sanitation, basic amenities, and soil contamination. Moreover, the non-significance in the study with regards to gender disparity shows that infection with STHs is not gender-dependent and may be attributed to the fact that sexes in the study area had the same level of exposure. The findings from this study did not agree with the reports by Babatunde *et al* [29] where a significant higher prevalence has been reported to occur in males than females.

Prevalence of soil transmitted helminths by parents' level of education

The prevalence of soil-transmitted helminths (STHs) among pupils based on their parents' level of education in both rural and urban areas has not shown any considerable difference. It is commonly known that caregivers, particularly mothers, are often responsible for both food preparation and health education of children in their families, and they significantly influence the health of their children. If a mother is educated, she is more likely to know about the dangers of STHs and how to prevent it, and thus will more likely incorporate safe health habits into the home practices [15,17]. A higher prevalence of STHs infections was observed among pupils whose parents had no formal education in our study, thus agreeing with the study carried out by Taiwo *et al* [27], in which parents with no formal education had the highest prevalence.

Although there exist these differences in infection of children with STIs in relation to their parents' level of education, the chi-square test conducted to assess the association between parental education levels and STHs infections in their children indicated that there was no statistically significance in both rural ($p = 0.727$) and urban ($p = 0.941$) areas. This contradicts the finding of Taiwo *et al* [27] who reported that the education levels of caregivers were significantly associated with STHs infections among pre-school and school children. Notably in this study, *Ascaris lumbricoides* showed a particularly high prevalence among pupils in urban communities, likely due to factors such as overcrowding, poor hygiene practices, and favorable environmental conditions conducive to the high fecundity of *A. lumbricoides*. Conversely, *Ancylostoma duodenale* exhibited a higher prevalence in rural communities, potentially attributed to the prevalence of farming occupation, the use of fecal deposits as fertilizers, and the lack of shoes among some pupils.

Conclusion

High prevalence of soil-transmitted helminths among pupils in both rural and urban areas observed in North-central Nigeria, indicates endemicity of these parasites in the region. The absence of a statistically significant difference between rural and urban communities suggests

that social, health, and sanitary facilities in these areas are uniform. We recommend implementation of a comprehensive health education program focusing on personal hygiene and community health practices, vigilant monitoring of mass deworming programs, particularly in the study area to ensure their effectiveness and coverage.

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