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Water Resource, Hygienic Practice, and Soil Transmitted Helminthiasis in Some Rural Communities of Osun State, Nigeria

Toluwani Sunday Fafunwa[1], Hammed Oladeji Mogaji[1,2], Akinola Stephen Oluwole[1], Abdulhakeem Adebiyi Adeniran[1], Mariam Tobi Fagbenro[1], Sammy Olufemi Sam-Wobo[1], Babatunde Saheed Bada[3], Uwem Friday Ekpo[1]

[1]Department of Pure and Applied Zoology, Federal University of Agriculture, Abeokuta, Nigeria
[2]Department of Animal and Environmental Biology, Federal University Oye-Ekiti, Oye-Ekiti, Nigeria
[3]Department of Environmental Management and Toxicology, Federal University of Agriculture, Abeokuta, Nigeria
Email: mogajihammed@gmail.com

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Abstract

Provision of water, sanitation and hygiene (WASH) resources has been advocated as necessary add-on strategy for sustainable control of soil-transmitted helminthiasis (STH) alongside annual mass drug administration (MDA) of albendazole to endemic communities. This study investigated the burden of STH and status of WASH resources in eight rural communities in Aiyedaade LGA, Osun State, Nigeria. Four of the communities were supported with improved water and hygiene resources (Category A), and another four supported only with improved water resources (Category B). Two hundred and sixteen (216) fresh stool samples were collected from consenting community members and screened for *Ascaris lumbricoides*, Hookworm and *Trichuris trichiura* infections using ether concentration method. The status and condition of WASH resources were determined using questionnaire and physical observation. An overall prevalence of 35.2% was observed for any STH infection. Species' prevalence of *Ascaris lumbricoides*, Hookworm and *Trichuris trichiura* prevalence was 33.8%, 22.7%, and 0.5% respectively. Intensity of STH infection was significantly higher in Category A communities than in Category B communities. The prevalence of STH in Category A communities was higher (42.0%) than that in Category B communities (30.1%). There were significant differences (p = 0.000) in STH infections between the two categories. The status of improved water supply was not significantly different (p = 0.3153) in the two categories. Knowledge, attitude, and practices about STH, its transmission and control were low in both categories of communities. These results imply that current implementation of WASH which tends to focus on resource distribution, equity, and coverage, is unlikely to impact on STH transmission and control. Therefore, it is necessary for WASH providers to consider STH transmission control in their planning and implementation

of WASH intervention for STH endemic communities.

Keywords

Water, Sanitation, Hygiene, Soil Transmitted Helminthiasis, Osun State, Nigeria

1. Introduction

Soil-Transmitted Helminths (STH) infections affect more than 2 billion people worldwide, with the greatest indices in sub-Saharan Africa, Americas, China and East-Asia [1] [2] [3] [4]. Four species of worms cause most infection: *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale* and *Necator americanus* [5]. These groups of worms are not uncommon in rural developing countries, usually because their transmission cycle requires the existing adequate soil moisture and warm temperature for larval development [6] [7] [8]. Other exacerbating factors that aid the development of their eggs and transmission of infective larva to susceptible hosts include lack of water supply source, sanitation, and poor personal hygiene especially shoe wearing and hand washing [7] [9].

Preventive chemotherapy (*i.e.* the periodic large-scale administration of anthelmintic drugs to at-risk populations without prior diagnosis) has been employed in the control of this disease, but there has been remarkable rise in reinfection patterns after treatment is stopped [10]. Providing access to improved Water, Sanitation, and Hygiene (WASH) resource has therefore gained traction as the world tries to eliminate the disease by 2020.

WASH resources programming includes providing access to safe water, improved sanitation and good hygiene practices and education. Implementation of WASH continues to gain momentum with increased commitment from governmental and non-governmental donors through the provision of funds and resources [11]. For instance, Nigeria has benefited substantially from UNICEF's assisted WASH resources either community-based or school-based due to poor safe water and sanitation coverage rates in the country [11]. There is a standing belief that access to improved WASH resources coupled with preventive chemotherapy would have a long-term educational impact on the development and transmission of STH in endemic areas [12].

Although, the findings of Ekpo *et al.* (2008) in Ogun State, Nigeria have highlighted the relationship between helminthiasis and hygiene practices in school children [13]. There is an urgent need to provide evidence, if any, on the impact of current provision of community-based WASH resources on the transmission and control of STHs.

2. Methodology

2.1. Study Area

The study was conducted in Aiyedaade LGA, Osun state in South-western Nigeria (**Figure 1**). The LGA is supported by UNICEF in the provision of WASH

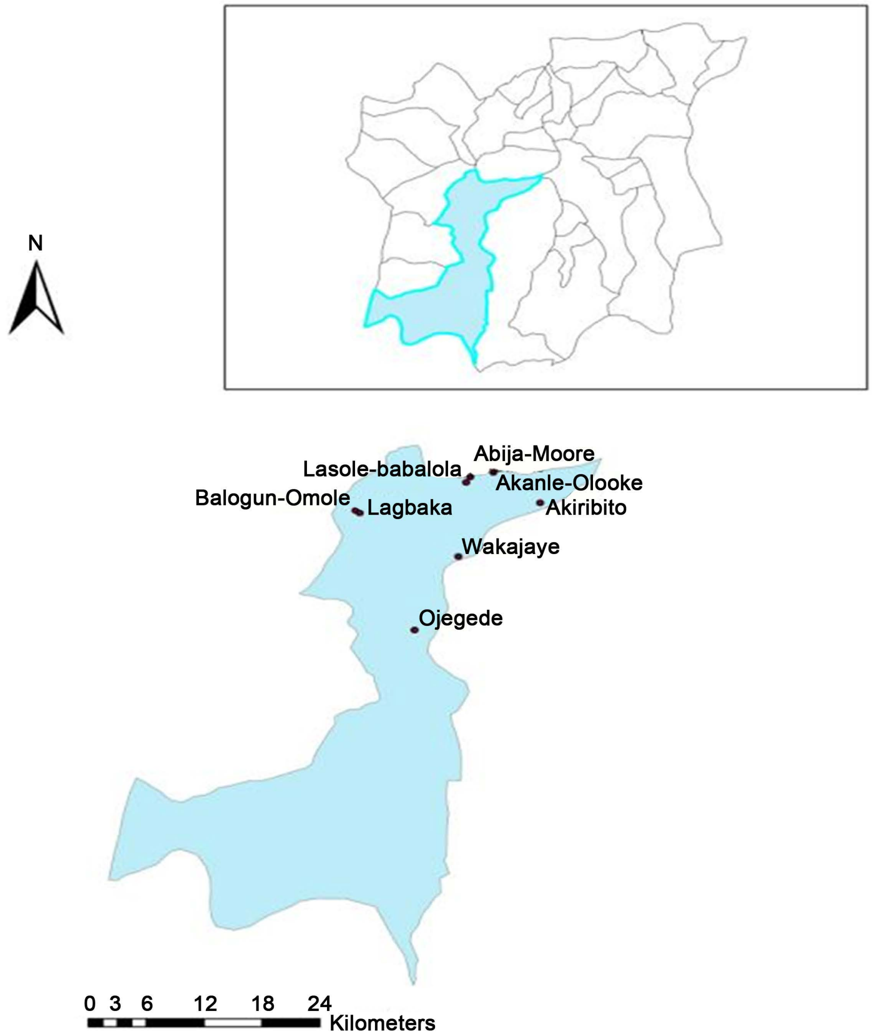

Figure 1. Map of Aiyedaade LGA showing the study communities with Osun state as insert.

resources at schools and communities. These include provision of safe water supply, behavioural change promotional activities and community resource management planning for improved sanitation. The provided WASH resources was neither targeted at STH transmission control nor complimentary to MDA, but solely of equity, coverage, and prevention of water borne diseases, most especially diarrhoea.

Of the 329 communities in this LGA, fourteen were supported by UNICEF with provision of safe water supply source, behavioural change promotional activities and community resource management planning for improved sanitation (Category A-Full WASH). Whereas, twelve other communities were supported by UNICEF with only provision of safe water supply (Category B-Partial WASH). There was no direct provision of improved sanitation facilities in the study area. However, community members are being encouraged to construct toilets using local resources within their reach at community management planning meetings.

2.2. Sampling Procedures

Purposeful sampling was employed in the selection of 8 communities based on their level of WASH support (Table 1). Category A communities had full WASH implementation and includes; Lasole-babalola, Akanle-olooke, Abija-moore, and Wakajaye, while communities in Category B with partial WASH implementation were Ojegede, Akiribito, Lagbaka, and Balogun-omole. A complete census of the selected communities was then carried out to calculate the required sample size. The total population of the community was used for the determination of the required sample size using the method of Yamane [14].

2.3. Ethics Statement

Ethical clearance for the study was obtained from the Federal University of Agriculture; Abeokuta ethics review board and Osun State Ministry of Health. Permit to use the selected communities for sample collections were obtained from Aiyedaade LGA Primary Healthcare Centre. Pre-survey contact/advocacy meetings were also made to the community heads as well as the community members to ensure their support and co-operation. Written/verbal informed consent was obtained from coomunity leaders, parents, and guardians prior the conduct of the study.

Table 1. Demography of the study participants.

		Category A: Communities with full implementation				Category B: Communities with partial implementation				
		Lasole-babalola	Akanle-olooke	Abija-moore	Wakajaye	Ojegede	Akiriboto	Lagbaka	Balogun-omole	Total
		NE (%)	NE (%)	NE (%)	NE (%)	NE (%)	NE (%)	NE (%)	NE (%)	NE (%)
Age group	≤4	4 (20.0)	0 (0.0)	1 (5.0)	7 (35.0)	0 (0)	3 (15.0)	3 (15.0)	2 (10.0)	20 (9.3)
	5 - 14	7 (25.9)	1 (3.7)	6 (22.2)	1 (3.7)	0 (0)	3 (11.1)	8 (29.6)	1 (3.7)	27 (12.5)
	15 - 24	5 (26.3)	1 (5.3)	1 (5.3)	5 (26.3)	3 (15.8)	4 (21.1)	0 (0.0)	0 (0.0)	19 (8.8)
	25 - 34	6 (17.1)	4 (11.4)	1 (2.9)	4 (11.4)	2 (5.7)	6 (17.1)	10 (28.6)	2 (5.7)	35 (16.2)
	35 - 44	2 (6.7)	1 (3.3)	3 (10.0)	4 (13.3)	3 (10.0)	5 (16.7)	6 (20.0)	6 (20.0)	30 (13.9)
	45 - 54	1 (4.8)	2 (9.5)	2 (9.5)	1 (4.8)	0 (0.0)	8 (38.1)	4 (19.0)	3 (14.3)	21 (9.7)
	≥55	7 (10.9)	5 (7.8)	0 (0.0)	11 (17.2)	3 (4.7)	23 (35.9)	9 (14.1)	6 (9.4)	64 (29.6)
	Total	32 (14.8)	14 (6.5)	14 (6.5)	33 (15.3)	11 (5.1)	52 (24.1)	40 (18.5)	20 (9.3)	216 (100.0)
Sex	Female	15 (14.5)	10 (8.1)	5 (4.0)	19 (15.3)	6 (4.8)	31 (25.0)	21 (16.9)	14 (11.3)	124 (57.4)
	Male	17 (18.4)	4 (4.3)	9 (9.7)	14 (15.2)	5 (5.4)	21 (22.8)	19 (20.7)	6 (6.5)	92 (42.6)
	Total	32 (14.8)	14 (6.5)	14 (6.5)	33 (15.3)	11 (5.1)	52 (24.1)	40 (18.5)	20 (9.3)	216 (100.0)
Educational attainment status	None	10 (11.8)	8 (9.4)	5 (5.9)	12 (14.1)	5 (5.9)	24 (28.2)	11 (12.9)	10 (11.8)	85 (39.4)
	Primary	13 (18.3)	3 (4.2)	6 (8.5)	15 (21.1)	5 (7.0)	7 (9.9)	18 (25.4)	4 (5.6)	71 (32.9)
	Secondary	8 (15.1)	3 (5.7)	3 (5.7)	5 (9.4)	1 (1.9)	17 (32.1)	10 (18.9)	6 (11.3)	53 (24.5)
	Tertiary	1 (14.3)	0 (0.0)	0 (0.0)	1 (14.3)	0 (0.0)	4 (57.1)	1 (14.3)	0 (0.0)	7 (3.2)
	Total	32(14.8)	14(6.5)	14(6.5)	33(15.3)	11(5.1)	52(24.1)	40(18.5)	20(9.3)	216(100.0)

NE: Number examined.

2.4. Data Collection

Data were collected using two different field forms. The demographics (name, date of birth, age, sex, educational attainment) and the Knowledge, Attitude, and Practices (KAP) were collected using the first field form. Another form was used to assess the status and conditions of WASH resources at the community level. These include the type and condition of water supply source.

2.5. Determination of STH Burden

A single stool sample was collected from each consenting community member, processed within two hours using Sodium acetate-acetic acid formalin concentration method (SAF-Ether) and examined for intestinal ova of STH. STH eggs were counted for each species observed, and the mean number of egg per one gram (EPG) of stool was recorded for each community to compute infection intensities.

2.6. Scoring of Status and Condition of Water Supply

The type, conditions, adequacy, and usage of water resource were assessed using a WHO/UNICEF recommended checklist for improved WASH interventions. The status and condition of the WASH resources were carefully observed during field visitations and those that met the WHO/UNICEF set standards (*i.e.* improved conditions) were scored one point, while those not meeting the set standards were scored a negative point as appropriate. A cumulative test score was computed and used for comparison using chi-square statistics.

2.7. Data Analysis

Descriptive statistics were used to describe the characteristics of the study population. The number of egg per gram of stool were transformed using log (n + 1) of raw count. The differences in prevalence and intensity of STH infections between the community category were determined using chi-square statistics, t-test and analysis of variance respectively. Significances were set at $p \leq 0.05$.

3. Results

3.1. Demography of Study Participants

Of the 216 participants, 124 (57.4%) were females and 92 (42.6%) were males. By age category, participantsaged55 years were 29.6% of the total study population. There were no significant differences ($p = 0.579$) in sex distribution, unlike ($p = 0.002$) in age distribution among the study participants. By educational attainment status, 85 (39.4%) of the participants were not learned, 71 (32.9%) had primary education while 53 (24.5%) and 7 (3.2%) had secondary and tertiary education respectively. However, there exist no significant difference in educational attainment status across the participants ($p = 0.201$) (Table 1).

3.2. Status of Water Supply across the Surveyed Communities

There were similarities in the sources of water and their conditions in the two categories of communities. All communities had hand-pump boreholes as their source of water supply. In Lasole-babalola and Akiriboto communities there are protected dug wells in addition to the hand-pump borehole. However, in Lasole-Babalolathe hand-pump borehole in the community produces undrinkable water. A cumulative score of 11 (91.6%) for safe water supply and conditions was recorded for Category A, while a cumulative score of 12 (100.0%) was recorded for communities in Category B. There was no significant difference ($p = 0.3153$) in safe water supply between the two group of communities (Table 2).

3.3. Prevalence of Soil Transmitted Helminths (STH) Infection

A total of 76 (35.2%) of 216 participants examined were infected with at least a species of any STH. Species prevalence for *Ascaris lumbricoides*, hookworms, and *Trichuris trichiura* was 33.8%, 22.7%, and 0.5% respectively. Comparison of STH prevalence between the two categories of communities shows a prevalence of 42.0% in Category A compared to 30.1% in Category B. There was a significant difference in STH prevalence between the two categories ($p = 0.001$) (Table 3).

3.4. Intensity of Soil Transmitted Helminths (STHs) Infection

Ascaris lumbricoides infection intensities were the highest of all the STHs recorded. The intensity of *Ascaris lumbricoides* infection for Category Acommunities (103.31 ± 30.33 epg) was significantly higher ($p = 0.011$) when compared to intensity of infection for Category Bcommunities (50.60 ± 17.283 epg). Likewise, there was a significant difference ($p = 0.021$) in the intensities of *T. trichuria* infection which was higher in Category A communities (0.11 ± 0.108 epg)

Table 2. Status of water supply across the surveyed communities.

	Water source (test-score)	Condition of water source (test-score)	Supply of water (test-score)	Cummulative test score
Communities with full implementation				
Lasole-babalola	Protected Dug well and Hand-pump borehole (1.0)	Functioning and Dirty (−1.0)	Daily (1.0)	2.0
Akanle-Olooke	Hand-pump borehole (1.0)	Functioning and Clean (1.0)	Daily (1.0)	3.0
Abija-moore	Hand-pump borehole (1.0)	Functioning and Clean (1.0)	Daily (1.0)	3.0
Wakajaye	Hand-pump borehole (1.0)	Functioning and Clean (1.0)	Daily (1.0)	3.0
Total	4.0	3.0	4.0	11.0 (91.6%)
Communities with part implementation				
Ojegede	Hand-pump borehole (1.0)	Functioning and Clean (1.0)	Daily (1.0)	3.0
Akiriboto	Hand-pump borehole andProtected dug well (1.0)	Functioning and Clean (1.0)	Daily (1.0)	3.0
Lagbaka	Hand-pump borehole (1.0)	Functioning and Clean (1.0)	Daily (1.0)	3.0
Balogunomole	Hand-pump borehole (1.0)	Functioning and Clean (1.0)	Daily (1.0)	3.0
Total	4.0	4.0	4.0	12.0 (100%)

p-value = 0.3153.

Table 3. Prevalence of Soil Transmitted Helminths (STH) infection.

	NE	*Ascaris lumbricoides*	*Trichuris trichiura*	Hookworm	Any STH
		NI (%)	NI (%)	NI (%)	NI (%)
Category A-Communities with full implementation					
LasoleBabalola	32	13 (40.6)	0 (0.0)	12 (37.5)	9 (59.4)
AkanleOlooke	14	6 (42.9)	1 (7.1)	3 (21.4)	6 (42.9)
Abija Moore	14	11 (78.6)	0 (0.0)	8 (57.1)	11 (78.6)
Wakajaye	33	12 (36.4)	0 (0.0)	8 (24.2)	13 (39.4)
Total	93	42 (45.2)	1 (1.1)	31 (33.3)	39 (42.0)
Category B-Communities with Part implementation					
Ojegede	11	2 (18.2)	0 (0.0)	2 (18.2)	2 (18.2)
Akiriboto	52	9 (17.3)	0 (0.0)	5 (9.6)	12 (23.1)
Lagbaka	40	12 (30.0)	0 (0.0)	5 (12.5)	12 (30.0)
BalogunOmole	20	8 (40.0)	0 (0.0)	6 (30.0)	11 (55.0)
Total	123	31 (25.2)	0 (0.0)	18 (14.6)	37 (30.1)
Overall NE	216	73 (33.8)	1 (0.5)	49 (22.7)	76 (35.2)
P-value		0.003	0.043	0.003	0.001

NE = Number examined, NI = Number infected.

compared to Category B communities (0.00 ± 0.00 epg). However, there was no significant difference (p = 0.354) in the intensity of Hookworms infection in Category A (13.87 ± 4.983 epg) compared to Category B (8.87 ± 3.678 epg) (Table 4).

3.5. Survey on Knowledge, Hygiene Attitude, and Practices

Knowledge about how STH is been transmitted was poor and not significantly different (p = 0.027) among members in both categories of community (Table 5). For category A, 83(41.1%) and 85 (41.7%) of the community members were unable to link human faeces and dirty water with STH transmission respectively. Likewise, in Category B there were 119 (58.9%) and 119 (58.3%) community members who could not link human faeces and dirty water with STH transmission respectively. Defecation inside the bush was a common practice for community members in Category B compared to members in Category A (98 (76.6%) vs 25 (28.4%) respectively. There was a significant difference (p = 0.000) in the defecation methods between the community groups. Other hygienic practices that could prevent STH transmission such as cutting of nails and wearing of footwear was not common in both category of communities. 56.2% and 56.9% of community members in Category B neither cut nails nor wear sandal regularly, as compared to 43.8% and 43.1% respondents from communities in Category A respectively (Table 5).

Table 4. Intensity of soil-transmitted Helminths.

	Category A: Communities with full implementation	Category B: Communities with part implementation	*p* value
	Mean Log EPG	Mean Log EPG	
Ascaris lumbricoides	103.31 ± 30.33	50.60 ± 17.283	0.011
Hookworms	13.87 ± 4.983	8.87 ± 3.678	0.354
Trichuris trichiura	0.11 ± 0.108	0.00 ± 0.00	0.021

EPG = Egg Per gram.

Table 5. Survey on knowledge, hygiene, attitude, and practices.

		NE (%)	Category A: Communities benefitting from water provision and hygiene educational activity support NE (%)	Category B: Communities benefitting only from water provision support NE (%)	*p* value
Have you heard of WASH	Yes	23 (10.6)	16 (69.6)	7 (30.4)	0.007
	No	193 (89.4)	77 (39.9)	116 (60.1)	
Knows faeces can contain worms	Yes	14 (6.5)	10 (71.4)	4 (28.6)	0.027
	No	202 (93.5)	83 (41.1)	119 (58.9)	
Knows one can get worms from dirty water	Yes	12 (5.6)	8 (66.7)	4 (33.3)	0.089
	No	204 (94.4)	85 (41.7)	119 (58.3)	
Where do you defecate	Bush	128 (59.3)	30 (23.4)	98 (76.6)	0.000
	Toilet	88 (40.7)	63 (71.6)	25 (28.4)	
What do you use for anal cleaning	Leaf	17 (7.9)	14 (82.4)	3 (17.6)	0.002
	Water	198 (91.7)	79 (39.9)	119 (60.1)	
	Paper	1 (0.5)	0 (0.0)	1 (100.0)	
Presence of clean fingernails	Yes	13 (6.0)	4 (30.8)	9 (69.2)	0.356
	No	203 (94.0)	89 (43.8)	114 (56.2)	
Presence of footwear	Yes	107 (49.5)	46 (43.0)	61 (57.0)	0.985
	No	109 (50.5)	47 (43.1)	62 (56.9)	
Do you wash your hands after toilet use	Yes	202 (93.5)	79 (39.1)	123 (60.9)	0.000
	No	14 (6.5)	14 (100.0)	0 (0.0)	
What do you use for hand-washing	Water	128 (58.3)	31 (24.6)	95 (75.4)	0.000
	Soap	88 (40.7)	60 (68.2)	28 (31.8)	
	Ash	2 (0.9)	2 (100.0)	0 (0.0)	

4. Discussion

This study presents for the first time the conditions and status of UNICEF supported community-based WASH resources, and its possible impact on the transmission and control of STH infections in the study area. An overall prevalence of 35.2%was recorded for any STH infection. This prevalence is higher than that reported for Ile-ife, Osun State [15], and reflects the worrisome burden of STH in the communities surveyed. This observation calls for mass administration of albendazole by WHO prevalence cut-off recommendations [16]. Non-school aged population should not be excluded from any treatment activity, as neglecting them can be a source for community re-infection especially in the case of Hookworm infection [17].

Unexpectedly, higher prevalence and intensities of STH were recorded in Category A communities (benefitting from a fully implemented WASH programme), and this issues a call of concern. It is expected that areas benefitting from WASH resource programming should have lower prevalence and intensity, in comparison with areas where intervention is either not on-going or partly implemented. However, our results show provision of WASH resources in these communities may have minimal impact on STH transmission.

There are several explanations to this. First, programming for WASH improvement in low- and middle-income countries is aimed at increasing equitable access to clean water, adequate sanitation, especially at the unit of the household, and improved hygiene education to people living in poor rural and deprived urban settings [11]. In actual terms, WASH programming have not been directed towards STH prevention or control, although there is a secondary influence of WASH resources on STH [18]. It is, therefore, understandable that implementation of this programme in Aiyedade LGA might be sub-optimal to trigger reduction of STH infection. This study did not conduct an in-depth evaluation survey for the WASH intervention in the areas visited. This is a research gap. There is need to understand further the thresholds that exist for each WASH resource component to trigger STH prevention or control.

On a second note, higher prevalence and intensities of STH in Category A communities may be an indication that the hygiene component of WASH resources has not resulted in any significant hygiene behaviour that could help reduce transmission of STH infection. This is more so as community members' knowledge of STH transmission was very low in these communities. Hygiene education if properly embraced by community members could help in reducing helminth infection by creating an enabling environment for both effective chemotherapy and sanitation efforts [19] [20], but non-compliance to the dictates of an hygiene education would cause continuous re-infection [20]. This observation, therefore, call into question the effeciveness of behavioural change promotional activities implemented in Category A communities, and if they were targeted at breaking STH transmission cycle?

It is also important to take into consideration that there was no support for provision of improved sanitation facilities in the study area. Providing toilet infrastructure would require huge cost and community involvements. However, in place of providing toilet infrastructure, communities are usually being encouraged during community planning meetings to mobilize local resources in the construction of latrines that would prevent direct exposure to faecal materials. Since there is no support for toilet resource, community member usually defecates in open grounds or nearby bushes [21]. This observation might be a probable reason for the continued contamination of soil, thus promoting STH reinfection, even when water resource and hygiene education programmes are in place.

Other reasons for the disparities in prevalence between both categories of communities could be related to educational attainment status, standard of personal and environmental hygiene and probably social habits [22]. Our findings shows that knowledge, attitude, and practices associated with STH transmission between communities with full and part implementation of WASH intervention was poor. Although members of communities with full implementation recorded higher knowledge, attitude, and practices as compared with communities with part implementation, nevertheless it was still poor. These overall poor knowledge, attitude and practices have been implicated as factors that promotes contamination of soil with eggs and as well transmission of infective stages of the nematodes to humans [23]. There is need to reemphasize on strategies of harmonizing health-educational tools given improving hygienic behaviours and attitudes of people living in areas where STH are endemic [10] [24].

5. Conclusion

Our study demonstrates that current strategy of UNICEF supported WASH programming focusing on equity and coverage may not necessarily compliment STH transmission control in benefiting STH endemic communities unless WASH providers review this strategy. However, this will require synergies between WASH providers and STH disease control managers in the planning and implementation of WASH resources in STH endemic communities.

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