Soil-transmitted Helminths and Urinary Schistosomiasis Co-infection: Risk Factors among School Children in Riverine Areas of Wamakko Local Government, Sokoto State, Nigeria

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Abstract Epidemiological study was conducted to determine the prevalence of urinary schistosomiasis and intestinal helminth co-infection among primary school pupils in Wamakko Local Government, Sokoto State, Nigeria. Urine and stool samples were collected from 400 pupils and analyzed using filtration and formol-ether concentration techniques respectively. Out of 400 samples, 63(32.8%) were co-infected with *Schistosoma haematobium* and one or more intestinal helminths. The co-infection of *S. haematobium* with *Ascaris lumbricoides* was most prevalent (74.6%), while *S. haematobium* with *A. lumbricoides*, hookworm, and *S. haematobium* with *A. lumbricoides* and *S. mansoni* had the least prevalence (1.6% each). Being male, 10-12 years of age and not washing hands before and after meals were the major risk factors for the spread of urinary schistosomiasis and intestinal helminths co-infection in the study area. An integrated strategy that involves the provision of health education to the communities, regular treatments, provision of safe water supply and sanitation facilities is highly recommended.

Keywords Urinary Schistosomiasis, Wamakko, School Children, Soil-transmitted Helminths, Co-infection

1. Introduction

Schistosomiasis and intestinal helminthiasis pose major health and socio-economic problems in developing countries [1, 2].

More than two billion people are estimated to be infected with schistosomiasis and intestinal helminthiasis worldwide, of which over 300 million suffer from associated severe morbidity [3]. Schistosomiasis is a major cause of morbidity and mortality for developing countries in Africa, South America, Caribbean, Middle East, and Asia [4].

Over 610 million school-aged children are at risk due to schistosomiasis and soil-transmitted helminthiasis [5]. School-aged children, compared to any other age group, are the most susceptible group and harbor the greatest numbers of worms. Consequently, they experience stunted growth, reduced physical fitness, impaired academic performance and reduced attendance to school [6-8]. Helminthic co-infection is closely tied to socio-economic, environmental and other factors such as ignorance, overcrowding, lack of clean water and tropical climate [9, 10].

Humans become infected with these infections when they ingest infective eggs (*Ascaris lumbricoides* and *Trichuris trichiura*) or larvae (*Ancylostoma duodenale*) or through skin penetration of infective larvae contaminating

the soil (*Necator americanus* and *Strongyloides stercoralis*) or freshwater (schistosomes) [5].

Schistosomiasis and intestinal helminthiasis cause morbidity or even death by adversely affecting the nutritional status of the host, impairing cognitive processes, causing complications that require surgical intervention and inducing reaction in tissues [5].

Most parasitological field researches in tropical areas are focused on a single parasite, despite, in reality, the subjects are usually infected with two or more species of parasites concurrently. The pattern of distribution of parasite species among hosts is in part determined, among other things, by host genetics, physiology, nutrition, and socioeconomic status. Hosts concurrently infected with more than one species of the parasite are not only at infection risk with each parasite species but also with more severe diseases due to synergistic interaction among parasite species [6, 7].

Co-infection (or polyparasitism) is defined as the concurrent presence of different parasite species in a single host [11]. Co-infection is ubiquitous in people in the developing countries, but little is known regarding the potential for one parasite to act as a risk factor for another [12]. Concurrent schistosomiasis and co-infection with soil-transmitted occur alongside each other with other tropical diseases and with a wide range of co-infecting organisms. Studies have demonstrated that areas with high prevalence of schistosomiasis are also endemic for soil-transmitted helminthiasis [13].

Soil-transmitted helminthiasis and urinary schistosomiasis are endemic in all regions of Africa and

their public health importance has been described by many researchers [14, 15, 16, 17, 18, 19, 20]. Studies on concurrent schistosomiasis and co-infection with helminths parasites are few. This study was designed to provide current epidemiological data with regards to the prevalence and of urinary schistosomiasis and intestinal helminth co-infection in Wamakko local government of Sokoto State in Nigeria.

2. Materials and Methods

2.1. Study Area

The study was conducted in the Wamakko Local Government of Sokoto State, Nigeria. Wamakko local government comprises of the following districts: Wamakko, Gumbi, Dundaye, and Gumburawa (Figure 1). The major occupations of the inhabitants are farming and fishing and minor occupations such as laundry and trading. The local government was populated by the Hausa people. Wamakko local government is located in the north-west geopolitical zone of Nigeria and lies between latitude 12°N - 13° 58'N and longitude 04°8' E - 6°55'E. The local governments share borders with Sokoto North, Sokoto South, Kware, Binji, Silame, Bodinga, Yabo and Tangaza local governments of Sokoto State [21]. These four primary schools were selected: Kaura Kimba, Wajeke, Tangwale, and Gidan Bubu.

Source: Arc map

Drawn by Abubakar Salah Dept. of Geography UDUS (2017)

Figure 1. Map of Nigeria, Sokoto State and Wamakko Local Government Area Showing the four surveyed districts

2.2. Sample Population

The study population was made up of primary school pupils. Participants not enrolled in primary schools were excluded from the study.

2.3. Ethical Consideration

Ethical consideration was obtained from Wamakko local government Education Authority. Informed consent was obtained from parents/guardians of the pupils after explaining the purpose and procedure of the study. Subjects were not forced and were free to withdraw at any stage of the study.

2.4. Sample Collection

Four hundred samples each of stool and urine were collected between 10:00 am- 2:00 pm from four hundred school pupils. Each pupil was given two sterile, labeled clean screw-capped containers and guided on how to

collect stool and urine samples. Collected stool and urine samples were transported to Parasitology Laboratory, Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria for analysis.

Stool samples were analyzed using the Formol-ether concentration technique [22]. Eggs and larvae of intestinal helminths were identified according to the chart provided by WHO [23].

The urine samples were analyzed for the presence of *S. haematobium* using standard filtration technique [24]. Eggs with a terminal spine, the characteristic of *S. haematobium*, were counted for each sample found positive and reported as eggs/10 ml of urine.

2.5. Determination of Nutritional Status

Anthropometric measurements were taken [25]. Bathroom scale was used to measure the pupil's weight while height was measured using tape rule. The nutritional status was based on Body Mass Index (BMI) for age [26], where $BMI = \text{Weight (kg)} / \text{Height (m}^2\text{)}$.

2.6. Questionnaire Administration

A well-structured questionnaire was administered to each pupil from whom samples were collected to obtain information such as sex, age, the source of drinking water, water contact activity, type of toilet and body hygiene. Questionnaires were interpreted in their local language and assisted in completing them. Each questionnaire was numbered to correspond to the number labeled on the pupil's urine/stool container.

2.7. Data Analysis

Chi-square (χ^2) statistical analysis and then multivariate analysis with binary logistic multiple regression were used to determine the association between parasitism and risk factors (school, sex, age, the source of drinking water, water contact activity, type of toilet, body hygiene, and nutritional status). P values less than 0.05 were considered significant. Data were analyzed using Quantitative Parasitological Software Ver. 3.0.

3. Results

A total of 400 primary school pupils were included in the survey of four primary schools of Wamakko local government. The five most common parasites encountered during the study are as follows: *A. lumbricoides* 85.1%, *S. haematobium* 48.0%, *S. stercoralis* 10.8%, hookworm (*Ancylostoma duodenale* and *Necator americanus*) 2.0%, and *S. mansoni*, 2.0%. Of these, 63 pupils were found to be co-infected with *S. haematobium* and intestinal helminths with a prevalence of 32.8% (Table 1).

Two types of parasite combinations were encountered in this study. A combination of *S. haematobium* with one other parasite was encountered in 52 pupils while 11 pupils had *S. haematobium* with two other parasites. The co-infection of *S. haematobium* and *A. lumbricoides* was identified in 47 (74.6%) of 63 pupils, which was significantly more prevalent than *S. haematobium*+*A. lumbricoides*+ hookworm co-infection (14.3%) ($P<0.05$) (Fig. 1).

Table 1. Prevalence and Intensity of Urinary Schistosomiasis and Intestinal Helminth Co-infection among Primary School Pupils in Wamakko Local Government Area, Sokoto.

		Status of Urinary Schistosomiasis					
		Negative		Positive		Total	
Helminths	Negative	No.	%	No.	%	No.	%
	Positive	71	34.13	63	32.81	134	33.5
	Total	208	100	192	100	400	100

Figure 2. Prevalence of parasites co-infection in Wamakko Local Government Area, Sokoto, Nigeria.

The co-infection was highest in pupils from Tangwale primary school (12.5%), followed by Gidan Bubu (8.9%) and Kaura Kimba (6.8%), while pupils in Wajeke had the least prevalence (4.7%). Chi-square analysis indicated no significant association of parasite co-infection with school ($P>0.05$) (Table 2).

The co-infection of parasites was identified significantly more in boys (26.4% in boys, 16.7% in girls; $p<0.05$) (Table 3). Co-infection rates were elevated with age and suddenly dropped at 13 years and above. Age group-specific prevalence of the co-infection showed that pupils aged 10-12 years had the highest prevalence (14.6%) followed by 7-9 years (9.4%), 13 years and above (4.7%), and 4-6 years with least prevalence (4.2%). There is a significant association between parasite co-infection with age group ($P<0.05$) (Table 3).

The prevalence of co-infection in relation to the source of drinking water was presented in Table 4. Prevalence of co-infection in relation to water contact activity indicated that pupils who could not mention their water contact activity recorded the highest prevalence, while those who go to the river to feed animals had the least prevalence. The occurrence of parasitic co-infection significantly associates with water contact activity ($P<0.05$) (Table 4).

The results of this study revealed that pupils who defecate in an open space had a higher prevalence of co-infection (24.0%) compared to those who use pit latrine (8.9%). However, no significant association was observed in the occurrence of co-infection and type of toilet ($P>0.05$) in Table 5. The prevalence of the co-infection in relation to nutritional status indicated that underweight pupils recorded the highest prevalence (24.0%), then those whose nutritional status is within the normal range (7.8%), while obese pupils were the least infected (1.0%). Chi-square statistical analysis revealed no significant association between the occurrence of co-infection and the nutritional status of the pupils ($P>0.05$) (Table 5).

The occurrence of parasite co-infection significantly associates with the pupil's body hygiene ($P<0.05$). Pupils who do not wash their hands before and after eating recorded the highest prevalence (32.3%). Pupils who do not wash their hands after the toilet and who walk barefooted had 27.6% and 15.1% infection rates respectively (Table 6).

Table 2. School and Class Prevalence of Urinary Schistosomiasis and Intestinal Helminth Co-Infection among Primary School Pupils in Wamakko Local Government Area, Sokoto

Parameters	No. Infected n = 192	Prevalence (%)
School		
Wajeke	9	4.7
Tangwale	24	12.5
Kaura Kimba	13	6.8
Gidan Bubu	17	8.9

Table 3. Sex and Age-Specific Prevalence of Urinary Schistosomiasis and Intestinal Helminth Co-Infection among Primary School Pupils in Wamakko Local Government Area, Sokoto

Parameters	No. Infected n = 192	Prevalence (%)
Sex		
Males	50	26.0
Females	32	16.7
Ages (Years)		
4-6 years	8	4.2
7-9 years	18	9.4
10-12 years	28	14.6
13+ years & above	9	4.7

Table 4. Prevalence of Urinary Schistosomiasis and Intestinal Helminth Co-Infection among Primary School Pupils in Wamakko Local Government Area in Relation to Source of Drinking Water and Water Contact Activity

Parameters	No. Infected n = 192	Prevalence (%)
Source of Drinking		
water	1	0.5
River	13	6.8
Tap	49	25.5
Well		
Water contact activity		
Bathing	17	8.9
Irrigation Farming	2	1.0
Feeding Animals	1	0.5
Fetchng	9	4.7
Passing	0	0.0
Washing	3	1.6
Do not know	31	16.2

Table 5. Prevalence of Urinary Schistosomiasis and Intestinal Helminth Co-Infection among Primary School Pupils with Relation to Type of Toilet and Nutritional Status

Parameters	No. Infected n = 192	Prevalence (%)
Type of Toilet		
Open space	46	24.0
Pit latrine	17	8.9
Nutritional Status		
Normal	15	7.8
Obese	2	1.0
Underweight	46	24.0

Table 6. Prevalence of Urinary Schistosomiasis and Intestinal Helminths Co-Infection among Primary School Pupils in Wamakko Local Government Area, Sokoto with Respect to Body Hygiene

Parameters	No. Infected n = 192	Prevalence (%)
Body hygiene		
Do not Wash hands before and after eating	62	32.3
Do not wash hand after toilet	53	27.6
Walk barefooted	29	15.1

4. Discussion

Our findings indicate that the prevalence of the co-infection of urinary schistosomiasis and intestinal helminthic infections is 32.8%, which is higher than what was reported in Oyo State in Nigeria (28.9%) [24], and Cameroon (9.0%) [25]. However, a higher prevalence of *S. haematobium* and intestinal helminths of 37.4%, 45.8%, and 53.3% have been reported respectively [26, 27] in Oyo State, Maiduguri and Ogun States of Nigeria.

The occurrence of five species of parasites in this study area suggests that the prevailing environmental conditions support the transmission of a wide range of parasites. Co-infections of *A. lumbricoides*, hookworms, and *S. haematobium* was the most common combination in the study area. This observation is in accordance with the outcomes of Agbolade and colleagues [28] who showed that the triad of hookworm/ *Ascaris* / *S. haematobium* was common in most parts of Nigeria.

The significant association of parasite co-infection with *S. haematobium* and *A. lumbricoides* observed in this agrees with the findings Salawu and colleagues [24] reported an association of *A. lumbricoides* with *S. haematobium* to be most significant. The presence of these parasites in the study area could be attributed to ignorance, the customary habit of indiscriminate defecation, coupled with inadequate access to health care and basic facilities. However, with the current economic depression and dietary deficiencies, the harboring of multiple parasites by children could have considerable adverse short and long-term consequences [27].

The lack of significant association of parasite co-infection with the school could be attributed to the proximity of the schools to the river (1 km) and poor sanitary condition coupled with lack of personal hygiene, the absence of basic social amenities, besides the schools examined share similar environmental and cultural factors. There is also the unhygienic behavior of the pupils such as indiscriminate defecation, not washing hands before and after eating and not washing hands after the toilet. Earlier, school children normally played in or around rivers and defecation sites and most of the schools lack proper toilet facilities [26]. All these contribute to the spread of parasites.

The significant association of co-infection with gender observed in this study might be attributed to the fact that males are frequently exposed to infective places such as faecally polluted soils, infected water bodies, where they usually bath and play, these can serve as a source of infection for both urinary schistosomiasis and intestinal helminths infections. On the other hand, females are restricted by cultural and religious beliefs. The significant occurrence of parasites in male students has been reported by several authors [24, 28-30]

In the present study, a significant association of co-infection with age was observed. Pupils aged 10-12

years (14.61%) were significantly more infected compared to pupils of other age groups. Pupils of this age group are more exposed to soils that are faecally contaminated and play around the river when fetching water or assisting their parents in irrigation farming during which they may get infected with the parasites. The significant occurrence of parasites in children aged 10-12 years reported in this present study agrees with findings [31] that found children in the age bracket 10-15 years to be significantly more infected with parasites than children in the other age groups. However, no significant difference was found in parasite co-infection rates among different age groups [26].

The occurrence of co-infection significantly associates with water contact activity. Pupils who could not specifically mention their water contact activity recorded the highest prevalence (16.15%). It may be these pupils engaged in many water contact activities such as bathing, washing, fetching, feeding animals and irrigation farming, thereby not certain of a particular one as to indicate as their water contact activity. These set of pupils were significantly more infected, because they may have more than one water contact activity. Several findings have indicated gender, age, and water contact activities to significantly associate with parasite occurrence [32, 33].

The findings of this study indicated a lack of significant association of parasite co-infection with the type of toilet. Whether pupils use open space or pit latrine they may defecate indiscriminately in school, at home or while on the farm during irrigation farming. The type of toilet system used by individuals may also serve as a risk factor for infection [33] significant association of parasite infection with bush defecation was found.

The lack of significant association in the occurrence of co-infection with nutritional status suggests equal exposure of pupils to the source of infection regardless of nutritional status. However, the significant occurrence of parasitism was found in children severely malnourished [27].

The findings of this study revealed that pupils who do not wash their hands before and after eating were significantly more infected. The reason may be attributed to the use of hands during playing in faecally polluted soil or contaminated water without washing their hands at home and in school and playing in cercariae contaminated water body through which they may get infected with infective stages of these parasites. Lack of personal hygiene may serve as a risk factor for infection.

5. Conclusions

Being male, 10-12 years of age and not washing hands before and after meals were the major risk factors for the spread of urinary schistosomiasis and intestinal helminths co-infection in the study area. Urinary and intestinal parasites are still being actively transmitted in the study area. These intestinal parasites might cause severe

conditions like dysentery, dehydration, hemorrhage, anemia, appendicitis, which sometimes lead to death. Ascariasis interferes with protein digestion in children and in combination with hookworm infection or other intestinal parasites could cause, accompany or accentuate kwashiorkor. *Schistosoma haematobium* causes dysuria, increased frequency of micturition and haematuria (urine with blood) conditions which can eventually lead to kidney failure if untreated.

Conflict of Interest

The authors declare that there is no conflict of interest.

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