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Human intestinal schistosomiasis and associated factors among children aged 5–15 years in Buyende district, eastern Uganda

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ABSTRACT

Schistosomiasis infection is one of the neglected tropical diseases associated with significant morbidity and mortality in Uganda. A cross-sectional study in Uganda aimed to determine the prevalence of schistosomiasis and its associated factors in children aged five to fifteen. Three hundred forty eight (348) study participants were recruited, and data was collected using a questionnaire. Stool samples were collected for macroscopic and smear microscopy examinations. The data was analyzed using Excel and SPSS. A chi-square test performed to establish factors associated with Schistosomiasis, Bivariate and multivariate logistic regression were performed. A P-value of less than 0.05 was considered statistically significant.

The study participants consisted of schoolchildren between 5 and 15 years old; the majority, 71.5% (249/348), were in the 5–10 age group, and most of the respondents were female, 54.3% (189/348), with a mean age of 8.86.

Out of 348 specimens examined, 52 had *Schistosoma mansoni* eggs, giving a prevalence of 15% (52/348). Being at school (P-value 0.03), children whose parents or guardians were farmers (P-value 0.005), a lake as a source of water for home use (P-value 0.01), lack of pit latrines (P-value 0.02), and footwear utilization (P-value 0.001) were the factors that were associated with intestinal human schistosomiasis.

Intestinal human schistosomiasis is a non-ending health challenge among school-going children, as indicated by its high prevalence. There is a need to enhance the current control and preventive measures through health education and improved sanitation, the provision of reliable and safe water sources, and encouraging the use of footwear for all school-going children in the study area.

Keywords: Intestinal schistosomiasis, children aged 5–15, associated factors, *Schistosoma mansoni, Uganda*

INTRODUCTION

Human Schistosomiasis illness affects 207 million people worldwide (WHO, 2019). Africa accounts for 85% of global cases (Chitsulo et al., 2000), with over 90% of cases occurring in sub-Saharan Africa (Hotez PJ, 2009). In Uganda, the disease affects mainly children with the prevalence of 27.7% (Natalie G Exum, 2018) which is higher than the national prevalence of 25.6% (Exum et al., 2019). Children are more susceptible to infection due to poor hygienic practices (Kibira et al., 2019). The disease occurs when the cercaria shade from the Biomphalaria snail species penetrates the skin when in contact with infested water (Christine et al., 2023).

The risk factors for this infection included fishing in infested water sources, washing from infested waste sources, swimming and walking barefoot, being a farmer, fecal pollution water sources, and age group (Ugochukwu et al., 2013, Huang and Manderson, 1992). The geographic distribution of the appropriate intermediate host snails determines the infection's distributions (Van der Werf, 2003, Manyangadze et al., 2016). Buyende district located in Eastern Uganda, is surrounded by lake Kyoga. Fishing is one of the main economic activity with more than 40 species of fish in the lake Kyoga, rivers and wetlands. The presence of multiple water sources serve as breeding sites for Biomphalaria snails which are the suitable intermediate hosts (Andrus et al., 2023). The district population projections for 2020 were 414,600 people, and children aged 0–17 years contributed 61.3% of the total population. Fishing is one of the main economic activity with more than 40 species of fish in the lake Kyoga and surrounding rivers and wetlands (Byaruhanga, 2023, Obubu et al., 2022). Those involved in fishing including children aged 5 – 17 are at great risk of schistosomiasis infection. Studies have assessed the disease burden around shoreline communities somewhere else in the general population (Seto et al., 2012), and little is known in children aged 5–15 years despite them being at great risk.

The study suggests a strong link between water source, sanitation, hygiene, and schistosomiasis disease. This research aimed at determining the prevalence and factors associated with human intestinal schistosomiasis in Buyende district among children aged 5 – 15 years. The findings are of great relevance since they inform stakeholders ranging from government institutions/authorities to household heads and research community about the need to provide reliable and safe water sources, footware, encouraging proper disposal of human fecal matter in addition to deworming and health sensitization.

MATERIALS AND METHODS

Study area and design

Between October and November 2020, a cross-sectional study was conducted at Kidera Health Centre IV in Kidera Sub County, Budiope West County, in Buyende District. Kidera HCIV serves as a referral hub for all medical facilities in the district, with an estimated 265,100 people overall (Boulos, 2005). The district is surrounded by Lake Kyoga and is bordered by Amolatar District to the northwest, Kaberamaido District to the north, Serere District to the northeast, Kaliro District to the east, Luuka District to the southeast, Kamuli District to the south, and Kayunga District to the west. Buyende district, situated at a height of 1054.73 meters (3460.4 feet) above sea level, experiences tropical monsoon weather and

a yearly temperature of 24.71 ºC (76.48 ºF). The district population projections for 2020 were 414,600 people, and children aged 0–17 years contributed 61.3% of the total population. Fishing is one of the main economic activities, with more than 40 species of fish in the lake Kyoga and surrounding rivers and wetlands (Byaruhanga, 2023; Obubu et al., 2022).

Sample size and study Population

The research enrolled children aged 5 to 15 who were presenting with abdominal pain and diarrhea and were seeking medical attention at Kidera Health Centre IV in Kidera Sub County, Budiope West County, in Buyende District, Uganda. Following the estimation of the sample size using the Kish (1965) method based on the estimated proportion of parasite infection (34.7%) (Abdulkadir, 2017). Three hundred forty-eight (348) study participants were recruited.

Selection criteria

The study recruited children 5–15 years old who presented with diarrhea and abdominal pains upon assent. Children who were on treatment for intestinal helminth infection and those who had recently received dewormers were excluded from taking part in the study.

Sampling Technique

A consecutive sampling technique was used to recruit study participants until the required sample size was attained. Sterile stool containers and instructions for stool collection were given to study participants, and stool specimens were collected for examination. A pretested, standardized interview guide was used to collect qualitative data regarding intestinal schistosomiasis-related factors from parents or guardians.

Stool sample collection and laboratory processing

Researchers briefed and gave instructions on specimen collection to all study participants before specimen collection. All samples were collected aseptically in sterile, leak-proof, and labeled containers. Samples were examined from the Kidera Health Centre IV Laboratory; stool samples were analyzed macroscopically for consistency, color, and microscopically using direct wet techniques and formal ether concentration techniques. Approximately 1-2 g (bean size) of stool was emulsified in 10 ml of 10% formal saline and sieved; ether was added to the suspension, and the contents were centrifuged at 3,000 rpm for 5 minutes. The sediment was mixed thoroughly, and the contents were transferred to a slide using a sterile pasture pipette for microscopic examination using 10x ocular lens and 40x high power objective lens for morphological identification of schistosome eggs. Eosin and Dobell's iodine mounts were prepared after formal ether concentration of stool specimens. Specimens were preserved in 10% formal saline. All waste was discarded appropriately, following waste segregation and disposal guidelines.

Data analysis and management

After being cleaned and examined for accuracy, consistency, and completeness, Data was analyzed using Excel and SPSS version 20 for descriptive data analysis, and the results

were displayed in frequency tables and graphs. A chi-square was used to establish factors associated with intestinal schistosomiasis. The factors included age group, schooling, occupation of the parents or guardians, domestic water source, and possession of the latrine. Multivariate logistic regression was performed to determine factors associated with intestinal schistosomiasis. A p-value of less than 0.05 was considered statistically significant. The number of positive cases of intestinal schistosomiasis divided by the entire sample size (348) yielded the prevalence of intestinal schistosomiasis, which was then displayed in frequency, percentages, and table form.

Quality control

Samples were transported to the laboratory for analysis and examination at ambient temperatures as soon as they were collected. Visual aids such as colored plates and charts were used to confirm the identity of the parasites or unusual structures. 10% of the examined specimens were proofread by a senior medical laboratory scientist for quality control. If a delay in examination was anticipated, stool specimens were kept in a dark place to avoid the miracidia hatching from the eggs.

RESULTS

Socio-demographic ccharacteristics of study participants

A data collection guide was used to collect information about the social demographic characteristics of respondents, and the findings are shown in Table 1.

Table. 1. Showing the socio-demographic characteristics of the study participants

Variables	Frequency (n=348)	Percentage (%)
	Mean (S.D)- 8.86 (2.86)	
Age in completed years (categorical)		
05-10	249	71.5
11-15	99	28.5
Gender		
Male	158	45.7
Female	189	54.3
Whether the child goes to school		
No	58	16.3
Yes	290	83.3
Occupation of the of the guardian		
Government employee	54	15.5
Farmer	63	18.1
Business man/woman	131	66.4

Laboratory findings

Stool samples were examined microscopically for *Schistosoma mansoni* eggs. Out of 348 stool specimens examined by stool smear microscopically, 52 had *S. mansoni* eggs.

Therefore, the prevalence of intestinal schistosomiasis was 15%, and *Schistosoma mansoni* was the only *Schistosoma* species responsible for all infections.

Factors associated with intestinal human schistosomiasis

This section presents factors associated with human intestinal schistosomiasis after running the chi-square test (Table 2). There was a significant association between schistosomiasis status and age (P-value of 0.027), gender of the children (P-value of 0.04), occupation of parents (P-value 0.023), and using footwear outside the house (P-value 0.001), water source for home use (P-value > 0.05), and pit latrine ownership by households (P-value 0.001).

Table. 2. Bivariate analysis out put

Variables	Infection status		X^2	P-value
	Positive (n (%))	**Negative (n(%))**		
Age				
5-10	36 (70.6)	213 (71.7)	9.12	0.027
11-15	15 (29.4)	84(28.3)		
Gender				
Male	24 (47.0)	135(45.5)	7.32	0.04
Female	27(53.0)	162 (54.5)		
Child goes to school				
Yes	40 (78.4)	250(84.2)	1.04	0.3
No	11(21.6)	47(15.8)		
Occupation of parents				
Government	5(9.80)	49(16.5)	8.92	0.023
Farmer	16(31.4)	47(15.8)		
Do business	30(58.8)	201(67.7)		0.023
Has the child ever received drugs for treatment of schistosomiasis				
Yes	16 (31.4)	101 (34.0)	0.32	
No	35 (68.6)	196 (66.0)		0.71
How often the child comes into contact with water bodies				
Daily	31 (60.8)	196 (66.0)	0.43	0.41
Regularly	18 (35.3)	81 (27.3)		
Never	02 (3.9)	20 (6.7)		
How often does the child wear shoes outside house				
Yes	9 (18.0)	69 (23.2)	12.3	0.001
No	41 (82.0)	228 (76.8)		
Sources of water for home use				
Bore hole	11 (21.6)	70 (23.6)	6.95	0.03

Dam	2 (3.9)	22 (7.4)		
Swamp	17 (33.3)	95 (32.0)		
Lake	21 (41.2)	110 (37)		
House hold having a pit latrine				
Yes	16 (31.4)	239 (90.2)	17.25	0.001
No	35(68.6)	26 (9.8)		

A logistic Regression showing the relationship between prevalence of schistosomiasis and the factors associated with schistosomiasis

Following a bivariate analysis, a logistic regression analysis was performed (Table 3). Factors associated with schistosomiasis included going to school (P-value 0.03), children whose parents were farmers (P-value 0.005), using a lake as the source of water for domestic use (P-value 0.01), and a lack of pit latrines (P-value 0.02). These factors were significantly associated with schistosomiasis.

Table. 3. Multivariate analysis showing the association between prevalence of schistosomiasis and factors associated

Variables	Adjusted OR (95% CI)	p-value	Lower Interval	Upper Interval
Age in completed years				
5-10	1			
10-15	0.98	0.45	0.92	1.03
Child goes to school				
Yes	1			
No	1.92	0.03	1.86	1.99
Occupation of parents				
Government	1			
Farmer	1.89	0.005	1.83	1.97
Business man/woman	0.96	0.17	0.91	1.01
Source of water for home use				
Bore hole	1			
Dam	**1.06**	0.09	0.98	1.14
Swamp	1.03	0.29	0.97	1.09
Lake	1.01	0.01	1.01	1.17
Household having a pit latrine				
Yes	1			
No	1.90	0.02	1.83	1.98

DISCUSSION

Intestinal human schistosomiasis is a non-ending health challenge among school-going children, as indicated by its high prevalence in this study findings. There is a need to enhance the current control and preventive measures through health education and sensitization, the provision of reliable and safe water sources, and encouraging the use of footware for school-going children in the study area, which could help improve the current disease situation.

Prevalence of intestinal schistosomiasis

Out of the 348 study participants who were recruited, 52/348 had *Schistosoma mansoni* eggs resulting the prevalence of *S. mansoni* 15%. The findings are in agreement the study findings among Caucasian immigrants and indigenous Ugandans living near the shore of Lake Victoria and Entebbe showed a prevalence of *S. mansoni* to be (14%) in immigrants living in Kampala and Entebbe with definite history of swimming in Lake Victoria (Emmanuel et al., 2008). This results however are low compared to findings from the study that assessed *Schistosoma mansoni* infections in children aged between 1-5 years along Lake Victoria shoreline in Eastern Uganda were the prevalence was higher at 39.3% (95%CI: 38.0–41.1%) (Nalugwa et al., 2015), 44.1% (95% CI 38.0–50.2) in Bugiri district (Adriko et al., 2014). This difference could be attributed to the sensitivity differences in laboratory methods where the later study used Kato Katz technique that is more sensitive thus detecting more positive cases.

This could also be associated with the difference in population characteristics in terms of age groups that could be directly linked to the host immune status in that age groups between 1 and 5 years do not have a fully developed immunity as compared to those aged between 5 and 15 years. The differences could also be attributed to the existing current interventions like deworming and mass sensitization that have kept the disease burden under check, and therefore enhancement will create a more positive impact on the disease burden.

The study findings are also lower compared to other studies among Ugandan shoreline villages of Lake Albert with a prevalence of 68.7% in children, Lake Victoria at 58.6% of children being infected (Sousa-Figueiredo et al., 2010). The differences could be attributed to the different snail populations in L. Kyoga, L. Victoria, and L. Albert and also variation of water conditions that favor snail survival (Rowel et al., 2015, Plam et al., 2008). The implication of the findings is that intestinal schistosomiasis is a health challenge, more so in children aged 5–15 years among Buyende communities along the shorelines of L. Kyoga, thus requiring interventions including routine deworming, screening, snail management and improved sanitation if this endemic disease is to be eliminated. Numerous reasons, such as inadequate sanitation and water hygiene, as well as the existence of snail intermediate host breeding sites in the current water bodies that create the perfect habitat for schistosomiasis transmission, could be responsible for the existence of intestinal schistosomiasis (Kazibwe et al., 2006).

Schistosoma mansoni was the only *Schistosoma* species responsible for the positive cases in this study. The ecological needs of the intermediate snail host determine the range of schistosomiasis; the presence of freshwater areas inhibits the disease's spread. The study findings are in agreement with the study along the L. Victoria shoreline among children aged

5 years and below, where only *S. mansoni* was detected (Nalugwa et al., 2015). This could be because there has been an increase in the geographical distribution of *S. mansoni across* different places in Uganda, whereas *S. haematobium* is localized mainly in sporadic foci in the north of Uganda (Emmanuel et al., 2008). This could also be associated with the presence and the distribution of suitable freshwater snail species (Biomphalaria snails) in L. Kyoga and L. Victoria that play a key role in the transmission and spread of *S. mansoni* among communities along the shorelines (Andrus et al., 2023). The existence of the suitable snail species in different water sources calls for interventions tailored with snail management if schistosomiasis is to be eliminated from areas where the disease is endemic.

Contrary to the study findings, Other studies have detected both *S. haematobium* and *S. mansoni* as Schistosoma species responsible for schistosomiasis (Emmanuel et al., 2008, Taylor and Makura, 1985, Wiegand et al., 2021, Dawaki et al., 2016, Nyantekyi et al., 2010). The could be attributed to by different ecological needs of the intermediate snail host that determines the range of schistosomiasis; the presence of freshwater areas inhibits the disease's spread.

Risk factors associated with intestinal schistosomiasis

From the study findings, factors associated with schistosomiasis were going to school, children whose parents are farmers, using lake and swamps as the source of water for domestic use, lack of the pit latrines were significantly associated with schistosomiasis study participants

The lack of pit latrine and open defecation practices as shown by the study findings are associated with schistosomiasis infection, this is in line with the study by Khalid Hajissa1 (2018),which suggested that open defecation sustains the continuity of life cycle of the schistosomes, therefore increasing infection rate. Therefore, encouraging ownership and use of pit latrines could be helpful in interrupting schistosomiasis life cycle in this area. The findings also revealed that using un protected and safe water sources like Lake water as a source for domestic use is significantly associated with schistosomiasis infections. This is also in agreement with the findings from a studies Khalid Hajissa1 (2018), (Nyantekyi et al., 2010). Children have the responsibility to fetch water for domestic purposes and may have time to go swimming in these unprotected and unreliable water sources; hence, they have more exposure to sources of infection compared to individuals from communities with protected, safe, and reliable water sources for domestic use.

Occupation was also associated with the infection for example being a farmer was a significant risk factor and this is in line with the studies from other places (Ugochukwu et al., 2013, Huang and Manderson, 1992). This is because farming activities for example in swampy areas increases intensity of exposure or contact with water that could be harboring suitable snail intermediate hosts.

Hence, our findings suggest that chemotherapy and sensitization alone may not contribute to a significant reduction of the schistosomiasis prevalence rate in these communities, more so among children, and therefore integrated control measures, including the provision of reliable and safe water sources, should be implemented.

CONCLUSION AND RECOMMENDATIONS

Intestinal human schistosomiasis is a non-ending health challenge among school-going children aged between 5 – 15 years, as indicated by a prevalence of 15%. There is a need to enhance integrated control measures through health education and improved sanitation, the provision of reliable and safe water sources, and encouraging the use of footwear for school-going children in the study area could help improve the current disease situation.

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CONFLICT OF INTEREST

All authors declare no conflict of interest in the study.

ETHICAL CONSIDERATIONS

Ethical approval was sought from the Faculty of Medicine Research Committee at Mbarara University of Science and Technology, and administrative permission was sought from the Buyende District Health Office and the in-charges of health centers. Voluntary informed assent was also sought from all study participants after explaining the objectives or purpose and other details of the study. To ensure the confidentiality of study participants details, codes were used to identify study participants, not their names.

SUBMISSION DECLARATION AND VERIFICATION

The authors declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

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