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## Article

# Epidemiological Survey of Human Zoonotic Fascioliasis and Schistosomiasis in the Lake Victoria and Southern Highland Ecological Zones of Tanzania

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**Simple Summary:** Zoonotic fascioliasis and schistosomiasis are emerging snail-borne trematode infections worldwide with a great spreading capacity linked to animal and human interaction and movements, climate change, and population dynamics of snail hosts. The aim of the current study was to determine the burden of fascioliasis and schistosomiasis among community members in Tanzania who were not involved in mass drug administration programmes including pre-school children and adults. Understanding the burden of zoonotic fascioliasis and schistosomiasis in the two age groups not only helps in planning and implementation of mass drug administration, but also serves as a wake-up call for the Neglected Tropical Disease control program of the Ministry of Health to incorporate diagnosis and treatment in routinely health care services.

**Abstract: Background:** Zoonotic fascioliasis and schistosomiasis, caused by trematode parasites transmitted by freshwater snails, are neglected tropical diseases with medical and veterinary importance. There are currently knowledge gaps regarding the transmission dynamics of these infections in humans and animals in endemic communities, especially on the African continent. Therefore, the current study aimed to determine the burden of human zoonotic schistosomiasis and fascioliasis among different age groups, focusing on the Lake Victoria and Southern highlands of Tanzania. **Methods:** A cross-sectional study was conducted among preschool, school-aged children, and adults. A total of 1557 stool and urine samples were collected, 400 from preschool children, 804 from school-aged children, and 353 from adults. Stool samples were processed using the Kato-Katz and the formol-ether concentration methods to examine *Schistosoma mansoni* (*S. mansoni*) and *Fasciola*, respectively. Urine samples were processed using the urine filtration method to examine for *Schistosoma haematobium* (*S. haematobium*) infection. While the data analysis was done using Stata V 17, t-test or One-way ANOVA was used to assess the statistical differences in mean egg counts of *S. mansoni* and *S. haematobium* exposure groups. **Results:** The overall prevalence of *S. haematobium* was 4.9% (95% CI: 0.4–6.1%), *S. mansoni* was 1.2% (95% CI: 0.7–1.9%) with no age difference but with a significant difference among sex groups 1.8% [ $\chi^2(1) = 4.47$ ,  $P = 0.034$ ]. Males have a higher prevalence of *S. haematobium* and *S. mansoni* than females. The prevalence of *Fasciola* infection was 0.9% (95% CI: 0.4–1.5%), with the highest prevalence found in adults ( $\geq 18$  years). **Conclusions:**

Zoonotic schistosomiasis and fascioliasis are prevalent in the study area, affecting all age groups. However, this is the first study of its kind to report the presence of *Fasciola* infection in Lake Victoria and the Southern highlands of Tanzania. This calls for the Ministry of Health, through the Tanzania NTDs control program, to recognize and include them in the neglected tropical diseases control program as a disease of high priority.

**Keywords:** schistosomiasis; *Fasciola*; *Schistosoma*; zoonotic; ecological; fascioliasis; tanzania; public health

## 1. Introduction

Schistosomiasis is the most important trematode/blood fluke infection of humans [1]. Two major schistosome species are prevalent in the African region, namely *S. mansoni* and *S. haematobium*, causing intestinal and urogenital schistosomiasis, respectively [2,3]. Tanzania is endemic for both *S. mansoni* and *S. haematobium*, where the prevalence of human schistosomiasis ranges from 12.7 to 87.6% [4]. The country is the second after Nigeria, among countries with the highest burden of schistosomiasis in Sub-Saharan Africa [4]. The prevalence of schistosomiasis is highest in rural communities with limited access to clean and safe water, proper sanitation, and hygiene facilities [4]. Schistosomiasis transmission is determined by water contamination by viable schistosome eggs, the presence of snail intermediate hosts, in which the ciliated miracidia stage can penetrate and develop into infective cercariae, and ongoing human water contact activities [5]. *S. mansoni* infection is associated with hepatosplenic disease characterized by hepatosplenomegaly and progressive periportal fibrosis (PPF), which can lead to portal hypertension and its related sequelae such as ascites, liver surface irregularities, oesophageal varices and haematemesis [6–8], while *S. haematobium* infection is associated with anaemia, nutritional deficiencies and lesions of the urogenital tract such as kidneys, urinary bladder and ureters, and cervix in women. Chronic, untreated infections can lead to cancers of the urinary bladder, such as squamous cell carcinoma [9].

Worldwide, it is estimated that approximately 779 million people are at risk of schistosomiasis, where 250 million people are mainly from Sub-Saharan Africa [3; 10]. Annual mortality from schistosomiasis is highly controversial, and estimates vary between 10,000 and 200,000 people worldwide [11].

Preventive chemotherapy (PC) using mass drug administration (MDA) of praziquantel targeting primary school-aged children within the school environment is the main strategy for controlling schistosomiasis in Tanzania [12]. However, the adult and pre-school-aged children population at any level of transmission risk is excluded from mass PC [13]. The major drawback of this approach is leaving out other community members who are out of the school environment, such as pre-school children and adult community members. Adult community members not involved in mass preventive chemotherapy carry the highest burden of hepatosplenic disease [6]. In addition, untreated community members maintain transmission of the disease in the environment and serve as a source of infection to treated school children [6]. To reach the global targets of eliminating schistosomiasis as a public health problem by 2030 and responding positively to the global sustainable development goals (SDGs) of not “leaving anyone behind” and the concept of integration of intervention measures [14], public health interventions should be integrated and reach the entire community.

Fasciolosis is caused by the liver fluke of the genus *Fasciola* [15]. *Fasciola* parasites have a two-host life cycle with an intermediate host (gastropod) and a final ruminant host (e.g., cattle, sheep, and buffalo). Two species are known to infect humans, namely *Fasciola hepatica* (*F. hepatica*) and *Fasciola gigantica* (*F. gigantica*), with the latter being less widespread globally but more pathogenic than *F. hepatica* [16,17]. Humans are infected by eating raw or undercooked liver or raw, poorly washed aquatic plants with metacercaria and or drinking field water contaminated with metacercaria. Acute

symptoms of *Fasciola* infection include abdominal pain, loss of appetite, and fever. Chronic infections can lead to hepatomegaly and portal cirrhosis [15].

Approximately 2.4 million people worldwide are infected with fascioliasis, while 180 million people are at risk of infection [18]. Overall, trematode infections affect more than 10% of the world population; an estimated 14 million DALYs are lost annually due to trematode infections [19]. Human Fascioliasis is known to be endemic throughout Africa. However, most reports come from Egypt, Morocco, Tunisia, Algeria, Nigeria, and South Africa [20]. Except for schistosomiasis, the impact of most human trematodes is commonly understudied [21].

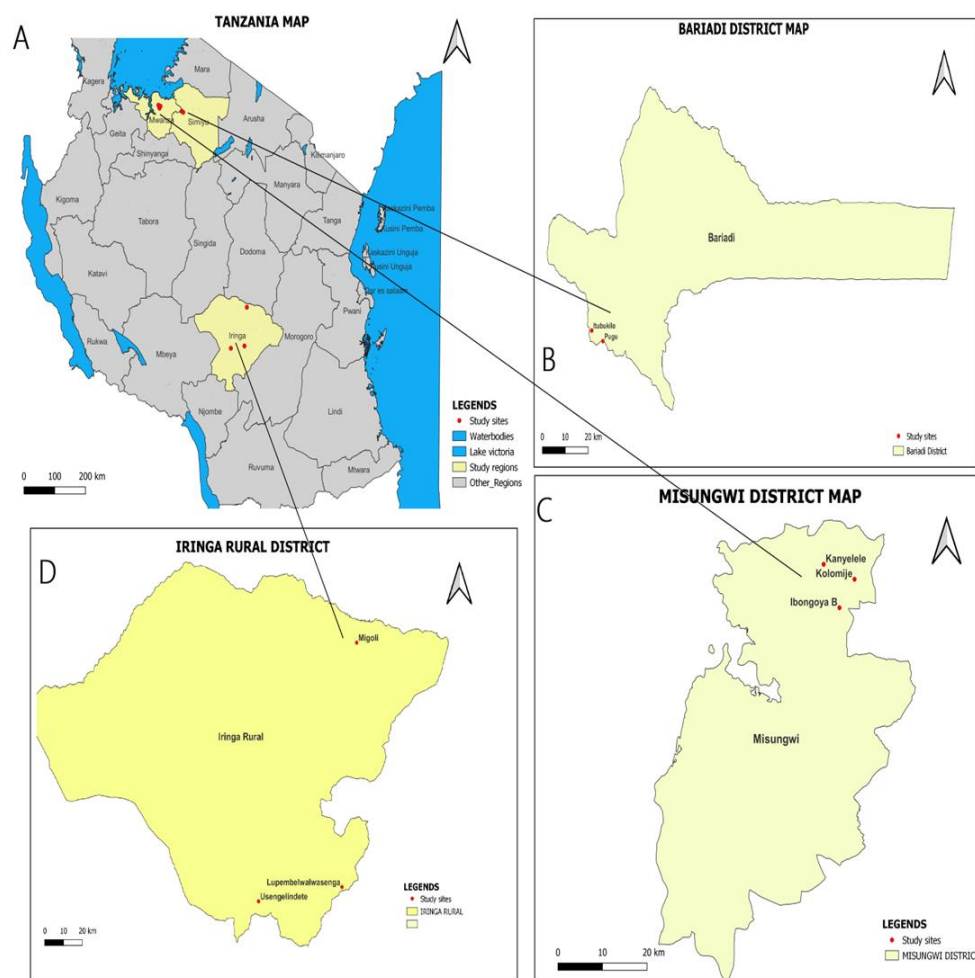
Fascioliasis and schistosomiasis are emerging snail-borne zoonotic infections with a great spreading capacity linked to animal and human movements, climate change, and anthropogenic modifications of freshwater environments. Larger-scale control interventions have been implemented in Tanzania, including mass drug administration using praziquantel (PZQ) targeting school-aged children. However, evidence has shown that the problem persists partly because adult and pre-school-aged children are excluded from treatment [13]. However, there have not been any larger-scale control interventions against Fascioliasis in Tanzania, and the disease is not included in the Tanzania NTD Control Master Plan [22]. On the other hand, very few studies on human fasciolosis have been conducted in Tanzania, despite the known higher prevalence of the disease in animals [23] and the fact that the disease is zoonotic, as animals share the same environment and water bodies with humans [23]. Further, human fascioliasis in Tanzania is not routinely diagnosed in health facilities, which might result in many 'hidden' cases. Therefore, the current study aimed to examine the burden of zoonotic schistosomiasis and fascioliasis, focusing on two ecological zones in Tanzania, to generate evidence that will guide the planning and implementation of targeted disease control interventions.

## 2. Materials and Methods

### 2.1. Study design

This was a cross-sectional study, conducted from March to May 2023 in Misungwi, Bariadi, and Iringa Districts, Tanzania. Misungwi district is located in Mwanza region, while Bariadi district is located in Simiyu region within the Lake Zone area of Tanzania. Iringa district is located in Iringa region in the Southern Highlands of Tanzania. Within the Misungwi district, the study was carried out in Kanyelee, Koromije, and Ibongoya B villages. In the Bariadi district, the study was conducted in Pugu and Itubukilo A villages. On the other hand, in the Iringa rural district, the study was conducted in Lupembelwasenga, Usengelindeti, and Migori villages (See Figure 1). The study districts and villages were selected purposively based on the available human population, previous reports of *Fasciola* infections in cattle, schistosomiasis and fascioliasis disease history, and disease epidemiology described in routine reports from the respective local District Medical offices. The location and climatic characteristics of the study districts have been described elsewhere [23]





**Figure 1.** Administrative map of Tanzania (A) showing the study areas along Lake Victori, Bariadi District Council (B) and Misungwi District Council (C), and the highland area of Iringa Rural District Council (D).

## 2.2. Study population and eligibility criteria

This study recruited pre-school children ( $\leq 6$  years), school-aged children (7–17 years), and adults ( $\geq 18$  years) in selected villages located along Lake Victoria and the Southern Highlands zones of Tanzania. In this study, children aged  $\leq 17$  years and adults  $\geq 18$  years living in the study villages, who were either male or female and had signed parent/guardian informed consent.

## 2.3. Sample size and sampling strategies

The sample size was determined using the single population proportion formula:  $n = \frac{Z_{\alpha/2}^2 P(1-P)}{d^2}$ , where P is the prevalence (%) of human schistosomiasis of 21% [24], the desired absolute precision (d) of 2%, and the Standard normal deviate (Z) corresponding to the level of significance of 1.96 at a 95% confidence interval (CI) was used. These values were inserted into the formula, and the total sample size of 1593 was obtained.

The sampling strategy used in this study has been described elsewhere [25]. A random selection of 150–200 preschool and school-aged children from the list of registered students in the school attendance book was made on the day of sample collection. Briefly, the selection of preschool and school-aged children to participate in the study was determined by the probability proportional to the size of the school and the class population. Systematic sampling techniques were used, with the class registers used as the sampling frame. After obtaining the sampling interval and a start point from a table of random numbers, the required number of children was selected from each class. For the selection of adults, in each school/village, 50 adults were invited to participate in the study.

## 2.4. Data collection

### 2.4.1. Collection of participants' demographic information

A data collection form was used to collect demographic information (age, sex, village, district, and height) for preschool, school-aged children, and adults. The structured questionnaire for preschools was administered to their caregivers (parents/guardians). The data collection form was translated to Kiswahili and back-translated to English before data entry.

### 2.4.2. Examination for *Schistosoma mansoni* using the Kato Katz technique

Duplicate Kato Katz [26] thick smears were prepared from a single stool sample collected from each participant (preschools, school-aged children, and adults). A template of 41.7 mg was used to make the thick smears, which were examined by two independent laboratory technicians trained on the KK technique. *S. mansoni* ova appeared yellowish white with a lateral spine shape against a greenish background. For quality assurance, 20% of all the positive and negative KK thick smears were re-examined by a third laboratory technician blinded to the results of the other two technicians.

### 2.4.3. Examination for *Schistosoma haematobium* infection using the urine filtration method

A single urine sample was collected from pre-school, school-aged children, and adults who participated in the study. The urine filtration method [26] was used to screen urine samples, and light microscopy was used to examine urine filters to determine the presence of *S. haematobium* eggs [27]. *Schistosoma haematobium* eggs-stained orange with a terminal spine shape. Each sample was examined independently by two medical laboratory technicians. At the end of each fieldwork day, 20% of all positive and negative samples were re-examined by a third laboratory technician blinded to the results of the other two technicians.

### 2.4.4. Examination for *Fasciola* sp. infection using the Formal-Ether Concentration Method

The Formal-Ether Concentration method was used according to Uga et al. [28] and Sato et al. [29] with some modifications. Before observation, 10g of the collected stool samples were homogenized in the collection tube. After homogenization, samples were separated into 1 g and prepared for sedimentation. The pellet mixtures were mixed with 7 mL 10% formalin in a 15 mL conical bottom polypropylene tube (Falcon®-type tube). Three milliliters of ether were added, and the solution was shaken vigorously for at least 60 seconds, occasionally releasing the air pressure in the tube. The mixture was centrifuged for 10 min at 15000 rpm. The ring of the floating residue and then the formalin were decanted. The sedimentation process was repeated twice to clarify the sediment. The remaining pellet was suspended in formol-saline up to 200 µL, from this suspension, 30µL was examined on a slide under a light microscope, completely and systematically. Two slides (coverslip of 24×32 mm) were examined under a light microscope on the same day for each sediment sample. *Fasciola* sp. eggs were confirmed by egg morphology measurement, where an average of fifty eggs from each positive sample were measured and an average size was calculated.

## 2.5. Data management and analysis

Data were double-entered into a Microsoft Excel sheet for simple cleaning before being exported to STATA version 17 for further management and analysis. Continuous variables (age, egg intensities) were summarized using mean (SD) and median (IQR), as appropriate. The categorical variables were summarized by frequencies and percentages/proportions. The Pearson Chi-square ( $\chi^2$ ) test was used to examine associations between the prevalence of human zoonotic fascioliasis and schistosomiasis at different levels of predictor variables. An independent sample t-test for two groups and one-way analysis of variance (ANOVA) for more than two groups were used to assess the difference in mean egg counts of *S. mansoni* by sex and age groups. However, the arithmetic mean egg counts were obtained from the counts of four KK smears and multiplied by 24 to get the

individuals’ eggs per gram of feces. The intensity of *S.mansoni* infection was categorized according to WHO criteria, 1–99epg, 100–399epg, and ≥ 400epg, defined as low, moderate and heavy intensities infections, respectively [30]. For *S. haematobium*, infection intensities were classified into two categories as per WHO recommendation, light infection (< 50 eggs/10 ml of urine) and heavy infection (≥ 50 eggs/10 ml of urine) [31].

2.6. Ethical considerations

The National Health Research Ethics Committee (NATREC) of the National Institute for Medical Research (NIMR) approved the study (ethics clearance certificate number NIMR/HQ/R.8a/360). The Methods used to collect the presented data followed the recommended standard operating procedures (SOPs). The study received further permission from regional and district authorities of the Misungwi, Bariadi, and Iringa rural districts, Tanzania. Parents and guardians of preschool and school-aged children received information through the village government and school leadership, respectively. Written informed assent and consent forms were obtained from children and parents/guardians before participation in the study. Furthermore, children provided verbal assent to ensure that their participation was voluntary. If a parent or guardian refused, the child’s name was removed from the list of participants. Confidentiality was maintained throughout the study. Those participants diagnosed with either *S. haematobium*, *S. mansoni*, and *Fasciola* were treated with PZQ at 40 mg/kg and Triclabendazole at 10mg/kg, respectively, following WHO recommendations.

3. Results

3.1. Demographic characteristics of the study participants

A total of 1,557 participants were recruited from Bariadi (400), Iringa (563), and Misungwi District Councils (594), respectively. Of these participants, 353 were adults (22.7%), 804 were school-aged children (51.6%), and 400 were preschool children (25.7%). The median age for school and preschool children was 12 (IQR 6-15), with more than half of the study participants 812 (52.2%) were females (Table 1).

Table 1. Demographic characteristics of the study population.

Characteristics	Frequency (N)	Percent (%)
Age group		
Pre-school children (≤ 6 yrs)	400	25.7
School-aged children (7-17 yrs)	804	51.6
Adult (≥18 yrs)	353	22.7
Sex		
Male	745	47.9
Female	812	52.2
Village		
Ibogoya B	200	12.9
Itubukilo	350	22.5
Kanyelege	194	12.5
Koromije	200	12.9
Lupembelwasenga	189	12.1
Migoli	188	12.1
Pugu	50	3.2
Usengelindete	186	12.0
District		
Bariadi DC	400	25.7
Iringa DC	563	36.2

Misungwi DC	594	38.2
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3.2. Prevalence and infection intensity of *Schistosoma haematobium* infection

The overall prevalence of *S. haematobium* based on the urine filtration technique was 4.9% (95% CI: 0.4–6.1%) (Table 2). The prevalence of *S. haematobium* was higher in adults (≥18 years), 5.1% [95% CI: 3.3–8.0%] compared with other age groups. However, this difference was not statistically significant ( $\chi^2(2)=0.20$ ,  $P=0.905$  (Table 2). Moreover, the prevalence of *S. haematobium* was significantly higher in males, 7.7% [ $\chi^2(1)=23.81$ , 0.000], than in females (Table 2). Concerning *S. haematobium* infection intensity, 3.2% (50/1557) and 1.7% (26/1557) of the participants had light and heavy infection intensity, respectively. The overall geometric mean eggs/10 ml of urine was 25.7 eggs/10 ml (95% CI: 17.3–38.1) with no significant differences among males and females ( $t=0.53$ ,  $P=0.60$ ) (Table 3).

Table 2. Prevalence of *S. mansoni*, *S. haematobium* and *Fasciola* stratified by age and sex.

Characteristics	<i>S. mansoni</i>		<i>S. haematobium</i>		<i>Fasciola</i>	
	Infected N(%)	$\chi^2$ , P-value	Infected N(%)	$\chi^2$ , P-value	Positive N(%)	$\chi^2$ , P-value
<b>Age (years)</b>						
Pre-school children (≤6yrs)	7(1.8)		18 (4.5)		5(1.3)	
School-aged children (7-17 yrs)	8(1.1)	$\chi^2(2)=1.48$ , $P=0.477$	40 (5.0)	$\chi^2(2)=0.2$ , $P=0.905$	4(0.5)	$\chi^2(2)=3.47$ , $P=0.176$
Adult (≥18 yrs)	3(0.9)		18 (5.1)		5(1.4)	
<b>Sex</b>						
Male	13(1.8)	$\chi^2(1)=4.47$ , $P=0.034$	57(7.7)	$\chi^2(1)=23.8$ , $P=0.000$	3(0.4)	$\chi^2(1)=3.56$ , $P=0.059$
Female	5(0.6)		19(2.4)		11(1.4)	

Table 3. The relationship between the geometric mean of intensity of infection (GMI) in *S. mansoni* and *S. haematobium* among study participants by age and sex.

Characteristics	<i>S. mansoni</i>			<i>S. haematobium</i>		
	Infection n	GMI (95% CI)	f/t, P-value	Infection n	GMI (95% CI)	f/t, P-value
<b>Age group</b>						
Pre-school children (≤6yrs)	7	3.87 (1.96-7.65)		18	65.35 (26.92-158.65)	
School_aged_children (7-17 yrs)	8	2.25 (1.20-4.21)	$f=0.73$ , $P=0.17$	40	29.80 (18.44-48.15)	$f=9.33$ , $P=0.0002$
Adult (≥18 yrs)	3	3.17 (0.87-11.53)		18	7.25 (4.04-13.00)	
<b>Sex</b>						
Male	13	2.59 (1.54-4.36)	$t=-1.01$ , $P=0.33$	57	27.28 (17.29-43.06)	$t=0.53$ , $P=0.60$
Female	8	4.09 (1.38-12.13)		19	21.40 (9.12-38.07)	

3.3. Prevalence and intensity of *Schistosoma mansoni* infection

The prevalence of *S. mansoni* infection was 1.2% (95% CI: 0.7–1.9%) with no age difference but with a significant difference among sex groups 1.8% [ $\chi^2(1)=4.47$ , 0.034]. The prevalence of *S. mansoni* was higher in precshool children (≤6 years) compared with other age groups. However, this difference was not statistically significant ( $\chi^2(2)=1.48$ ,  $P=0.477$  (Table 2). Moreover, the prevalence of *S. mansoni* was significantly higher in males, 1.8% [ $\chi^2(1)=4.47$ , 0.034], than in females (Table 2). The overall geometric mean number of epg per gram of faeces (epg) was 2.94 epg (95% CI: 1.9–4.5). No



difference in mean epg of faeces was observed among sex and age groups ( $t = -0.01$ ,  $P = 0.33$ , and  $f = 0.73$ ,  $P = 0.17$ , respectively)(Table 3)

### 3.4. Prevalence and intensity of *Fasciola* infection

The overall prevalence of *Fasciola* infection was 0.9% (95% CI: 0.4–1.5%). The highest prevalence of *Fasciola* infection was observed in adults ( $\geq 18$  years) 1.4% [95% 0.6–3.4%] but no significant difference among age groups [ $\chi^2(2)=3.47$ , 0.176]. There was no significant differences in prevalence among males and females [ $\chi^2(1)=3.56$ , 0.059] (Table 2).



**Figure 2.** Microscopic view of *Fasciola* eggs showing size measurement.

### 3.5. The distribution of *S. haematobium*, *S. mansoni*, and *Fasciola* infection across study villages from each district

Overall, infections of schistosomiasis and *Fasciola* by villages were highly observed in the Bariadi district, with the highest prevalence of *S. haematobium* infection observed in Pugu and Itubukilo villages (14.3% and 12.3%), respectively. Likewise, the prevalence of *S. mansoni* was highest in Itubukilo village (2.2%) compared to other villages in other districts (Figure 3). The *S. haematobium* infection was more prevalent in all the villages in the Misungwi district compared to other districts. However, there were no *Fasciola* infections observed in Ibongoya B and Kanyebelele villages of the Misungwi district. Villages from the Iringa district had a lower prevalence of these infections compared to villages from other districts. Generally, *S. haematobium* infection was the most prevalent trematode infection across all districts, while *S. mansoni* infections were relatively low compared to other infections in all districts, and *Fasciola* infection was the least prevalent trematode infection across all three districts (Figure 3).

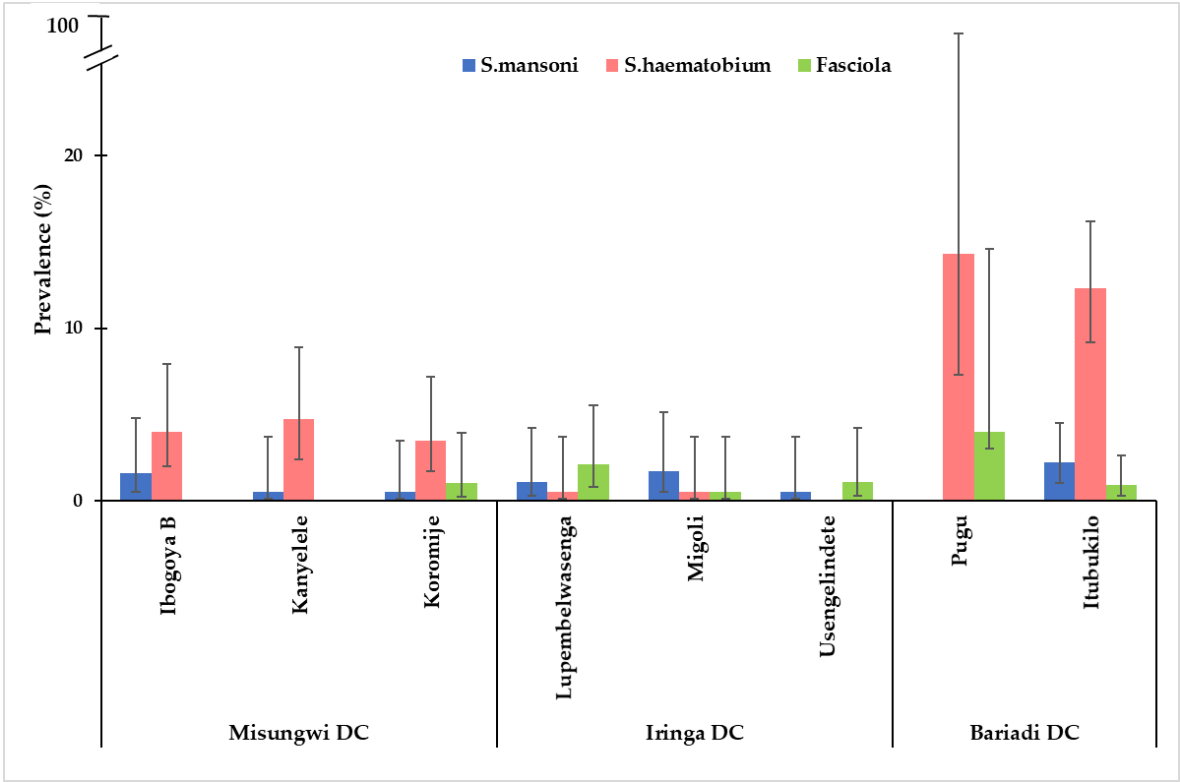


Figure 3. Prevalence of *S. haematobium*, *S. mansoni*, and *Fasciola* by village in each district.

4. Discussion

The present study examined the burden and distribution of human zoonotic trematode infections, namely schistosomiasis and fascioliasis, among different age groups in two ecological zones of Tanzania. To our knowledge, this is the first study to provide clear evidence of the presence and transmission of fascioliasis, urogenital and intestinal schistosomiasis among different age groups in the Lake Victoria and Southern Highlands ecological zones of Tanzania. The current study found the prevalence of *S. haematobium* at 4.9%, *S. mansoni* at 1.2%, and *Fasciola* infection at 0.9%, indicating that these infections are prevalent in the study areas [32].

The prevalence of *Fasciola*, *S. haematobium*, and *S. mansoni* seems to vary across districts and villages, with the highest overall prevalence observed in districts/villages located on the Lake Victoria ecological zone compared to districts/villages on the southern highlands of Tanzania. These findings on the endemicity of *S. haematobium*, *S. mansoni* and *Fasciola* infections along Lake Victoria and the Southern highlands of Tanzania are consistent with previous research findings from Tanzania [24; 33-36]. However, this is the first study of its kind to report the presence of *Fasciola* infection in Lake Victoria and the Southern highlands of Tanzania. The variation in prevalence from one epidemiological setting to another can be explained by the abundance and competence of the snail intermediate hosts, human activities leading to water contact activities such as rice farming, livestock rearing system and level of environmental contamination with human faeces [37,38]The overall prevalence of *S. haematobium* in the studies population was comparable to reports of previous studies conducted in Zanzibar 5.4% [39], Mtera [36], and Masasi [40]. However, the observed prevalence was higher than the 0.83% reported by Mazigo [24] in the Southern highlands, Nyasa district. In contrast, the observed prevalence of *S. haematobium* in the present study remained lower than that of 32.8% in Morogoro municipality [41] and North-western Tanzania, 34.8% [37]. The variation in prevalence of *S. haematobium* from one epidemiological setting to another can be explained by the focal distribution of *S. haematobium*, abundance and competence of the snail intermediate hosts, proximity of the villages/communities to transmission sites such as the lake and effectiveness of available control intervention such as MDA and level of environmental contamination with human faeces [25; 37; 38]. The observed prevalence of *S. haematobium* was significantly lower in pre-school and school-aged

children than in adults. Further, males were more infected with *S. haematobium* than other groups, consistent with the findings from studies in Ethiopia and Senegal [42,43], which showed that males have a higher mean intensity of *S. haematobium* infection than females. This might be due to the kinds of games males prefer, such as swimming in ponds, rivers, and lakes than their counterparts.

The overall prevalence of *S. mansoni* was lower compared to the prevalence recorded in the previous studies among pre-school and school-aged children along the shoreline of Lake Victoria in north-western Tanzania and elsewhere probably due to the effective community response to the control interventions, the abundance and competence of the snail intermediate hosts, proximity of the villages/communities to transmission sites. [24; 35; 44-45].

The prevalence of *S. mansoni* infection was associated with age group in line with previous studies, whereby it was shown that young participants had a higher prevalence compared to older age groups [46]. This is a common observation in *S. mansoni* endemic communities where the age prevalence curve shows that *S. mansoni* prevalence and infection intensities usually peak at the age groups 6–19 years, thereafter, decline with increased age [47]. The present study also noted that *S. mansoni* infection starts at very young ages (<6 years), meaning that children are exposed at a very young age, which in turn calls for inclusion of the young age group in the treatment programme [45; 48].

The overall prevalence of fascioliasis observed in the present study was 0.9% (95% CI: 0.4–1.5%). ) which is lower compared to studies conducted in Arusha [49; 50] and elsewhere [51–53]. These variations could be attributed to differences in ecological conditions, participants' dietary habits, hygienic conditions, and the diagnostic test used. Further, poor fecal egg yield has been reported in patients presenting to health facilities with acute infections and abdominal symptoms [54,55]. The epidemiological classification set for human fascioliasis, areas are considered hypo-endemic, meso-endemic, and hyper-endemic when the prevalence of *Fasciola* infection is below 1%, between 1 and 10%, and greater than 10%, respectively [56]. Hence, the Lake Victoria and Southern highlands ecological zone of Tanzania could be regarded as the hypo-endemic region for human fascioliasis. Overall, there is underreporting of fascioliasis in humans, attributed to a lack of prioritization in both clinical and research settings in developing countries, including Tanzania, which in turn calls for a paradigm shift and prioritization of human fascioliasis as a public health problem. The current study had limitations such as small study area coverage, such that the findings might not be representative of other areas in the country, because the prevalence and distribution of schistosomiasis and human fascioliasis vary across localities based on ecology and population dynamics of snail intermediate hosts.

## 5. Conclusions

The present study showed that human zoonotic schistosomiasis and fascioliasis are prevalent among pre-school, school-aged children, and adults in the Lake Zone and Southern Highlands of Tanzania. The findings serve as a wake-up call for the Ministry of Health and the NTD control program in Tanzania to recognize fascioliasis as a disease of priority and incorporate *Fasciola* diagnosis in our routine health services, and include preschool children and adults in mass preventive chemotherapy programmes. Furthermore, there is a need for increased research focus, surveillance, and resource allocation for human fascioliasis, which remains underreported despite its economic and public health significance.

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