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SCHISTOSOMIASIS OUTBREAK AND RISK FACTORS OF INFECTION AMONG SCHOOL CHILDREN IN KOINADUGU DISTRICT, SIERRA LEONE, MARCH 2023

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ABSTRACT

Schistosomiasis, a parasitic infection caused by Schistosoma species, is among the neglected tropical diseases and is a public health problem, particularly in sub-Saharan Africa. On the 6th of March 2023, the Community Health Officer in Alkalia Community Health Center, Koinadugu district, reported an increased number of school children complaining of blood in their urine and stool. We investigated the cases to identify risk factors associated with the outbreak.

We described the outbreak and conducted an unmatched case-control study (138 cases and 138 controls) to identify risk factors associated with it. We reviewed clinical records and interviewed cases and relatives to collect demographic, clinical, and epidemiological data. Urine and stool samples were collected to investigate the presence of Schistosoma haematobium and Schistosoma mansoni. Multivariate analysis was used to calculate adjusted odd ratios (aOR) at the 95% Confidence level to identify risk factors associated with the outbreak.

A total of 421 suspected cases were identified; 71.7% (302) were males, and median age was 10 years (range: 2 to 50 years). Of the total, 62.7% (264) were positive for Schistosomiasis (S. heamatobium and mansoni), and 98.5% (260) were positive for Schistosomiasis haematobium. Almost 98% (260) of the positive cases were school children. Of the positive cases, 95% (252) were presented with bloody urine. The case-control study identified bathing 5.4 (1.8-16.1), and drinking river/stream water 6.6 (2.4-18.2) factors associated with Schistosomiasis outbreak at the multivariate level.

This study confirmed a Schistosomiasis outbreak in the Koinadugu district, particularly among school-aged children. Risk factors associated with Schistosomiasis infection included drinking water from rivers or streams, bathing in rivers or streams, and exposure to the Teria River. We recommend providing clean and safe drinking water sources to limit exposure to rivers or streams, promote health education, and effectively distribute drugs.

keywords: Assessment, risk factors**,** Schistosomiasis outbreak, school children, Koinadugu, Sierra Leone

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INTRODUCTION

Schistosomiasis, also called Bilharzia, is a parasitic disease caused by the genus Schistosoma's blood flukes (trematode worms) (*CDC - Schistosomiasis - Epidemiology & Risk Factors*, 2019). It is among the neglected tropical diseases common in tropical areas, especially in Africa. The infection can be acute or chronic (Chelsea and William A, Jr, 2023). The transmission begins when human excreta containing parasitic eggs infect susceptible snails in water bodies. The parasite multiples in snails and adult parasites are then released in water, leading to the spread of the infection (Chelsea and William A, Jr, 2023). The incubation period of Schistosomiasis usually ranges from 14-84 days for acute and for years in chronic cases (WHO, 2023). People with Schistosomiasis may be asymptomatic in the early stages and present with an itchy rash, fever, chills, muscle pain, and diarrhea in the later stages (*CDC - Schistosomiasis - FAQs*, 2020). Children and adults frequently exposed to contaminated water are the most vulnerable to Schistosomiasis infection (PAHO and World Health Organization, 2017).

Schistosomiasis is endemic in sub-Saharan Africa, accounting for about 85% of global cases (WHO, 2023). Globally, It is estimated to infect over 240 million people in endemic areas (WHO, 2023) and cause over 200,000 deaths annually (Verjee, 2019). Schistosomiasis affects health and socio-economic activities among the poorest populations in both rural and urban settings (Rinaldo *et al.*, 2021), especially those with poor sanitation and inadequate hygiene practices. Schoolchildren in rural communities are mostly affected by the disease as they tend to spend more time in water bodies swimming and fishing (*CDC - Schistosomiasis - Epidemiology & Risk Factors*, 2019).

Sierra Leone, like many other African countries, is endemic to schistosomiasis, with eastern and northern regions accounting for the majority of the cases (Koroma *et al.*, 2010). In 2008, the integrated National Tropical Disease Control Program (NTDCP) was established in to reduce schistosomiasis prevalence in all districts to <10% (Bah *et al.*, 2018). Despite the establishment of the program with several mass drug administrations to interrupt the transmission, the disease is still prevalent in most parts of Sierra Leone (Koroma *et al.*, 2010). Koinadugu district is one of the endemic districts for schistosomiasis, with a prevalence of 28.7% and 7.0% for *S. mansoni* and *S. haematobium,* respectively (Bah *et al.*, 2019).

On 6th March 2023, the Koinadugu District surveillance unit received an alert from a community health officer (CHO) in charge of the Alkalia Community Health post (CHP). The alert indicated that eight school-aged children visited the health facility complaining of blood in their urine during urination. The rapid response team was initiated upon receipt of notification, and an investigation was started within 48 hours. This study aimed to describe and identify factors associated with the Schistosomiasis outbreak in Koinadugu District, Sierra Leone.

The results of this work will guide the WHO's road map to ending Schistosomiasis by 2030. Control efforts include reducing the number of people infected with the Disease and eliminating the vector population. Given that no vaccines have been approved for schistosomiasis, understanding the factors

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associated with outbreaks will aid the prevention and control of the disease.

METHODS

Study design and period

We employed a descriptive study to assess the Schistosomiasis outbreak among people living in the Alkalia community, Koinadugu district. The descriptive study was followed by an unmatched case–control study to identify the factors associated with the outbreak. The study was conducted from March 9 to 13, 2023.

Study setting

This study was conducted in Kionadugu District, one of the sixteen districts in Sierra Leone, and is located in the Northern Province. This district borders Falaba District to the northeast, Karene District to the northwest, Bombali District to the west, Tonkolili District to the southwest, and Kono District to the south. The district has an international border with the Republic of Guinea (*DISTRICT FOCUS Koinadugu District: Kabala*, 2020). The district has a population of 249,974 people (projected from the 2015 population and housing census). Alkalia community, located in Kalian Chiefdom of Koinadugu District, has an estimated population of 5000 (projected from the 2021 Mid-term census), 74 Km away from the district headquarters town, Kabala. It is the business center for the Kalian chiefdom, and the population mainly depends on farming, trading, and fishing. The town has one health facility, twelve schools, three nurseries, five primary, two junior secondary, and two senior secondary.

The township has few hand pump wells, pipe-borne water through four gravity fall water systems, and streams and rivers surrounding the community. The main pipe-borne water was rehabilitated in 2021 by UNICEF through the Family Home Movement (FMH). The gravity waterfall system has not been functioning properly due to seasonality and insufficient water supply to meet the community's needs. Also, most of the water points are faulty, and dwellers seek to use an alternative source of water from the stream for drinking and domestic use (Fig 1: Map showing outbreak location, Koinadugu District- Sierra Leone, March 2023).

Study Population

The study was conducted among people residing in Alkalia community, Koinadugu district. A total of 276 pupils were selected for the case-control study, (138) cases from the 264 confirmed cases and 138 controls with a ratio of one case to one power.

Inclusion criteria: The cases represented pupils from schools in Alkalia community who tested positive for Schistosomiasis. For the controls, pupils from the same schools with similar age groups as those who tested negative for Schistosomiasis in the same community.

A case was defined as any pupil resident of Alkalia community who tested positive for *Schistosoma mansoni* or *Schistosoma heamatobium*, from 1st to 31st March 2023.

A Control was any pupil resident of Alkalia community for not less than two months who tested negative for *Schistosoma heamatobium* and/or *mansoni* during the same period. Controls were selected from populations with the same pattern of exposure as cases to reduce selection bias.

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Sample size determination

The sample size was calculated based on the unmatched case-control in the Epi Info 7.2.5.0 software. The odds ratio for exposure = 4.13, the proportion of exposure among cases = 96.5%, and the proportion of exposure among control = 88% based on previous literature (Mupakeleni *et al.*, 2017a). We considered Alpha (Zα2) as 0.05 (2-sided), the power (Zβ) as 0.80, and the ratio of controls to cases 1:1. The calculated sample size was 288. However, the actual sample size collected was 276 participants (138 cases and 138 controls).

Data collection

A semi-structured questionnaire was designed in Epi info 7 and used to collect data from study cases and controls. A face-to-face interview was conducted to collect data on demographics, clinical history, and potential exposures from both cases and controls. Information was gathered by interviewing cases for older children or adults and parents or caregivers of younger children. A line list including demographic details, clinical and exposure histories was prepared from data collected by investigators. For exposures, cases were interviewed about swimming, bathing and disposal of human waste in nearby water bodies. They were also asked about their clinical manifestations and when symptoms started.

The questionnaire was validated to reduce the information bias.

Laboratory investigation

We collected 410 urine and 20 stool samples from all suspected cases and sent them to the Central Public Health Reference Laboratory for analysis. Using a compound light microscope, stool samples were tested to identify the eggs of *Schistosoma mansoni*. While urine samples were tested using a urinalysis dipstick. The dipsticks identify the infection of Schistosomiasis using color matching.

Data analysis

We used Epi info 7.2.5.0 software to carry out analysis. The demographic characteristics of the cases, clinical information, laboratory, and environment were analyzed using frequencies and proportions. We considered the result of Schistosomiasis infection (positive and negative) as an outcome variable. Demographic, clinical, and exposure were considered as independent variables. To build a best logistic regression model, a p-value of 0.2 was used as a cut-off point to identify independent factors associated with the outcome variable to be included in the multivariate model, assuming no interaction. Variables, that scored less than the identified cut-off point, were included in the multivariate analysis. We calculated adjusted odd ratios (aOR) at a 95% confidence interval (CI) and p-value of 0.05. Any variable that scored <0.05 at the multivariate level was considered statistically associated with the outcome variable (Schistosomiasis infection).

Ethical consideration

The study did not require ethical clearance from the Sierra Leone Ethics and Scientific Review Committee because it is part of the routine surveillance activity and approval was granted by the Directorate of Health Security and Emergencies (DHSE) to perform this study. We obtained verbal consent from the parents/ gradients of study respondents before conducting interviews. The respondent's information was accorded due confidentiality

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and anonymity. We used coding to replace respondents' names to make identification simple while simultaneously protecting the respondents' real identities.

RESULTS

Descriptive analysis

A total of 421 suspected cases were identified in Alkalia community, Kalian chiefdom in Koinadugu district. Of the total suspected cases, 62.7% (264) were positive for Schistosomiasis. Of the positive case, 98.5% (260) were for *Schistosoma heamatobium*, and 67.8% (179) were males with a median age of 10 years ranging from 3 to 33 years. The majority 96.7% (255) of the cases seen were school pupils. Additionally, pupils between the age group, 6 to 10 years accounted for most of the cases with 48.5% (128), followed by those within the age group, 11-15 with 33% (89) and those between 1 and 5, 11.0% (29). Of the suspected cases, 65% (274 of 421) had blood in their urine, followed by painful urination with 60% (253 of 421), and fever with 46% (195 of 421). The main sources of drinking water for the suspected cases was well water at 79% (334), followed by stream water at 65% (273), and hand pump at 48% (200) (Fig 2: Sources of drinking water of study participants, Koinadugu district-Sierra Leone, March, 2023). Regarding contact with rivers/streams water, 73% (306) of suspected cases had contact through bathing, and 24% (105) through fishing activities (Table 1).

Analytical analysis:

Of the 276 participants selected for the unmatched case-control study, the median age of participants was 10 years (ranging: 3 to 20 years). At the bivariate level, variables with significant association with schistosomiasis infection were: drinking water from the well (OR =2.6, 95% CI: 1.4, 4.7), drinking water from a stream (OR=2.2, 95% CI: 1.3, 3.7), swimming in river/stream (OR=6.2, 95% CI: 3.6, 10. 4), fishing in river/stream (OR= 4.7, 95% CI: 2. 4, 9.1), bathing in river/stream (OR=24.5, 95% CI: 11.1, 54.1), Drinking in river/ stream (OR= 25.2, 95% CI: 11.8, 53.9) and Practicing open defecation (OR= 7.3, 95% CI: 4.0, 13.2) (Table 2).

In multiple logistic regression, the odds of having schistosomiasis was 16 times higher among people with painful urination compared to those without (aOR= 16, 95% CI: 6.5, 40.2). Also, the odds of developing schistosomiasis was 5 times higher among respondents bathing in river/stream compared to those without (aOR=6, 95% CI: (1.8-16.1). Similarly, the odds of developing schistosomiasis was 7 times more likely among respondents who drank from river/streams compared to those without (aOR= 6.6, 95% CI 95%: 2.4, 18.2) (Table 3).

DISCUSSIONS

This study identified the prevalence and factors associated with Schistosomiasis outbreak in Koinadugu District, Sierra Leone. The findings of this study showed that the majority of the cases were males. This could be because males are more involved in swimming and fishing activities as compared to females. A study conducted in Gambia showed a higher prevalence of schistosomiasis among males than females (Joof *et al.*, 2021). Our results indicate that schistosomiasis infection was prevalent in primary school children. Primary school comprises mostly children age 3 to 11 years, (Ministry of Basic and Secondry Education, 2021) and are the demographics in

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rural communities that are most likely to spend more time swimming, bathing, or playing in water contaminated with the schistosomiasis parasite. Our results are consistent with a study conducted in rural communities of Southern Nigeria, where children of males were more infected with Schistosomiasis than females (Opara *et al.*, 2021).

Our study further revealed that Schistosomiasis cases were presented with bloody urine and feeling pain during urination. Evidence showed that the deposition of *S. hematobium* eggs in the bladder and ureters of the infected person was a plausible reason. A study conducted in Nigeria showed that patients infected with *S. haematobium* presented similar symptoms (Mupakeleni *et al.*, 2017b). Also, hematuria has been reported among school children infected with *S. haematobium* in the White Nile River basin, Sudan (Ismail *et al.*, 2014).

Significantly, bathing in rivers or stream was associated with schistosomiasis infection. This could be likely those school children who are infected with the disease urinating or defecating Schistosomiasis eggs into the water basin where snails serve as hosts of these parasites. The *S. haematobium* eggs produce furcocercariae that penetrate the skin of uninfected children when exposed to this contaminated water (Mawa *et al.*, 2021). A study conducted in Côte d'Ivoire reported high infection rates among children who bathed in rivers (*Prevalence and Risk Factors for Schistosomiasis among Schoolchildren in two Settings of Côte d'Ivoire - PMC*, no date). We found out that drinking water from river or stream was associated with schistosomiasis infection. This may be due to the contamination of river or stream water by the schistosomiasis parasite with the existence of the snail that transmits the parasite. This finding is consistent with a systematic review on the relationship between water, sanitation, and Schistosomiasis infection ('Relationship between water and sanitation and maternal health: Evidence from Indonesia', 2021).

This study showed that contact with rivers through swimming or fishing was associated with schistosomiasis infection. This may be because people living along the rivers, particularly young school children, access the river for different purposes such as swimming, fishing, or getting water, which puts them at great exposure to schistosomiasis infection if the water is contaminated with the parasite. This finding was similar to a study conducted in Senegal, where people were infected with schistosomiasis as a result of contacting the water of the river basin (Sow *et al.*, 2011). It is worth mentioning that the Teria river has low water volume with slow flow the opportunity for the *Bulinus* snail to exist in high density which allows schistosomiasis to spread (Chimberengwa *et al.*, 2014).

The strength of this study was that we were able to identify the causative agent of the hematuria that was reported in Koinadugu district. However, the limitation was water samples collected were not tested due to a limited laboratory capacity to test water samples, which could have identified the presence of Furcocercous cercariae in water bodies. Also, adults with symptoms were shy about reporting and being included in the study.

CONCLUSION

This study confirmed the Schistosomiasis outbreak and identified the risk factors

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associated with Schistosomiasis infection in Alkalia community, Koinadugu district, Sierra Leone. Male school-aged children were mainly affected. Risk factors associated with Schistosomiasis infection included drinking water from river/streams, bathing or swimming in river or streams, and exposure to the Teria River. To control and reduce Schistosomiasis infection, the Ministry of Water Resources should make efforts in the provision of clean and safe water sources for drinking to limit contact with river or stream. The Ministry of Health should also intensify and promote health education efforts and the distribution of Praziquantel.

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Annexes

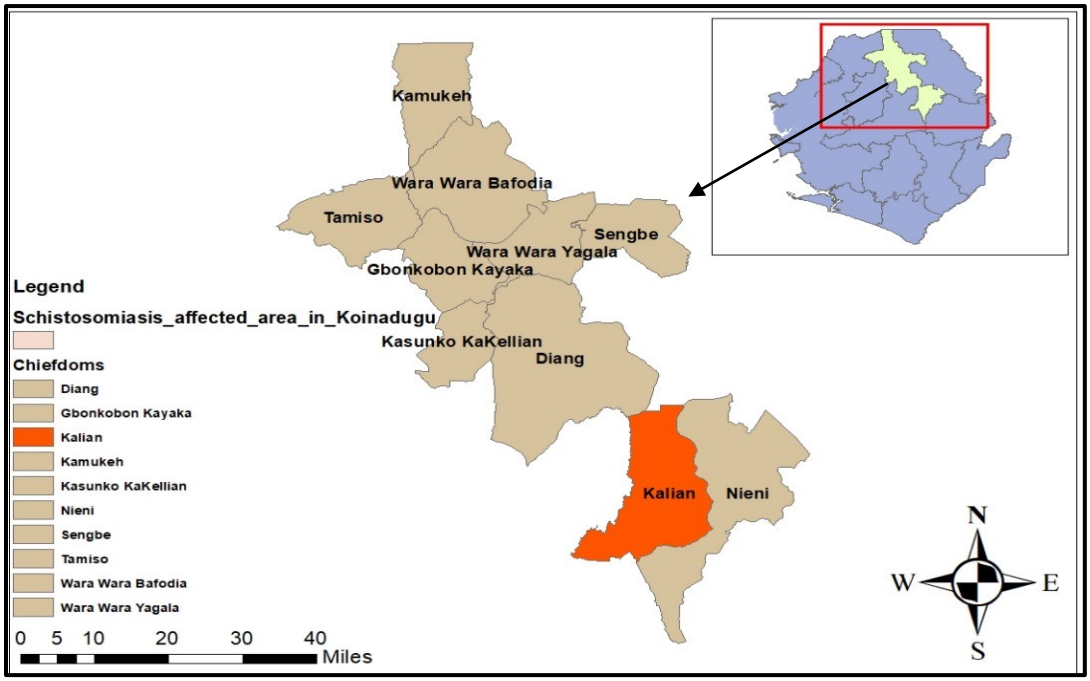

Fig 1: Map showing outbreak location, Koinadugu District- Sierra Leone, March 2023

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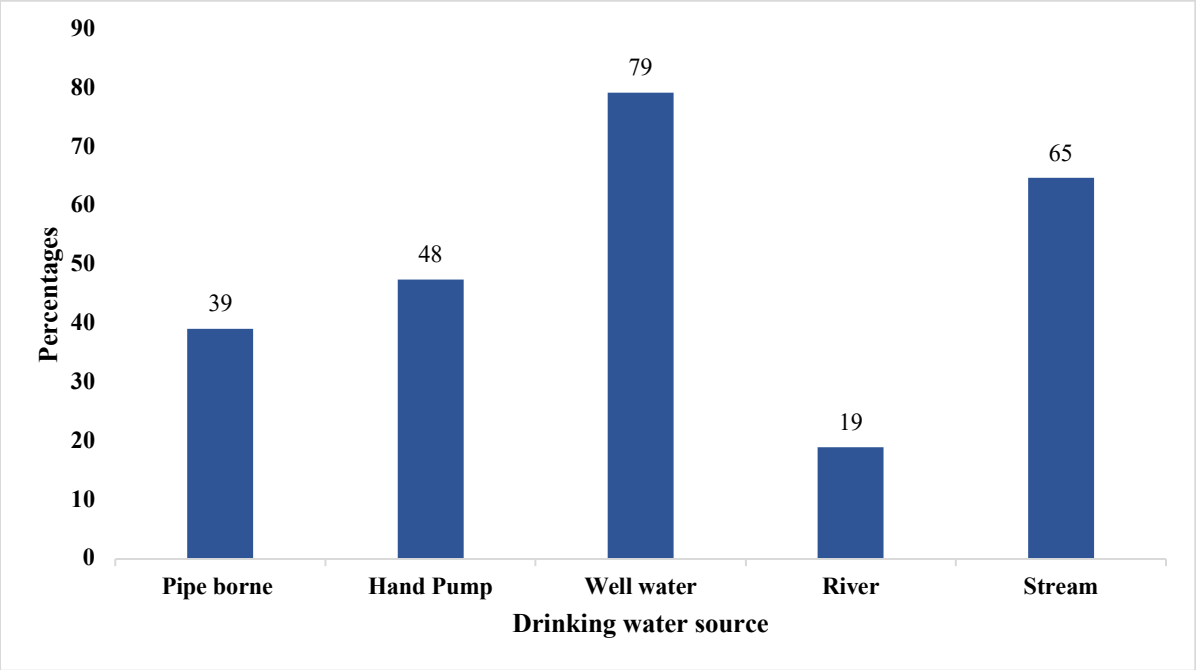

Fig 2: Sources of drinking water of study participants, Koinadugu district-Sierra Leone, March, 2023

Table 1: Demographic, clinical and exposure factors among study participants, Koinadugu district, Sierra Leone, March 2023

Variable	Frequency	Percent
Gender		
Male	302	71.7
Female	119	28.3
Age group		
<5 years	71	17.0
6-10	177	42.0
11-15	104	25.0
16-20	54	13.0
21-25	5	1.0
26-30	3	0.5
31-35	4	1.0
36 and above	3	0.5
Occupation		
Pupil	398	94.5
Farmer	4	1.0
Teachers	5	1.2
Others	14	3.3

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Fever	195	46.3
Itching skin	116	27.6
Abdominal pain	133	31.6
Blood in stool	31	7.4
Blood in urine	274	65.1
Pain while defecating	15	3.6
Pain while urinating	253	60.1
Swimming	248	59
Fishing	102	24
Bathing	306	73
Laundering	281	67
Crossing	113	27
Drinking water from unprotected sources	292	69

Table 2: Bivariate analysis of factors associated with Schistosomiasis infection, Koinadugu district-Sierra Leone, March 2023

Variables	Sub-variables	Cases	Controls	OR (95%CI)	P-value
Sex	Female	42	39	0.9 (0.53-1.51)	0.96
	Male	96	99	Ref	
Itchy skin	Yes	100	99	0.9(0.6-1.6)	0.81
	No	37	39	Ref	
Fever	Yes	73	78	1.1(0.7-1.8)	0.59
	No	64	60	Ref	
Abdominal pain	Yes	100	91	0.7(0. 4-1.2)	0.2
	No	37	47	Ref	
Painful urination	Yes	17	118	41.6(20.8-83. 4)	<0.001
	No	120	20	Ref	
Painful defecation	Yes	132	137	5.2(0.6-45.0)	0.09
	No	5	1	Ref	
Drinking from pipe borne	Yes	87	82	0.8(0.5-1. 4)	1. 5
	No	51	56	Ref	

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Drinking from hand pump	Yes	70	74	1.2(0.7-1.8)	0.6
	No	68	64	Ref	
Drinking from well	Yes	19	40	2.6 (1.4- 4.7)	<0.001
	No	119	98	Ref	
Drinking from River	Yes	116	103	0.6(0.3-1.3)	0.05
	No	22	35	Ref	
Drinking from stream	Yes	35	59	2.2(1.3-3.7)	<0.001
	No	103	79	Ref	
Swimming in river/ stream	Yes	33	91	6.2(3.6-10. 4)	<0.001
	No	105	47	Ref	
Fishing in river/ stream	Yes	93	125	4.7(2. 4-9.1)	<0.001
	No	45	13	Ref	
Bathing in river/ stream	Yes	8	83	24.5(11.1-54.1)	<0.001
	No	130	55	Ref	
Laundering in river/ stream	Yes	21	84	8.1(5.0-15.9)	<0.001
	No	117	53	Ref	
Crossing in river/ stream	Yes	87	120	3.9(2.1-7.2)	<0.001
	No	51	18	Ref	
Drinking in river/ stream	Yes	9	88	25.2(11.8-53.9)	<0.001
	No	129	50	Ref	
Teria river (contact with Teria River)	Yes	3	88	79.2(23.9-26.8)	<0.001
	No	135	50	Ref	
Yaragba stream (contact)	Yes	114	127	2.(1.1-5.2)	0. 0187
	No	24	11	Ref	
Dambayeifeh stream	Yes	95	102	1.3 (0.8-2.3)	0.28
	No	43	35	Ref	
Practice open defecation	Yes	18	72	7.3(4.0-13.2)	<0.001
	No	120	66	Ref	

Table 3: Multivariate analysis of factors associated with Schistosomiasis infection, Koinadugu district-Sierra Leone, March 2023

Variable			**AOR (95% CI)**	**P-value**
Painful urination				
Yes	17	118	16.2(6.5-40.2)	**<0.001**
No	120	21	Ref	
Swimming in stream/river				
Yes	33	91	1.4 (0.6-3.6)	0.4

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No	105	47	Ref	
Fishing in stream/river				
Yes	93	125	1.8 (0.6-5.5)	0.3
No	45	13	Ref	
Bathing in stream/river				
Yes	8	83	5.4 (1.8-16.1)	<0.001
No	130	55	Ref	
Laundering in stream/river				
Yes	21	84	1.4 (0.5-3.6)	0.5
No	117	53	Ref	
Crossing in stream/river				
Yes	87	120	0.8 (0.3-2.1)	0.7
No	51	18	Ref	
Drinking from stream/river				
Yes	9	88	6.6 (2.4-18.2)	<0.001
No	129	50	Ref	
Swimming or fishing Teria River				
Yes	3	88	10.7 (2.6-43.9)	<0.001
No	135	50	Ref	