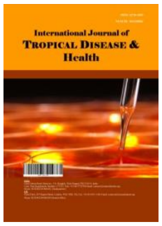

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Prevalence, Infection Intensity and Risk Factors of Schistosomiasis and Soil Transmitted Helminthiasis among School Aged Children in Tiko Health District, Southwest Cameroon: A Community-Based Cross-Sectional Study

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Authors' contributions

This work was carried out in collaboration among all authors. Author EME conceived and designed the study, participated in data collection and laboratory work and edited the draft manuscript. Author EEJ performed field and laboratory work, did the statistical analyses of the study and wrote the first draft of the manuscript. Author HMD supervised data collection and laboratory work. Author IVP participated in data collection and laboratory work. Author TN supervised data analyses and edited the draft manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study aimed at determining the prevalence, infection intensities and risk factors associated with Schistosomiasis (SCH) and Soil transmitted helminthiasis (STH) among school aged children (SAC) in Tiko Health District (THD).

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Study Design: A community-based cross-sectional study was conducted in three health areas (Likomba, Holforth and Tiko town) in Tiko Health District.

Place and Duration of Study: The study was carried out in THD from July to October, 2018.

Methodology: The study included 464 children of both sexes aged between 4 – 15 years. Stool and urine samples were collected from 464 children and processed using the Kato Katz and Urine filtration techniques respectively. Information on socio-demographic characteristics and risk factors were collected using structured questionnaires. Data was analyzed using SPSS version 25 with statistical significance set at $p< 0.05$.

Results: Of the 464 SAC examined, the overall prevalence of Schistosomiasis, STH and Schistosomiasis/STH co-infection rate in THD was 16.16%, 14.44% and 0.43% respectively. Females (18.98%; 14.81%) were more infected with Schistosomiasis when compared to STH than males (13.71%; 14.11%). The order of STH prevalence observed was Ascariasis (9.27%) > Hookworm disease (3.88%) > Trichuriasis (1.29%). The mean infection intensity for Urinary Schistosomiasis and STH was 4.36 eggs per 10ml and 11.74 eggs per gram (EPG) respectively. SAC residing in Likomba HA were significantly at higher risk of Schistosomiasis (aOR: 4.40, P=0.008) and STH (aOR: 2.14, P = 0.031). Use of tap water was associated with STH.

Conclusion: Tiko Health District can be considered as a moderate-risk zone for Schistosomiasis and a low risk zone for STH infection according to WHO classification.

Keywords: Schistosomiasis; soil-transmitted helminthiasis; prevalence, parasite density; risk factors; school-children; Tiko health district; South West region; Cameroon.

1. INTRODUCTION

Schistosomiasis and soil transmitted helminthiases are the most prevalent Neglected Tropical Diseases (NTDs) affecting people living in rural communities with limited or no access to safe water, inadequate sanitary and health facilities [1]. Schistosomiasis also known as Bilharzia, Snail fever or Schisto (in short), is a water-dependent, chronic, debilitating and one of the important infectious diseases of poverty; caused by digenetic trematode of the genus, *Schistosoma*. It can be grouped into 2 types based on the organ affected: Urogenital and Intestinal Schistosomiasis, with the former considered as the deadliest infecting over 112 million people annually in Sub-Saharan Africa (SSA) alone [2]. Of the world's 240 million cases of Schistosomiasis, SSA accounts for 93% (192 million cases) with almost about 300,000 deaths annually reported from Schistosomiasis in Africa [3,4]. Schistosomiasis transmission is through the penetration of the larval form of the parasite (furcocercus cercariae) – released by intermediate host i.e. freshwater snails during life cycle.

On the other-hand, Soil-transmitted helminthiasis (STH), also known as intestinal worm infection, is the most common type of parasitic infection affecting children globally. Soil-transmitted helminthiasis is caused by soil transmitted helminthes (*Ascaris lumbricoides, Trichuris trichiura* and Hookworms) – a sub-group under class Nematoda which encompasses of helminthes transmitted via faecally contaminated soil, hence their name "soil transmitted helminthes" [5]. Globally, more than 2 billion people are infected with STH infection, which is equivalent to about 24% of the world's population; of which 300 million are associated with severe morbidities as well as causing 9,000 to 135,000 deaths reported annually [4,5].

Amongst the STHs, *Ascaris lumbricoides, Trichuris trichiura* and Hookworms still infect 819, 464.6 and 438.9 million people worldwide respectively [6]. More so, 7.6 million children aged 1 to 15 years are at risk of STH infections in Cameroon [7]. STHs is gotten via ingestion of parasite eggs from contaminated soil – in the case of *A. lumbricoides* and *T. trichiura* – or by active penetration of the skin by larvae in the soil – in the case of hookworms. Compared with any other age group, preschool children and school-aged children are the most vulnerable groups and they harbor the greatest numbers of intestinal worms [4].

Schistosomiasis and STH infections are highly endemic in Cameroon but their distributions across the national territory are uneven. Transmission of Schistosomiasis is localized to water-logged areas where the snail intermediate host is found [8,9]. In the South West Region of Cameroon, the prevalence of STHs and Schistosomiasis was estimated at 46.2% and 17.8% respectively [10]. Tiko Health District being one of the 18 health districts in the South West Region of Cameroon, is considered as an agro-industrial zone with majority of its populace working in the Cameroon Development Corporation (CDC) – second highest employer after the Government in Cameroon. The THD is characterized by several fresh water courses which empties into the Atlantic Ocean. The “Ndongo” stream flows across Likomba town whereby the inhabitants of these areas use the water for almost all of their household activities as well as recreational activities. Furthermore, the daily temperatures of Tiko, which ranges from 28°C to 33°C, suits the survival of the Schistosome snail vectors. Despite the aforementioned favorable conditions present in THD that may permit the continuous transmission of human Schistosomiasis as well as existence of Schistosome vectors; the health district has always been excluded from the annual periodic school-based administration of Praziquantel to school children advocated by World Health Organization and other non-governmental partners.

School children co-infected with STH and Schistosomiasis are heavily associated with subtle, severe, aggravated and irreversible long term conditions such as growth stunting, impaired cognitive development and memory [11,12]. These adverse health consequences may combine to impair childhood educational performance in school-aged children [13].

So far, very few epidemiological studies have been conducted in Tiko Health District to determine co-infection rate associated with Schistosomiasis and STH among children in the community despite the prevailing environmental conditions such as presence of streams near homes, favorable climatic conditions and farming as a major occupational practice. The findings from this study will provide a clue on the disease morbidity and/or disease burden of Schistosomiasis and STH faced by school aged children in Tiko Health District and allow health policy makers and stakeholders to put more efforts and resources to tackle the disease. In addition, the present study will investigate and bring forth the possible risk factors associated with Schistosomiasis and STH among children specifically in rural communities.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out in three randomly selected health areas: Likomba, Tiko town and Holforth in Tiko Health District. The THD is one of the eighteen Health Districts in the South West Region of Cameroon. The district has a total surface area of 484 km^2, 64m elevation and located between Longitude 8.6°10'E and Latitude 4°5.2'N. It was originally called ‘keta’ by the Bakweris. Tiko has a coastal equatorial climate with daily temperatures ranging from 28°C to 33°C. Two major seasons exist in the District, the rainy season (March to October) and dry season (November to February).

Soil types include the sandy alluvial and volcanic with high agricultural potentials. Agriculture is the major source of living done by the majority of the indigenes within the Tiko municipality. The main water courses in the Tiko municipality include River Mungo, Ombe River, Ndongo and Benyo streams which empty into the Atlantic Ocean. Of all the water courses flowing in Tiko municipality, “Ndongo” stream is the most contaminated source of water with vectors of schistosomes especially *Bulinus* species found along the banks of the stream.

The THD is bounded to the North by Buea, South by Bonaberi, West by Limbe and East by Dibombari. The district is headed by the District Medical Officer and it is made up of 8 Health Areas (HA) namely; Holforth, Kange, Likomba, Mutengene, Mondoni, Mudeka, Missellele and Tiko Town with about 90 communities and 21 health facilities. As of 2017, the town was estimated to have a population of 151,109 inhabitants (IBE Tiko statistics-2017). The study consisted of school children aged 4-15 years living in Likomba, Tiko town and Holforth HA in THD present at the time of the study.

2.2 Study Design and Study Population

A community-based cross-sectional study was carried out in Likomba, Tiko town and Holforth health areas in the Tiko Health District from July to October, 2018 aimed at determining the prevalence, infection intensities and associated risk factors of Schistosomiasis and STH among school-aged children. Prior to the start of the study, the various quarter heads and chiefs were visited to explain in detail the research procedures, benefits of the study, data collection dates for the various communities in the 3 health areas.

The participants in this study were both males and females aged 4-15years whose parents/legal guardians gave their consent by signing the informed consent forms. Children who were sick or suffering from severe medical conditions and who did not have the ability to produce stool samples were excluded from the study.

2.3 Sampling Method and Sample Size Determination

A multistage sampling technique was used to recruit the study participants. THD was regrouped into eight HAs. The HAs were assumed to be clusters. Three of the 8 HAs were selected by Simple Random Sampling. Random selection was done by writing the names of the HAs on a separate piece of paper, which was then placed in a box and thoroughly mixed before selection. Probability Proportionate to Size (PPS) sampling technique was used to determine the proportion of the sample size from each of the three sampled health areas.

The sample size for the study was calculated using a prevalence of Schistosomiasis (40.27%) reported by Ntonifor and others (2015) in Munyenge in the SWR of Cameroon [14]. This was done using the formula; $n = Z^2pq/d^2$ Where; n=the expected sample size, p= prevalence of Schistosomiasis from previous study, q=1-p, d= precision, z= 1.96 (95% CI). Estimated sample size for the study was 370, with a non-compliance rate of 5% giving us 389. Thus, a minimum sample size of 389 was needed for the study.

2.4 Administration of Questionnaire

Participants were interviewed by a well-trained field researcher using a structured questionnaire to obtain information on demographic (age, sex and residence), socioeconomic indicators (educational level and parental occupation), water source, toilet type, history of deworming and other behavioral factors. The questionnaires were administered in English.

2.5 Sample Collection and Laboratory Analysis

Children whose parents/guardians consented for the study were instructed on how to collect stool and urine samples. For stool collection, the participants were provided with an A4 sheet, toilet roll, applicator stick and a clean well labelled container. Each of the participants were instructed to pass out faeces on an A4 sheet to avoid contamination, and use the applicator stick provided to them to transfer a small portion of the stool into the labelled stool container.

Also, a sterile, wide mouthed, leak-proof screw capped plastic container was used for mid-stream urine collection with the aid of the children's parents/guardians. After the exercise, the children were provided with water and detergents to wash their hands. Samples were collected between 10am and 2pm which is the period corresponding with the peak excretion of Schistosome eggs [15]. Stool and urine samples were kept separately into cool flasks filled with ice packs and immediately transported to the Tiko District Hospital (TDH) laboratory for parasitological analyses.

Immediately arriving at the TDH laboratory, the urine samples were tested for microhematuria and proteinuria using urine reagent strips (Combi-11) as per the manufacturer instructions. Thereafter, *Schistosoma haematobium* ova were identified in urine samples using the filtration technique [16]. For the detection of *S. mansoni* ova and ova of STHs, the Kato-Katz technique was used. To avoid over clearing of Hookworm eggs, the Kato-Katz smeared slides were read within 60 minutes using the 10X and 40X objectives of the conventional light microscope. The intensity of infection was classified into three levels defined by WHO as light, moderate and heavy infection for the various STH species and *S. mansoni* while for *S. haematobium*, < 50 eggs/10 ml was classified as light intensity and ≥ 50 eggs/10 ml as heavy intensity [17].

2.6 Statistical Analysis

Data was entered into Microsoft Excel version 2016 spreadsheet and analyzed using IBM Statistical package for Social Sciences (IBM SPSS) version 25.0 after checking for consistency. The dependent variables were prevalence or infection intensities of Schistosomiasis and STH infection status among SAC while socio-demographic, environmental and behavioral factors were independent variables. Data was summarized into proportions and means. Pearson's Chi-square test was used to compare the differences in prevalence (proportions) between different groups. Due to the non-normality of eggs counts, the Mann-Whitney U test was used to compare the infection intensity (mean egg loads) between males and females while the Kruskall-Wallis H test was used to compare mean egg loads of more than two groups such as health areas, age groups and educational level. The multivariate logistic regression model was used to determine the possible risk factors associated with Schistosomiasis and STH among SAC. A $p < 0.05$ was considered statistically significant.

3. RESULTS AND DISCUSSION

3.1 Socio-demographic and Clinical Characteristics of the Study Population

A total of 464 school-aged children were enrolled in the study, of which 248 (53.4%) were males and 216 (46.6%) females with a Sex ratio (M/F) of 1.15:1. The participants were divided into three age groups: 4 – 7 years, 8 – 11 years and 12 – 15 years representing 29.1%, 43.3% and 27.6% respectively. Their ages ranged from 4 – 15 years with mean age (±SD) of 8.01±3.71 years.

Majority of the children's parents, (45.3%) were employees of Cameroon Development Corporation (CDC) while some were traders (36.4%). Regarding the health areas investigated, 164 (35.3%) of the participants resided in Likomba H.A, 165 (35.6%) resided in Tiko town H.A and 135 (29.1%) were from Holforth H.A. Almost all (98.92%) of the participants were Christians with just 2 (0.43%) being Muslims. A clear majority (93.8%) of the houses in the communities were made of blocks with a few constructed with either tiles (3.0%) or built with planks (3.2%). Clinically, 36 (7.76%) of the SAC were hematuria positive while 57 (12.3%) had proteinuria (Table 1).

3.2 Prevalence and Co-infection of Schistosomiasis and Soil-transmitted Helminthiasis among SAC in Tiko Health District

Out of the 464 SAC, 75 and 67 were infected with Schistosomiasis and STH giving a prevalence of 16.16% (95% C.I = 13.09 – 19.79%) and 14.44% (95% CI: 11.53 – 17.93%) respectively. The prevalence of Schistosomiasis/STH co-infection was 0.43%. Schistosomiasis was more prevalent than any species of STH infection or all STH infections combined. The order of prevalence was Schistosomiasis (16.16%) > Ascariasis (9.27%) > Hookworm disease (3.88%) > Trichuriasis (1.29%) (Fig. 1).

Though not significant (P =0.12), females were more infected (19.0%) with Schistosomiasis than males (13.7%). Similarly, no significant association was observed between prevalence of Schistosomiasis and knowledge of the disease (P=0.12). Our results showed that Schistosomiasis prevalence increased with age (P=0.08) but the prevalence of STH infection decreased with age (P= 0.086). The prevalence of Schistosomiasis was significantly associated with haematuria (P < 0.001), proteinuria (P < 0.001), defecation site (P=0.02), water contact (P=0.003), parents' occupation specifically business dwellers (P=0.025), and health areas investigated (P =0.001) (Table 1).

With regards to gender-prevalence of STH, we observed a similar infection rate between females (14.8%) and males (14.1%). The prevalence of STH was significantly associated with the source of water (P=0.025) and health areas investigated (P=0.033). Expectedly, STH was more prevalent among those with poor knowledge about the disease, though not significant (P=0.42) as shown on Table 1.

3.3 Infection Intensity of Schistosomiasis and Soil-transmitted Helminthiasis among SAC

Overall, the mean parasite load for Urinary Schistosomiasis was 4.36 ova/10 ml of urine with eggs count ranging from 2 - 170 ova/10 ml of urine. The parasite load was higher among females (4.46 ova/10 ml) than in males (4.28 ova/10 ml), though there was no significant difference observed (P=0.11). Equally, the mean parasite load of Schistosomiasis increased insignificantly (P=0.08) with increase in age. There was a significant difference in the intensity of Schistosomiasis with health areas examined (P = 0.002) (Table 2).

The mean fecal egg count for soil transmitted helminthiasis was 11.74 eggs per gram (EPG). The participants' egg count ranged from 24 – 456 EPG with no heavy or moderate infection intensity found. The infection intensity of STH was not associated with gender (P = 0.410) and age (P = 0.059). Males were more infected with Trichuriasis (1.4%) and Hookworm infection (4.0%) than females (Trichuriasis: 1.2%; Hookworm infection: 3.7%). The intensity of STH infection was highest significantly among SAC residing in Likomba HA as presented on Table 3.

3.4 Risk Factors Associated with Schistosomiasis and Soil-Transmitted Helminthiasis among School Aged Children in Tiko Health District

Table 4 shows the logistic regression analysis between schistosomiasis as dependent variable and socio-demographic, clinical and environmental factors as independent variables. Examining the association of Schistosomiasis with the possible risk factors, the bivariate analysis showed that, SAC aged 11 - 15 years (COR: 2.14; p = 0.029), water contact (COR: 2.03; p = 0.003), living in Likomba (COR: 2.03; p = 0.005), use of pit latrine [COR: 2.46; p = 0.045] and CDC as father's occupation [COR: 1.87; p = 0.026] were the 5 significant factors associated with schistosomiasis among children in THD.

Also, the bivariate analysis showed that hematuria and proteinuria were clinical features associated with schistosomiasis. These 5 significant (P < 0.05) factors were retained and forwarded to the multivariate logistic regression to eliminate possible confounders. Multivariate logistic regression analysis showed that, school children living in Likomba HA were at higher risk of being infected with Schistosomiasis (aOR: 4.40, P = 0.008) than those residing in other health areas within the THD as indicated in Table 4.

The multivariable logistic regression analysis revealed that, SAC using tap water (aOR: 2.14, P=0.016) and residing in Likomba HA (aOR: 2.14, P=0.03) were at higher risk of STH infection as indicated on Table 5. Proper handwashing (aOR = 0.36, p= 0.016) is a protective factor of STH infection among school children residing in THD.

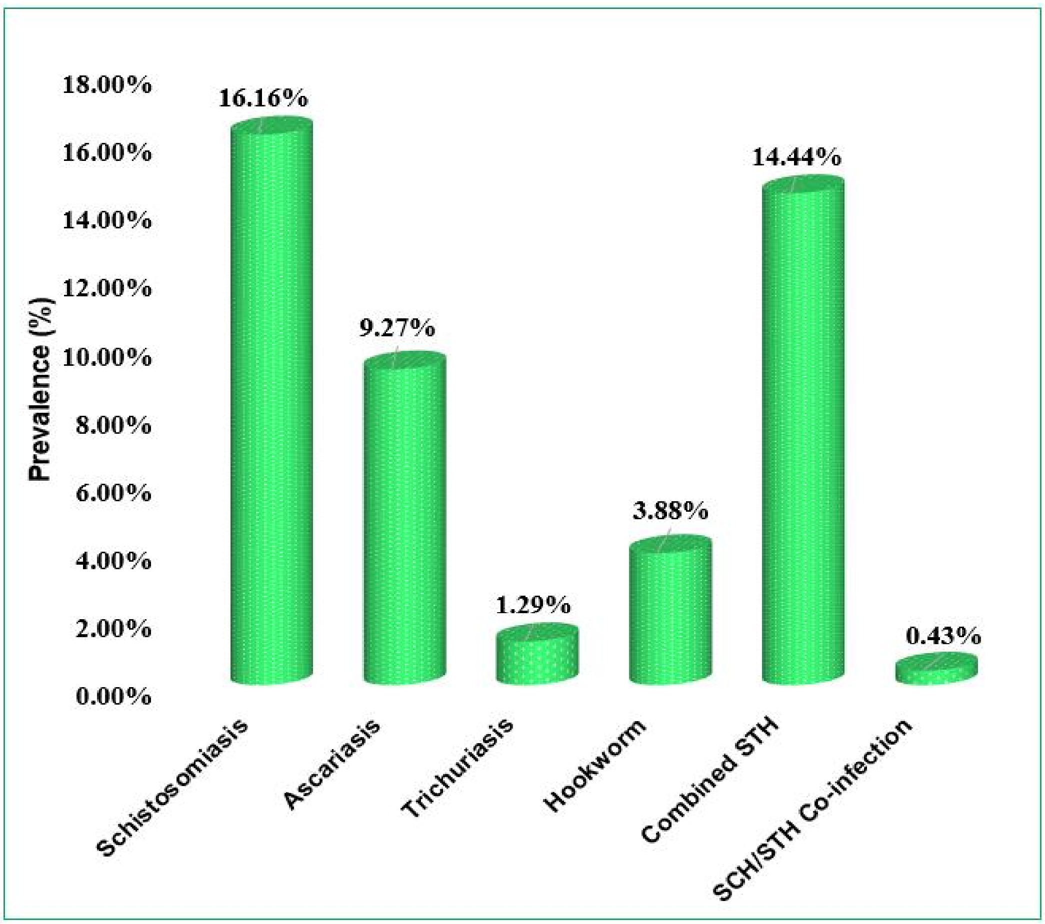

Fig. 1. Prevalence and co-infection rate of Schistosomiasis and STH in SAC in Tiko health District

Table 1. Socio-demographic and clinical factors associated with Schistosomiasis and STH infection

Characteristics	Level	Participants Examined (%)	Prevalence of Schistosomiasis	Prevalence of STH infection
Demographic factors				
Gender	Male	248 (53.4)	13.71	14.11
	Female	216 (46.6)	18.98	14.81
	M/F ratio	1.15	*P* = 0.124	*P* = 0.830
Age Group	1 – 5	135 (29.1)	11.85	16.30
	6 – 10	201 (43.3)	15.42	16.92
	11 – 15	128 (27.6)	21.88	8.59
	μ ± SD: 8.01 ± 3.71 years		*P* = 0.081	*P* = 0.086
Health Areas	Likomba	164 (35.3)	11.85	20.12
	Holforth	135 (29.1)	25.00	10.37
	Tiko Town	165 (35.6)	10.91	12.12
			P = 0.001*	*P* = 0.033*
Educational level	No school	65 (14.0)	12.30	10.77
	Nursery	39 (8.4)	17.95	23.08
	Primary	261 (56.3)	14.94	16.09
	Secondary	99 (21.3)	21.21	9.09
			P = 0.399	*P* = 0.115
Parents' occupation	Farmer	22 (4.70)	4.55	22.73
	Business	169 (36.4)	21.43	11.83
	CDC worker	210 (45.3)	13.61	17.62
	Civil servant	63 (13.6)	9.52	7.94
			P = 0.025*	*P* = 0.110
Religion	Christians	459 (98.9)	16.12	14.60
	Muslims	2 (0.43)	50.00	0.00
	Pagans	3 (0.65)	0.00	0.00
			P = 0.323	*P* = 0.653
House type	Block	435 (93.8)	16.1	13.6
	Tiles	14 (3.0)	14.3	28.6
	Planck	15 (3.2)	20.0	26.7
			P = 0.904	*P* = 0.114

Characteristics	Level	Participants Examined (%)	Prevalence of Schistosomiasis	Prevalence of STH infection
Household size	1 – 5	380 (81.9)	16.6	14.74
	> 5	84 (18.1)	14.3	13.10
			P = 0.605	*P* = 0.689
Water contact	Yes	223 (48.1)	21.52	14.80
	No	241 (51.9)	11.20	14.11
			P = 0.003*	*P* = 0.833
Toilet type	Pit latrine	342 (73.7)	61.4	14.04
	Flushing toilet	69 (14.9)	48.4	15.94
	No toilet (Bushes)	53 (11.4)	6.1	15.09
			P = 0.020*	*P* = 0.905
Source of water	Tap	277 (59.7)	17.69	17.69
	Well	140 30.2)	14.29	11.43
	Stream	47 (10.1)	12.77	4.26
			P = 0.538	*P* = 0.026*
Knowledge level	Good	93 (20.0)	21.51	11.83
	Poor	371 (80.0)	14.82	15.09
			P = 0.118	*P* = 0.423
Clinical factors				
Hematuria	Yes	428 (92.2)	72.22	27.78
	No	36 (7.8)	10.98	13.32
			P = 0.001*	*P* = 0.018*
Proteinuria	Yes	57 (12.3)	61.4	21.05
	Traces	31 (6.7)	48.4	6.45
	No	376 (81.0)	6.1	14.10
			P = 0.001*	*P* = 0.161
Dewormed at Home	Yes	148 (31.9)	17.57	18.24
	No	316 (68.1)	15.51	12.66
			P = 0.875	*P* = 0.111

*μ = Mean age; S.D = Standard Deviation; M/F ratio = Male/Female; * Statistically significant association, $p < 0.05$*

Table 2. Association between intensity of *Schistosoma haematobium* infection and demographic factors

Variable	Number examined	Number Infected	Intensity of infection			Mean Egg Count (MEC)
			Negative (%)	Light (%)	Heavy (%)	
Overall US	464	73	391 (84.27)	60 (12.93)	13 (2.80)	4.36
Gender						
Male	248	33	215 (86.7)	27 (10.9)	6 (2.4)	4.28
Female	216	40	176 (81.5)	33 (15.3)	7 (3.2)	4.46
			χ^2 = 2.371, *P* = 0.306			U =25314.5, *P* =0.114
Age Group						
4 – 7	135	15	120 (88.9)	14 (10.4)	1 (0.7)	1.69
8 – 11	201	31	170 (84.6)	24 (11.9)	7 (3.5)	4.90
12 – 15	128	27	101 (78.9)	22 (17.2)	5 (3.9)	6.34
			χ^2 = 6.348, *P* = 0.175			H = 5.089, *P* = 0.079
Health Areas						
Holforth	135	16	119 (88.2)	10 (7.4)	6 (4.4)	5.90
Likomba	164	39	125 (76.2)	34 (20.7)	5 (3.1)	5.16
Tiko town	165	18	147 (89.1)	16 (9.7)	2 (1.2)	2.31
			χ^2 = 17.019, *P* = 0.002*			H = 12.080, *P* = 0.002*

Negative, light and heavy infections correspond to 0, 1 – 49 and ≥ 50 eggs/10mL respectively;
χ^2 = Pearson's Chi square test; H = Kruskal Wallis H test; U = Mann Whitney U test

Table 3. Demographic factors associated with infection intensity of STH among school children in Tiko Health District

Variable	Number examined	Combined STHs	*Ascaris*		*Trichuris*		Hookworms	
		Mean egg count	Negative	Positive (%)	Negative	Positive (%)	Negative	Positive (%)
Overall	464	11.74	421	43 (9.3)	458	6 (1.3)	446	18 (3.9)
Gender								
Male	248	11.61	228	20 (8.1)	245	3 (1.4)	238	10 (4.0)
Female	216	11.89	193	23 (10.6)	213	3 (1.2)	208	8 (3.7)
		P = 0.410[a]	χ^2 = 0.917, P = 0.338		χ^2 = 0.029, P = 0.865		χ^2 = 0.033, P = 0.855	
Age Group								
4 – 7	135	14.04	118	17 (12.6)	134	1 (0.7)	131	4 (3.0)
8 – 11	201	14.57	180	21 (10.4)	199	2 (1.0)	191	10 (5.0)
12 – 15	128	4.88	123	05 (3.9)	125	3 (2.3)	124	4 (3.1)
		P = 0.059[b]	χ^2 = 6.484, P = 0.039*		χ^2 = 1.570, P = 0.456		χ^2 = 1.147, P = 0.564	
Health Areas								
Holforth	135	6.04	133	07 (5.2)	135	0 (0.0)	133	2 (1.5)
Likomba	164	16.39	155	21 (12.8)	158	6 (3.7)	155	9 (5.5)
Tiko town	165	11.78	158	15 (9.1)	165	0 (0.0)	158	7 (4.2)
		P = 0.015*[b]	χ^2 = 5.122, P = 0.077		χ^2 =11.119, P = 0.004*		χ^2 =3.258, P = 0.194	

*χ^2 = Pearson Chi square, * Significant association at P < 0.05 [a] Mann Whitney U test [b] Kruskal Wallis H test*

Table 4. Risk factors associated with Schistosomiasis among SAC in Tiko Health District

Variables	Schistosomiasis		Bivariate analysis		Multivariate analysis	
	N	% Infected	COR (95% CI)	*P*	AOR (95% CI)	*P*
Gender						
Male	248	13.71	1			
Female	216	18.98	1.48 (0.89 – 2.45)	0.1255	–	–
Age group						
1 – 5	135	11.85	1		1	
6 – 10	201	15.92	1.46 (0.75 – 2.82)		0.97 (0.43 – 2.19)	0.9415
11 – 15	128	21.09	2.14 (1.08 – 4.24)	0.0292*	0.80 (0.31 – 2.03)	0.6322
Health Areas						
Holforth	135	11.85	1		1	
Likomba	164	25.00	2.48 (1. 32 – 4.66)	0.0048*	3.39 (1.19 – 9.65)	0.0215*

Variables	Schistosomiasis		Bivariate analysis		Multivariate analysis	
	N	% Infected	COR (95% CI)	*P*	AOR (95% CI)	*P*
Tiko town	165	10.91	0.91 (0.45 – 1.86)		1.34 (0.46 – 3.89)	0.5874
Educational level						
No education	65	10.77	1			
Nursery	39	17.95	1.81 (0.58 – 5.63)		–	–
Primary	261	15.33	1.50 (0.63 – 3.52)	0.0875	–	–
Secondary	99	21.21	2.23 (0.89 – 5.60)		–	–
Water contact						
No	241	11.62	1		1	
Yes	223	21.08	2.03 (1.22 – 3.38)	0.0028*	1.01 (0.50 – 2.05)	0.9738
Hematuria						
No	428	11.45	1		**1**	
Yes	36	72.22	23.75(10.54 - 53.49)	< .001*	3.78 (1.18 – 12.12)	0.0250*
Proteinuria						
No	376	06.65	1		1	
Trace	31	48.39	13.16 (5.84 – 29.67)		12.56 (5.32– 29.62)	
Yes	57	61.40	22.34 (11.43–43.65)	< .001*	13.10 (4.93– 34.82)	< 0.001*
Knowledge level						
Good	93	21.51	1			
Poor	371	14.82	0.64 (0.36 – 1.12)	0.1193	–	–
Source of water						
Stream	47	12.77	1			
Tap	277	17.69	1.47 (0.59 – 3.65)		–	–
Well	140	14.29	1.14 (0.43 – 3.03)	0.7949	–	–
Occupation						
Business	169	13.02	1		1	
CDC worker	210	21.90	1.87 (1.08 – 3.26)	0.0264*	0.57 (0.17 – 1.88)	0.3532
Civil servant	63	9.52	0.70 (0.27 – 1.82)		0.54 (0.17 – 1.67)	0.2831
Farmer	22	4.55	0.32 (0.04 – 2.49)		0.25 (0.02 – 2.64)	0.2484
Toilet type						
Flushing toilet	69	8.70	1		1	
Pit latrine	342	19.01	2.46 (1.02 – 5.94)	0.0446*	1.99 (0.62 – 6.42)	0.242
No toilet	53	7.55	0.86 (0.23 – 3.21)		0.76 (0.14 – 4.23)	0.7567

*COR = Crude Odds Ratio; AOR = Adjusted Odds Ratio; CI = Confidence interval; * Significant at P < 0.05*

Table 5. Risk factors associated with STH infection among school children in Tiko Health District

Variables	STH infection		Bivariate analysis		Multivariate analysis	
	N	% Infected	COR (95% CI)	*P*	AOR (95% CI)	*P*
Gender						
Male	248	14.11	1			
Female	216	14.81	1.06 (0.63 – 1.78)	0.8299	–	–
Age group						
1 – 5	135	16.30	1			
6 – 10	201	16.92	1.05 (0.58 – 1.88)	0.8813	–	–
11 – 15	128	8.59	0.48 (0.22 – 1.04)	0.0634	–	–
Health Areas						
Holforth	135	10.37	1		1	
Likomba	164	20.12	2.48 (1.11 – 4.26)	0.0233*	2.14 (1.08 – 4.27)	0.0215*
Tiko town	165	12.12	1.19 (0.58 – 2.46)	0.6344	3.28 (1.01 – 10.57)	0.0480*
Educational level						
No education	65	10.77	1			
Nursery	39	23.08	2.49 (0.84 – 7.33)	0.0989	–	–
Primary	261	16.09	1.59 (0.68 – 3.72)	0.2861	–	–
Secondary	99	9.09	0.83 (0.29 – 2.35)	0.7234	–	–
Water contact						
No	241	14.11	1			
Yes	223	14.80	1.06 (0.63 – 1.77)	0.8325	–	–
Hematuria						
No	428	13.32	1		1	
Yes	36	27.78	2.50 (1.15 – 5.47)	0.0212*	2.38 (1.04 – 5.46)	0.0409*
Wash hand practice						
No	376	17.95	1		1	
Sometimes	31	14.46	0.77 (0.43 – 1.36)	0.3721	0.88 (0.48 – 1.60)	0.6749
Yes	57	7.77	0.39 (0.17 – 0.86)	0.0207*	0.36 (0.15 – 0.83)	0.0163*
Knowledge level						
Good	93	11.83	1			
Poor	371	15.09	1.33 (0.66 – 2.64)	0.4243	–	–

Variables	STH infection		Bivariate analysis		Multivariate analysis	
	N	**% Infected**	**COR (95% CI)**	***P***	**AOR (95% CI)**	***P***
Source of water						
Stream	47	4.26	1		1	
Tap	277	17.69	4.84 (1.13 – 20.61)	0.0331*	8.57 (1.72 – 42.74)	0.0088*
Well	140	11.43	2.90 (0.64 – 13.13)	0.1663	2.56 (0.55 – 11.99)	0.2317
Occupation						
Business	169	11.83	1			
CDC worker	210	17.62	1.59 (0.89 – 2.86)	0.1195	–	–
Civil servant	63	7.94	0.64 (0.23 – 1.79)	0.3976	–	–
Farmer	22	22.73	2.19 (0.73 – 6.59)	0.1626	–	–
Toilet type						
Flushing toilet	69	15.94	1			
Pit latrine	342	14.04	0.86 (0.42 – 1.76)	0.6805	–	–
No toilet	53	15.09	0.94 (0.35 – 2.52)	0.8982	–	–

*COR = Crude Odds Ratio; AOR = Adjusted Odds Ratio; CI = Confidence interval; * Significant at P < 0.05*

3.5 Discussion

Schistosomiasis and Soil transmitted helminthiases remain a major public health problem in many developing countries among rural populations in Sub–Saharan Africa particularly in Cameroon. The current study aimed at determining the prevalence, infection intensity and risk factors associated with Schistosomiasis and STH among school-aged children residing in Tiko Health District.

The overall prevalence of Schistosomiasis in Tiko Health District was 16.16% with a significant difference in the prevalence of urogenital (15.73%) and intestinal Schistosomiasis (0.43%). A prevalence of 16.16% shows that THD is a moderate-risk zone for Schistosomiasis based on WHO classification of endemic communities [17]. Our prevalence (16.16%) is similar to the findings of Mewabo et al. [18], who observed a prevalence of 16.59% among 229 school-aged children in Malentouen District of Western Cameroon. However, this prevalence (16.16%) was slightly lower than the overall prevalence (17.8%) reported in the South West Region of Cameroon [10]. Similarly, the current prevalence is in discordance with prevalence rates reported in various parts in the South West Region of Cameroon [12,19,20] and out of Cameroon [21]. Possible reasons for the lower prevalence observed in current study compared to other studies could be attributed to the seasonality in transmission of Schistosomiasis and differences in geographical settings. The current study was carried out during the rainy season (July – October, 2018) which may explain the lower prevalence observed. A study carried out in Southern Mauritania, also showed significantly higher Schistosomiasis prevalence in the dry season than in the rainy season [22].

This study showed a lower mean parasite load of Schistosomiasis as compared to studies carried out in Southwestern Ethiopia and in Senegal [21,23]. This lower parasite load observed could be attributed to differences in geographical settings.

In relation to gender, prevalence and intensity of Schistosomiasis was higher among females than males. Similar observations were reported by Ntonifor et al. [19] and by Morenikeji et al. [24] in Nigeria. The higher prevalence observed in females could be attributed to socio-cultural factors that expose them more to surface water contact during regular laundry, washing of household utensils, fetching of water and bathing. In other words, the fact that fetching of water and washing clothes are regarded as female duties in our local communities might likely explain the differences in infection rates observed. However, these findings are contradictory to the studies conducted by Ebai et al. [20] and Mewabo et al. [18], who reported higher prevalence among males than in females.

Equally, Schistosomiasis prevalence and intensity increased with increase in age. Usually, older children are afforded more liberty to involve in washing of clothes, fetching of water or bathing from streams. This observation is consistent with those documented in different States in Nigeria [25,26].

With regards to the health areas examined, the present study showed that Likomba HA was the most infected with Schistosomiasis. This is due to the proximity of the HA to the cercarial-infested stream compared to the other health areas.

Residing in Likomba health area was the only significant risk factor of Schistosomiasis. SAC living in Likomba HA were at higher risk of infection when compared to those in other HAs. This is in conformity with a recent study carried out by Anguh et al. [27] who regards Likomba as a newly unmapped focus for Urogenital Schistosomiasis. Likomba is closest to the cercarial-infested streams than the other two health areas investigated.

The overall prevalence of STH among SAC in THD was 14.44%. This prevalence is far lower than the overall prevalence (46.2%) of STHs in the SWR of Cameroon reported by Tchuente et al. [10] and other authors [14,28,29] who all reported significantly higher prevalence of STH compared to the current study. The main reason for the observed low prevalence of STH could be attributed to the free-of-charge nationwide mass deworming program in school-aged children that has been going on yearly since 2011.

However, the prevalence of STHs in the current study was significantly higher than those reported in the THD (1.0%) and in some communities in Mount Cameroon areas (2.5%) in Fako division of Cameroon [30,31]. The higher prevalence of STH in our study compared to the previous prevalence reported in THD by Egbe et al. [30] was due to the fact that their study was a post-intervention survey.

Females had a slightly higher prevalence of STH infection than males. This observation is in accordance with other findings within Cameroon [14,29]. This result is contrary to that of Hamit et al. [32] who found that males were more parasitized because they spend much time playing than females. The higher prevalence of STH noticed among females than in males can be attributed to their different activities. The practice of geophagy is predominant among women and girls than boys [33].

The prevalence of STH decreased insignificantly with increase in age. Similar pattern was observed in Loum, Cameroon and in a rural community in Brazil who all reported a decreasing STH prevalence with increase in age [34,35]. Possible explanations for the differences in infection rates among the age groups can be attributed to the participants' educational level and knowledge about the disease.

Our findings affirmed that polyparasitism co-exist among children in Tiko Health District. The prevalence of co-infection between Schistosomiasis and STH in the study was 0.43%. This result is similar to those reported by other researchers [10,14,34]. Though Schistosomiasis and STH co-infection was observed, the prevalence of co-infection was low.

Clinically, hematuria and proteinuria were identified as common symptoms associated with urogenital Schistosomiasis (US). When compared to non-hematuria and non-proteinuria individuals, children with hematuria and proteinuria had significantly higher parasite loads ($p < 0.001$). This is an indication that, higher parasite loads are associated with renal damage that leads to extrusion of blood into the bladder as noticed during urination [36].

The present study showed that just a few (20%) of the participants were knowledgeable about Schistosomiasis and STHs. This implies that the majority (80%) of the respondents were unaware about mode of transmission, treatment and preventive measures of schistosomiasis and STHs. This indicates that there is still a gap in health education among the targeted populations in the control and prevention of schistosomiasis and STHs. Surprisingly, the prevalence of Schistosomiasis was insignificantly higher among children with good knowledge on Schistosomiasis than those with poor knowledge. This indicates that sensitization alone does not necessarily result in behavioural changes, which are often more difficult to be achieved, and requires longer periods of time to ensure compliance with healthier practices.

Some limitations of this study include: the prevalence of Schistosomiasis and STHs as well as the co-infection may have been underestimated due to the temporal variation in egg excretion over hours and days. Moreover, information on water contact activities was collected using a structured questionnaire, while the frequency and/or duration of water contact were not investigated. Quantifying water contact activities is essential and very necessary to assess the contribution of water contact behavior to Schistosomiasis in endemic communities.

3.6 New Knowledge Contributed by This Study

This study affirms the co-existence of Schistosomiasis and soil transmitted helminthiasis among SAC residing in Tiko Health District as previously reported by Egbe et al. [30] and Anguh et al. [27]. However, the study throws more depth on the infection intensities as well as the level of knowledge of the disease among the school-children within the Tiko Health District. Furthermore, the current study reports the existence of *S. mansoni* compared to all previous studies conducted within the THD.

4. CONCLUSION

Based on our findings, the overall prevalence of Schistosomiasis, STH and Schistosomiasis/STH co-infection among school-aged children in Tiko Health District was 16.16%, 14.44% and 0.43% respectively. All the STH infections were of low intensity with a mean fecal egg count of 11.74 EPG and the significant risk factors of STH were the use of tap water and living in Likomba HA. The mean parasite load for Urinary Schistosomiasis was 4.36 ova/10 ml of urine. Compared to the other health areas investigated, school children living in Likomba were at higher risk of being infected with STH infection. Proper hand washing was a protective factor of STH.

It therefore shows that Schistosomiasis and soil transmitted helminthiasis constitute a major public health challenge in Tiko Health District. As such, the provision of portable water and distribution of Praziquantel and Mebendazole to school-age children alongside health education may significantly reduce the prevalence of the disease in this area.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

The study protocol was approved by the Faculty of Health Sciences Institutional Review Board of the University of Buea. Administrative authorizations were obtained from the South West Regional Delegation of Public Health and the Tiko Health District Service. Before the commencement of the study, the objectives and plan of action were explained to the quarter heads of the selected communities to get their cooperation and permission to conduct the survey. Assent was obtained from all parents/guardians for the participation of their children. All data recorded from all participants was handled with utmost confidentiality and only the researcher had access to the data.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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