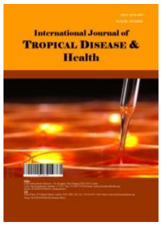

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An Update on Schistosomiasis: Prevalence, Intensity of Infection and Risk Factors among School-Aged Children in Njombe, Littoral Region, Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. Author CGDN conceived and designed the study, carried out field activities and edited the manuscript. Author MK conceived and designed the study, edited the manuscript and coordinated the field activities. Author BT conceived and designed the study, drafted the primary manuscript and analyzed the data. Author SA carried out field activities and analyzed the data. Author TWJM carried out field activities and edited the manuscript. All authors read and approved the final manuscript prior to submission.

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ABSTRACT

Aims: The study aimed to assess an update of the burden of schistosomiasis among primary school children.
Study Design: The study was a school-based cross-sectional study carried out among children aged between 4 to 15 years old.
Place and Duration of Study: The study took place in Njombé, Littoral Region, Cameroon from March to April 2017.
Methodology: Urine and stool samples were collected were collected from 412 school-aged children and examined using the urine filtration method and the Kato-Katz technique respectively. A questionnaire was administered to assess their water related activities. The data were analyzed using SPSS version 2.0. Logistic regression and odds ratio was used to measure association and strength between variables respectively. P-value < .05 at 95% CI was considered as statistically significant.
Results: The overall prevalence of schistosomiasis was 9.7%, with 7,8% and 1,9% of school children infected with *S. mansoni* and *S. haematobium*, respectively and 0.7% co-infection with both species. The intensities of *S. haematobium* and *S. mansoni* infection were 2.1 eggs per 10 mL of urine, 94 eggs per gram of stool respectively. The multiple regression analysis revealed that itching after bathing in backwater (Odds ratio (OR)= 2.427, confidence interval (CI): 1.080 - 5454, *P*=.03). And school children attending EPB Alpha (OR= 2.024), CI: 1.203 – 4.804, *P*=.011). were predictors of schistosomiasis infection. However, significant association was found between schistosomiasis and playing in the stream and the presence of the river and back water in the vicinity of schools.
Conclusion: There was a drastic decline in the prevalence of schistosomiasis infection in school children in Njombé compared to previous reports. The decrease is attributed to the bi-annual deworming campaign by the Public Health Authorities.

Keywords: Schistosomiasis; risk factors; school-age children; Njombé; Littoral; Cameroon.

1. INTRODUCTION

Schistosomiasis constitutes a major public health problem in the tropic and sub-tropic. The disease accounts for more than 800 million being at risk of infection, affecting 240 million people [1]. The global burden of schistosomiasis is estimated at about 1.4 million disability-adjusted life years (DALYs) annually [2] and sub-Saharan Africa bears a disproportionately high burden of schistosomiasis with approximately 92% of human schistosomiasis.

Otherwise called bilharzia, schistosomiasis a water-borne parasitic infection, is caused by six species of blood flukes of genus *Schistosoma* namely*: Schistosoma haematobium, S. guineensis, S. intercalatum, S. mansoni, S. japonicum,* and *S. mekongi* [3]. From those six species, 3 of them are important since infect humans in a large scale namely *S. mansoni*, *S. haematobium*, and *S. japonicum*. Studies performed in children infected with Schistosoma species revealed that infection can cause growth retardation, fatigue, weakness, chronic anaemia, impairment of memory and cognitive reasoning, and increased risk of anaemia, leading to poor academic performance, thus limiting the potential of infected children [4]. Spurred by successful schistosomiasis control and possible elimination in Japan, China, Philippines, Brazil, Egypt and in some sub-Saharan African countries, control of schistosomiasis with progression towards the elimination of the disease is achievable [5].

Community directed strategy based on the distribution of praziquantel to school children is the cornerstone of Schistosomiasis control strategy in Cameroon [6]. The United States Agency for International Development (USAID) through the Neglected Tropical Diseases Control Program significantly contributed to a dramatic decline in the estimated prevalence during 1986-2002. However, from 2003 to 2010 there was an increase in prevalence rates from 12% to 26% rural areas [5]. Operational difficulties, bad state of roads and limited budget have limited the success of the control interventions to only high schistosomiasis transmission foci [7]. The Sanaga River basin, Kotto Barombi lake, Lake Chad and the Lagdo Dam, are considered hotspots for schistosomiasis. Cameroon has over 23,739,218 inhabitants [8], but only 45.2% of the population has access to improved sanitation and 74.1% access to improved (clean) drinking water. The most infected people are school-aged children under 14, living in rural and urban slum settings. An estimated 3.6 million children in Cameroon require annual deworming, however, implementation strategy in the country only covers 10% of the schistosomiasis infected population [9]. Unfortunately, most Health Districts in Cameroon do not have a local surveillance system to guide the planning and implementation of control interventions at that level. Despite, a relative success recorded by the Ministry of Public Health through the National Programme for the Control of Schistosomiasis and Soil-Transmitted Helminthiasis (NPCS/STH), schistosomiasis persists many rural, remote and enclaved localities in the country.

The paucity of data on the prevalence and risk factors associated with this infection in several foci hindered planning and interventions. Tchuem Tchuenté [7] posited that the transmission of schistosomiasis is dynamic over time, particularly after years of mass administration of drugs and other interventions. Thus, the present study aimed to update the prevalence, intensity of schistosomiasis and to identify the associated risk factors of this disease among school-aged children in Njombé, where sustainable active control is on-going.

2. MATERIALS AND METHODS

2.1 Study Site and Population

The school-based study was conducted in Njombé, in the Mungo Division, Littoral Region, Cameroon. This area has an estimated population of about 17.392 inhabitants [8]. The climate is equatorial made up of two distinct seasons; the wet and dry seasons. The former takes place between April and October, while the latter occurs from November to March. Njombé shows an annual average rainfall of 3000 mm, an annual relative humidity of 78%, and an annual average temperature of 28°C [10]. The main rivers are; river Mungo and river Dibombé, in addition to a numerous stream such as Mbanga, Boko, Moumbé, Tondè, Mbomè. The soil type is very diverse but all from volcanic origin, that have developed to produce fertile soils. There has been serious deforestation due to the activities of large plantations and small farms. It worth mentioned that *Puereria pubescens* has been introduced as a cover crop, meanwhile, smallholders grow palm oil, banana, coffee, spices, solo pawpaw, oranges and pineapple [11]. The criteria in selecting this study area were; rural, undergoing active control and where most of the active population works in Plantations du Haut Penja (PHP). Moreso, the selection process was done based on schistosomiasis related information obtained from the Health personnel of the Njombé District Health Service. These farmlands and industrial plantations depend on streams and rivers as the main source of water for domestic and irrigation purposes. In Njombé, the population consists mainly of the Bafoun, the Bonkeng, the Abo, the Bamilékés, the Bafia, the Bassa'a, the Béti, the Nortwesterners, the Bakweri, and the Northerners. Being a rural area, the economy is predominantly agricultural with a strong wave of industrial plantations. The leading agricultural corporation is PHP.

2.2 Study Design

This was a school-based cross-sectional study designed to determine the prevalence, distribution of schistosomiasis and to identify the associated key factors among school-aged children in Njombé. The study was carried out in 5 randomly selected primary schools from April to June 2017. The study population consisted of primary school children age 6-15 years and attending 5 schools namely: École Publique de la Gare Groupe I (EPG I), École Publiques de la Gare Groupe II (EPG II), École Publiques de la Gare Groupe III (EPG III), École Primaire Bilingue Alpha (EPBA), and École Primaire Bilingue la Paix (EPBP). Njombé Health District is recognized as a hotspot of *S. mansoni* and *S. haematobium* transmission [7]. A structured questionnaire was used to assess water-contact patterns. Urine and stool samples were collected and transported to the HSJM (Hopital Saint Jean de Malte, Njombé) laboratory for analysis.

2.3 Sample Size Estimation

The required sample size was determined using the following formula for sample size calculation [12].

$$n = \frac{Z^2 x\, p(1-p)}{e^2}$$

Where n= The desired sample size, P= Population estimated assuming a 13% prevalence of schistosomiasis in Cameroon [13], Z= The standard deviation set at 1.96 which corresponds to the 95% confidence interval, 5% level of significance (α = .05), and e^2 = 5%

margin of error (D = .05). After computation and adding 10% for non-response rate, it was estimated that a sample of at least 378 school-aged children was required for this study. A total of 450 primary school children were finally approached.

2.4 Sampling Technique

Convenient sampling technique was used to select government primary schools in the vicinity of rivers or streams. Sample size was proportionally allocated to each school and each class of participating schools. Using the attendance registries of the participating schools, each child was given a number and selection of the children to participate in the study was achieved based on their age.

2.5 Data Collection Procedures

Questionnaire Survey: Parents of the children were mobilized and educated about the importance of the study. After the pre-test, the questionnaire was perfected, with the assistance of teachers. Teachers and research team members explained the process to the pupils thoroughly, and then the school children were interviewed individually. Their verbal responses were recorded. The questionnaires were administered in order to collect demographic data (age, gender) behavioural risks (water contact activities), and environmental sanitation (the type of latrine used).

Sample Collection (Urine/Stool): Urine samples were collected between the hours of 10 am and 2 pm along with the stool samples. For urine, they were instructed to collect midstream urine not less than an estimated volume of 10 ml and have the last few drops of the urine passed in clean, screw-capped, labelled plastic containers. A wide mouth 100 mL screw-capped containers pre-labelled with the participant's name and code were distributed to each participant for the collection of stool. These samples were taken to the HSJM laboratory in ice-block packed coolers where they were processed and analyzed.

2.6 Parasitological Examination

Examination of Stool for Eggs: The collected stool samples were processed using the Kato-Katz technique [14,15]. The faecal materials were examined under a microscope, and counts were multiplied by 24 to provide total estimated egg counts. The infection intensity of *S. mansoni* was classified according to the number of eggs per gram of stool (EPG): light (EPG <100), moderate (100 ≤ EPG <400), or high (EPG ≥400).

Examination of Urine for Eggs: Urine examination for *S. haematobium* eggs was carried out using the standard centrifugation method as described by [16]. The content of each specimen bottle was well mixed after which a sterile disposable 10 ml syringe was used to draw urine sample into a centrifuge tube and this was centrifuged for 5 min at 3,000 rpm. The supernatant was decanted while the sediment was re-mixed by tapping the bottom of the tube and a little drop placed on a slide. This was covered with a coverslip and examined microscopically, using ×10 and ×40 objectives. After examining the whole field, microscopic slides containing eggs of *S. haematobium* were recorded as positive while the absence of eggs was taken as negative. The intensity of infection was determined for positive samples and recorded as number of eggs per 10 ml of urine. The intensity was classified [17] as light infection (less than 50 eggs/10 ml of urine) and heavy infection (more than 50 eggs/10 ml of urine).

2.7 Malacological Survey

Snail intermediate hosts of *S. mansoni* and *S. hermatobium* were surveyed in Mboualè, Tondè et Yaoundé water. Field collectors carried out the sampling using snails scooped (mesh sieve or net on the end of a pole) and occasionally standard hands pick to collect snails directly as aquatic vegetation and wastes. Survey time was fixed to 15 minutes per location and was performed between 08:30h and 10:30h. Each sampling area per location was approximately $10m^2$, and lengths of 05 m along streams [18]. After each collection, snails from each site were appropriately labelled and transported in transparent plastic bucket containing 1% of 90° pure alcohol [19] to the HSJM laboratory where they were processed. At the laboratory, snails were identified to species level based on shell morphological characteristics using standard keys [20].

2.8 Statistical Analysis

Data were entered into Microsoft Excel, and coded appropriately and exported SPSS version 20.0 statistics for data analysis. The Chi-square test was applied to compare proportions between groups. The relationship between infection with

Schistosomiasis and socio-demographic and water contact variables was explored with logistic regression analysis. The odds ratio was used to determine the strength of association of results from sample examinations between groups of the population. All tests were carried out with a 95% level of confidence and a P-values of < 0.05 were considered statistically significant.

3. RESULTS AND DISCUSSION

3.1 Socio-demographic Characteristics of Study Subjects

The details of the study participants are shown in Table 1. A total of 450 primary school children were approached but only 412 (73.6%) between the age of 6 to 15 years were included in the analysis, of which 192 (46,6%) and 220 (53,4%) of them were males and females, respectively. The mean age (SD) of the study participants was 11.5 ±1.5 years, the sex ratio (M/F) of the participants was 0.87:1 with 192 males and 220 females. The individuals were divided into four age groups (8–9, 10–11, 12–13 and 14-15 years), representing 7.8%, 45.4%, 34.2 and 12.1% of the children, respectively.

Table 1. Study participants by sex, age and schools

Characteristics	Number (n)	Percentage (%)
Sex		
Male	192	46,6
Female	220	53,4
Total	412	
Age group (years)		
8 - 9	32	7,8
10 - 11	189	45,9
12 - 13	141	34,2
14 – 15	50	12,1
Total	412	
Primary schools		
EPB Alpha	107	26
EP GP 1	95	23,1
EP GP 2	118	28,6
EP GP 3	49	11,9
EPB la Paix	43	10,4
Total	412	

3.2 Knowledge and Attitudes Regarding Schistosomiasis

In the present study, 270 out of the 412 participants (65,5%) had heard about schistosomiasis as shown in Table 2. Half of the pupils, 208 (50.4%) had misconceptions on how the schistosomiasis parasite was transmitted while 194 (47.1%) of the respondents reported that the parasite was transmitted by sexual contact. Concerning the signs and symptoms of the disease, a majority of the respondents, 215 (52.1%) reported signs of blood in stool while 80 (19.4%), and 411 (35.4%) of the respondents reported haematuria and abdominal pains respectively. Most of the respondents seek treatment at the hospital 146 (35.4%) while other 80 (19.4%) preferred street drugs.

3.3 Knowledge of Risky Behaviours

The knowledge of participants on risk factors associated with schistosomiasis is described in Table 3. Majority of the children 402 (97.6%) reported that they had toilets at home while 9 (2.2%) respondent preferred to defecate in backwater. Presence of stream or backwater in the neighborhood was reported by 324 (78.6%) while bathing and playing in the streams/ backwater were acknowledged by 340 (82.5%) and 268 (65.0%) respondents respectively.

3.4 Prevalence, Distribution et Parasite Density of School Children

Prevalence and distribution of *Schistosoma haematobium* infection: Among the 412 participants, 8 were shedding eggs of *S. haematobium* in their urine, giving an urinary schistosomiasis (US) prevalence of 1.9%. Prevalence in schools ranged from 0.00% to 2.8%. The prevalence of US was highest in children recruited from E.P.B Alpha (2,8%) and E.P GP1 Gare (2,1%), while no infections were found in EPB la Paix. Sex-related prevalence showed that the females recorded higher prevalence 2,7% than the males 1.0% with no significant difference (*P*= .922). Age-related prevalence of US varied between 0% - 6%, with the age group 14-15 years having the highest (6%) with no significant difference between age groups (*P* =.05). The overall geometric mean ova intensity was 2.1 eggs/10 mL for *S. haematobium*. The intensity of infection with *S. haematobium* was higher in female (2.3 eggs/10 mL) than in male (1.5 eggs/10 mL). Two cases co-infection of *S. haematobium* and *S. mansoni* were found in EP GP2.

Prevalence and distribution of *Schistosoma mansoni* infection: Among the 412 participants, 32 were shedding eggs of *S. mansoni* in their stool, giving an intestinal schistosomiasis (IS) prevalence of 7.8%. Prevalence in schools ranged from .00% to 13.1%. The prevalence of IS was highest in children recruited from E.P.B Alpha (13,1%) and did not significantly varied between schools (*P* = .081). The prevalence of IS was higher in children above 14-15 years (14%) with a significant difference between age groups (*P* =.057). Sex-related prevalence showed that the males recorded higher prevalence (8,3%) than the females (7,3%) with no significant difference (*P* = .698). The overall geometric mean ova intensity was 94 EPG for *S. mansoni.* The intensity of infection with *S. Mansoni* was higher in male (88eggs) than in female (69 eggs).

The intensity of schistosomiasis infection among school children: Table 5 describes schistosomiasis infection intensity was classified according to the WHO guidelines [15] from light infection (light (1–99 epg), moderate (100–399 epg) to heavy (>400 epg). The infected children had only light infections for two species of *schistosoma*. the geometric mean parasite density was 2,1 ova/10 ml of urine of *S. haematobium* and 78 epg for *S. mansoni.*

The intensity of infection was higher in females with *S. haematobium* 2.3 ova/10 ml of urine than in males with 1.5 ova/10 ml of urine. Conversely, the intensity of infection of was higher in males (88 epg) with *S. Mansoni* than in females (69 epg). Few cases of mixed infection were observed. Children attending EPB Alpha had the highest parasite load (*S. mansoni*) compared to children from the other schools while children from EP GP1 and EP GP3 had the highest parasite load (*S. haematobium*).

Risk factors associated with schistosomiasis infection: Table 6 summarizes the prevalence schistosomiasis in relation to water contact activities of school-aged children in Njombé.

Assessment of risk factors indicated that, knowledge of schistosomiasis (OR=1.274(.610-2661), P=.51), presence of backwater in the neighbourhood (OR =2.390 (.823 - 6937), *P*=.139), contact with stream and backwater (OR =2.579 (.339 – 19.596) P=.495), playing in the stream and backwater (OR = 1.757 (.805 - 3837), *P*= .206), bathing in stream and backwater (OR = 1.800 (.617 – 5.253), *P* =.276), were not significantly associated with the risk of schistosomiasis. However, the prevalence of schistosomiasis was significantly associated with itching after bathing (OR = 2.427 (1.080 – 5.454), *P*=.03) and school children attending EPB Alpha (OR= 2.024), CI: 1.203 – 4.804, *P*=.011).

Malacological collection: During the malacological survey, a total of 20 snails were captured out of which 6 were intermediate hosts of human schistosomiasis (Table 6). Snails species were *Bulinus truncatus* and *Bulinus globosus* intermediate hosts of *S. haematobium* and *Biomphalaria pfeifferi*, intermediate host of *S. mansoni.*

3.5 Discussion

The study was aimed at assessing an update of the burden of schistosomiasis infection due to *Schistosoma species* in school children in Njombé, Littoral Region, Cameroon.

Our results showed an overall prevalence of 9.7% (40/412) of Schistosomiasis among school-going children aged 8–15 years in Njombé close to the pre-elimination threshold of 5%. The recorded prevalence in the study area can be classified as low-risk based on [21] WHO guidelines (2006). However, the persistence of schistosomiasis infection (48.5%) was reported by Kimbi [22] in Pupils of Kotto Barombi, Southwest Cameroon. The decline in the prevalence of schistosomiasis could be attributed to an annual distribution of praziquantel to school-aged children in schistosomiasis in highly endemic Health Districts in Cameroon since 2007 by the National Control Program for the Schistosomiasis and Soil-Transmitted Helminthiasis (NCPS/STH). Out of the 412 participants, our study indicated that females were the most affected (5.3%) than male (4.4%) even though the difference was not significant (P=.922). These findings are consistent with studies in South Africa [23] but contrary to that of Taha in Elkeriab and Tayba Elkababish villages, Sudan [24]. This could have been attributed to the fact that females than males have higher water contact activities such as bathing in streams and backwater, washing utensils and clothes and presence of streams and backwater in their proximity with exposed them to schistosomiasis infection. The prevalence of *S. haematobium* (1,9%%) was far lower than *S. mansoni* (7,8%) and *S. mansoni* prevalence was 4-fold higher. This is in line by the study in Cameroon [25] and Cote d' Ivoire [26]. In contrast, a study among children from five provinces in Yemen showed that *S. haematobium* was more prevalent than *S. mansoni* [27].

Table 2. Respondents who were aware of schistosomiasis by sex, age and school

Variables	Sex n (%)		Age group (year) n (%)				Primary school n (%)				
	Female n=220	**Male n=192**	**8 – 9 n=32**	**10 – 11 n=190**	**12 – 13 n=140**	**14 – 15 n=50**	**EPB Alpha n=107**	**EP GP1 n=95**	**EP GP2 n=118**	**EP GP3 n=49**	**EPB la Paix n=43**
Knowledge											
Heard about schistosomiasis	144(65.6)	126(65.6)	19(59.4)	118(52.1)	92(65.7)	41(82.0)	56(52.3)	65(68.4)	81(68.6)	49(100)	19(44.2)
Level of significance	X^2=.001	P=.97	X^2=7530	P= .05			X^2=44.553	P= .00			
Mode of transmission											
Drinking contaminated water	98(44.5)	77(40.1)	20(62.5)	88(46.3)	49(35.0)	18(36.0)	40(37.4)	25(26.3)	62(52.5)	23(46.9)	25(58.1)
Bathing in streams and backwater	102(46.4)	93(48.5)	8(25.0)	81(42.5)	87(61.7)	27(54.0)	45(42.1)	66(59.5)	42(35.6)	26(53.1)	16(20.4)
Sexual relationship	6(2.7)	5(2.6)	1(.2)	6(.9)	3(2.1)	1(2.0)	1(0.2)	3(3.2)	5(4.2)	0(.0)	2(4.7)
Drinking contaminated water/ Bathing	13(5.9)	15(7.8)	3(9.4)	14(7.4)	8(5.7)	3(6.0)	20(18.7)	1(.2)	7(5.9)	0(.0)	0(.0)
Drinking contaminated water/ Sexual	1(0.5)	2(1.0)	0(.0)	1(0.2)	1(0.7)	1(2.0)	1(.2)	0(.0)	2(1.7)	0(.0)	0(.0)
Level of significance	X^2=1607	P=.80		X^2=15789	P=.20		X^2=67.727	P= .00			
Signs and symptoms											
Bloody stool	110(50.0)	105(54.5)	11(24.4)	97(51.1)	76(54.3)	31(62.0)	47(43.9)	52(49.6)	59(50.0)	33(67.3)	24(55.8)
Level of significance	. X^2=.903	P= .34	X^2=6343	P= .09			X^2=8141	P= .08			
Haematuria	23(1.5)	**57(29.7)**	10(31.2)	42(22.1)	23(16.4)	5(10.0)	25(23.4)	12(12.5)	22(18.3)	9(18.4)	12(27.9)
Level of significance	X^2=24237	P= .00	X^2=7374	P= .06			X^2=5921	P= .20			
Itching after bath	130(59.1)	123(64.1)	**17(53.1)**	106(55.9)	93(66.4)	78(74.0)	65(61.7)	66(69.5)	54(45.9)	43(97.9)	24(55.9)
Level of significance	X^2=1069	P= .30	X^2=8292	P= .04			X^2=29720	P= .00			
Health seeking behaviour											
Hospital	80(35.4)	66(68.0)	15(46.9)	65(34.2)	51(36.4)	15(30.0)	180(16.8)	18(18.9)	41(34.7)	42(85.7)	27(62.9)
Traditional healers	1(.5)	0(.0)	0(.0)	1(.2)	0(.0)	0(.0)	0(0.0)	0(.0)	1(.9)	0(.0)	0(.0)
Street drugs	47(21.4)	33(17.2)	3(9.4)	28(14.5)	28(27.1)	11(22.0)	15(14.0)	29(30.5)	14(11.9)	15(34.9)	15(34.9)
Hospital/ Traditional healers	5(2.3)	3(1.5)	1(.2)	2(1.1)	4(2.9)	1(.2)	0(.0)	0(.0)	8(1.9)	0(.0)	0(.0)
Hospital /Street drugs	83(37.7)	86(44.8)	12(37.5)	89(46.8)	45(32.1)	23(46.0)	68(63.6)	48(50.5)	52(44.1)	1(.2)	1(.2)
Traditional healers/ Street drugs	3(1.4)	1(.5)	0(.0)	2(1.1)	2(1.4)	0(.0)	3(2.9)	0(.0)	1(.2)	0(.0)	0(.0)
Hospital/ Traditional healers/ Street drugs	1(.5)	3(1.5)	1(.2)	3(1.6)	0(.0)	0(.0)	3(2.9)	0(.0)	1(.2)	0(.0)	0(.0)
Level of significance	X^2=5458	P= .48	X^2=22664	P= .20			$X^2$163767	P= .00			

Table 3. Water contact activities of the subjects with respect to sex, age and school

Variables	Sex n(%)		Age group (years) n(%)				Primary school n(%)				
	Female n=220	**Male n=192**	**8 – 9 n=32**	**10 –11 n=190**	**12 – 13 n=140**	**14 – 15 n=50**	**EPB Alpha n=107**	**EP GP1 n=95**	**EP GP2 n=118**	**EP GP3 n=49**	**EPB Paix n=43**
Presence of stream / backwater in the neighbourhood	171(77.7)	153(79.7)	21(65.6)	152(80.0)	105(75.0)	46(92.0)	78(72.9)	83(87.4)	101(85.6)	42(85.7)	20(46.5)
Level of significance	X^2=0.235 P= .71		X^2=9 854 P= .02				X^2=37.691 P= .00				
Contact with streams and backwater	204(92.7)	182(94.9)	29(90.6)	175(92.1)	134(95.7)	48(96.0)	98(91.6)	94(98.9)	108(91.5)	48(98.0)	38(88.4)
Level of significance	X^2=0.739 P= .42		X^2=2.737 P= .43				X^2=9743 P= .04				
Toilet in the house	217(97.6)	185(96.4)	31(96.9)	195(97.4)	139(97.3)	47(94.0)	107(100)	93(97.9)	113(95.8)	49(100)	40(93.0)
Excrete into river	2(1.4)	6(3.1)	2(3.1)	5(2.6)	0(0.0)	3(0.7)	0(.0)	2(2.1)	4(3.4)	0(.0)	3(7.0)
Excrete into farm	0(.0)	1(.5)	0(.0)	0(.0)	1(.7)	0(.0)	0(.0)	0(.0)	1(.2)	0(.0)	0(.0)
Level of significance	X^2=2.357 P= .26		X^2=9.747 = .18					X^2=11.434 P= .17			
Farmed in swampy area	115(52.7)	95(49.5)	11(34.4)	92(48.4)	81(57.9)	27(54.0)	50(56.1)	60(63.2)	35(39.7)	30(61.2)	26(60.5)
Level of significance	X^2=0.433 P= .55		X^2=6.853 P= .07					X^2=31.813 P= .00			
Bathing in the streams and backwater	180(80.8)	160(83.3)	24(75.0)	149(78.4)	124(88.6)	43(86.0)	88(82.2)	89(93.7)	88(74.5)	41(83.7)	34(79.1)
Level of significance	X^2=.163 P= .69		X^2=7.443 P= .05				X^2=13779 P= .00				
Playing in the backwater / stream	124(56.4)	144(75.0)	15(46.9)	117(61.5)	98(70.0)	38(76.0)	54(50.5)	80(84.2)	81(68.6)	38(77.6)	15(34.9)
Level of significance	X^2=15.662 P= .00		X^2=9.802 P= .02				X^2=46598 P= .00				

Table 4. Prevalence, distribution et parasite density of school children

Variables	No examined		*S. mansoni*		*S. haematobium*		Co-infection *S. mansoni* / *S. haematobium*		Overall prevalence		ep 10 ml/epg	
	N	**(%)**	**N**	**(%)**	**N**	**(%)**	**N**	**(%)**	**N**	**(%)**	**ep10 ml**	**epg**
Sex												
Male	192	46,6	16	3.9	2	.5	1	0,2	18	4,4	1.5	105
Female	220	53,4	16	3.9	6	1.4	2	0,5	22	5.3	23	83
Total	412		32	7,8	8	1,9	3	0,7	40	9,7	21	94
Level of significance			X^2 = .161 P= .698		X^2 = 1.530 P= .216		X^2 = .210 P= .647		X^2 = .010 P= .922			
Age group	n	%	N	%	N	%	N	%	n	%	ep10 ml	epg
8 – 9	32	7,7	4	12,5	0	0	0	0	4	12,5	0	96
10 – 11	189	45,9	8	4,2	3	1,6	1	0,5	11	5,8	20	90
12 – 13	141	34,2	13	9,2	2	1,4	.0	.0	15	10,6	25	89
14 – 15	50	12,1	7	14	3	6	2	4	10	20	20	106
Total	412	100	32	7,9	8	1,9	3	0,7	40	9,7	21	94
Level of significance			X^2 = 7.518 P =.057		X^2 =5283 P = .152		X^2 = 8.749 P= .03		X^2 = 7.430 P = .05			
Primary school	n	%	N	%	N	%	N	%	n	%	ep10 ml	epg
EPB Alpha	107	26	14	13,1	3	2,8	1	.9	17	15,9	17	98
EP GP1	95	23	6	6,3	2	2,1	0	0	8	8,4	30	92
EP GP2	118	29	9	7,6	2	1,7	2	1,7	11	9,3	15	93
EP GP3	49	12	3	6,1	1	2	0	0	4	8,2	30	80
EPB la Paix	43	10	0	0	0	0	0	0	0	.0	0	0
Total	412	100	32	7,8	8	1,9	3	0,7	40	9,7	21	94
Level of significance			X^2 = 8311 P = .081		X^2= 1323 P =.858		X^2= 20958 P =.555		$X^{2=}$ 9410 P = .05			

Table 5. Intensity of schistosomiasis infection among school children

Classification of intensity	Type of infection					
	S. mansoni			*S. haematobium*		
	N	**%**	**Mean (epg)**	**N**	**%**	**Mean (ep 10 ml)**
Light	32	7,8	94	8	1,9	21
Moderate	-	-	-	-	-	-
Heavy	-	-	-	-	-	-
Total	32	7,8	94	8	1,9	21

Table 6. Bivariate analysis of factors associated with schistosomiasis among school children

Variable	No examined	Schistosomiasis		OR (95% CI)	P - value
		Infected	Non infected		
Knowledge of schistosomiasis					
Oui	270	26	244	1.274(.610 - 2661)	.51
Non	142	14	128		
Total	412				
Presence of backwater in the neighbourhood					
Oui	320	31	289	2.390 (.823 - 6937)	.139
Non	92	9	83		
Total	412				
Contact with stream and backwater					
Oui	384	36	348	2.579 (.339 – 19.596)	.495
Non	28	4	24		
Total	412				
Playing in stream and backwater					
Oui	271	29	242	1.757 (.805 - 3837)	.206
Non	141	11	130		
Total	412				
Contact with swampy area					
Oui	207	24	183	1.625 (.811 - 3256)	.173
Non	205	16	189		
Total	412				
Itching after bathing					
Oui	254	29	225	2.427 (1.080 - 5454)	.02
Non	158	11	147		
Total	412				
Bathing in stream and backwater					
Oui	388	37	351	1.800 (.617 – 5.253)	.276
Non	24	3	21		
Total	412				
Primary school					
EPB Alpha	107	16	90	2.024 (1.203 – 4.804)	.011
EP GP1	95	8	87	.910(.401 - 2063)	.821
EP GP2	118	9	109	.781(.357 - 1711)	.536
EP GP3	49	4	45	.886(.300 - 2619)	.827
EPB la Paix	43	0	43	1.130(1089 - 1172)	.029
Sex					
Male	192	17	175	.967(.491 – 1.904)	.922
Female	220	20	199		
Age group					
8 – 9	32	4	28	1.498(.495 - 4531)	.472
10 – 11	189	9	109	.399(.188 -.848)	.827
12 – 13	141	15	126	1.358(.681 – 2.709)	383
14 – 15	50	8	41	2.241(.960 – 5.238)	.056
Total	412				

The study also indicated that the prevalence of Schistosomiasis seems to increase with age and that is similar to study by Ismail [16] in Egypt and M'Bra in Cote d' Ivoire [26]. Prevalence was higher in the older age group (14–15 years old), however, showed no significant difference (P= .05). This may be due to the fact that children at this particular age groups are more involved in household chores, playing in backwater, and handpicking of snails for income generation in

Table 7. Distribution of snails by sites

Site	Snail intermediate host	Biotope
Mboualè	*Bulinus globosus*	Permanent lake
	Biomphalaria pfeifferi	Permanent lake
Tondè	*Bulinus truncatus*	Pool of water
	Biomphalaria pfeifferi	Pool of water
Yaoundé water	*Bulinus globosus*	Permanent lake

the family thus increasing the probability of having them in contact with water. Studies from snails monitoring indicated that transmission of schistosomiasis is seasonal and higher at the beginning and the end of raining seasons. The shedding of Cercariae by schistosomiasis intermediate host snails and subsequently schistosomiasis is much higher during these periods. The study has the merit to cover the beginning of the raining season. Even though the present study indicated a significant decrease in schistosomiasis in the school children, however, a recent study conducted in the general population of Penja, a focus few kilometres away, showed a persistent higher prevalence in the young adult and adults population [28]. This young adults' population might have been left out of the annual praziquantel mass administration to school children by the NPCS/STH.

Concerning schools selected, this present study showed that EPB Alpha had the highest prevalence of schistosomiasis and though the difference was significant. This might be due to the behaviour of the school children living at the proximity of contaminated water body and its usage for bathing, washing and swimming.

Njombé has witnessed a rapid urbanization in recent years, due to the presence of giant agro-industry such as Plantations de Haut Penja (PHP) and a very active smallholders' sectors that have embarked in the growing of pineapple, spices, cocoa, solo pawpaw, Consequently, this led to a decrease in the quality of social amenities in the area. It worth noted that, the presence of these agro-industrial establishments acts as a "population trap", pulling people from other parts of the country to take advantage of the opportunities available in these regions in terms of jobs and arable land to grow cash crops [29].

The prevalence of *S. hematobium* infection was 1.9% and ranged from 0.0% to 2.8% among school children. Interestingly, this reduction is down from 12% recorded by Tchuem Tchuenté [25]. In the present study, infection with *S. hermatobium* was observed to be higher in school children above 10 years of age. These observations are in line with that of Payne [28]. However, it contradicts the findings of Njunda [30] obtained in Magba, Cameroon. The findings of higher prevalence in children above 10 years of age could be attributed to the fact that these children are involved in fetching water and farming in swampy areas, thus increasing their water contact activities with contaminated water. The prevalence of *S. hematobium* was significantly higher in children who were Playing in the backwater / stream (*P*=.02). No significant association was observed between the prevalence of schistosomiasis infection and knowledge on the disease (P = .59).

Likewise, there was a significant reduction of the prevalence of *S. mansoni* in the school children from 64.0% recorded by Tchuem Tchuenté [25] down to 7.8% in the present study. The prevalence of *S. mansoni* increased with age. Prevalence was higher in the older age group of 14–15-year-old, which is in line with previous studies conducted in Cote d' Ivoire [26], but contradict that of Angora [30].

Infection intensity reflects the number of worms infecting the individual, and is a more reliable marker of treatment success [16]. According to the reports elsewhere in Cameroon, the intensities of *S. haematobium* were as high as 154.7 ova/ 10 ml of urine in Magba [30]. Also, the intensities of *S. mansoni* were 61.04 epg in Centre Region [25]. In the present study, all the infected children were considered to have light infection of both *S. haematobium* (EP10 < 50) and *S. mansoni* infections (EPG <100). The geometric mean parasite density was 2,1 ova/10 ml of urine of *S. haematobium* and 78 epg for *S. mansoni* respectively.

The sex-related parasitic load distribution shows that women (2.3 EP10 ml) were more infected with *S. haematobium* than men (1.5 EP10 ml). In contrast, the mean parasitic load of *S. mansoni* infection has shown that that males (105 epg) were more infected than females (85 epg). These data indicated that the intensities and prevalence of *S. haematobium* and *S. mansoni* infection in Njombé had decreased. This might reflect the impact of repeated mass distribution of praziquantel to the school children in the study area.

Several studies have documented that water contact activities such as fishing, bathing and farming were associated with an increased risk of *Schistosoma* infections. In the present study, the multiple regression analysis revealed that itching after bathing in backwater and school children attending EPB Alpha were predictors of schistosomiasis infection. Itching represents one of the early symptoms of the disease specifically when the cercariae penetrate the skin. At the entry point, the cercariae produce rashes which disappear within a couple of days. However, Presence of backwater in the neighbourhood, playing in stream and backwater, contact with the swampy area was not identified as a significant risk for schistosomiasis.

The distribution of the diseases caused by snail borne trematodes especially schistosomiasis is focal. Thus, the parasites distribution and presence is strongly tributary on the intermediate snail hosts distribution [31]. Interestingly, the malacological surveys of the Mbouale, Tondè et Yaoundé Water showed the presence of the snails *Bulinus globosus*, *Bulinus truncates,* and *Biomphalaria pfeifferi* (All intermediate host for *S. haematobium*) suggesting that transmission occurs primarily in these rivers. The number of *Snail spp.* were far lower than data obtained by Campbell [32] at Barombi Mbo and Barombi Kotto crater lakes and Tchouanguem [33] in Santchou Health District, Cameroon. However, similar intermediate hosts were identified in Malantouen district in Cameroon [33].

4. CONCLUSION

There was a drastic decline in the prevalence of schistosomiasis infection in school children in Njombé compared to previous reports. Implementation approach such as bi-annual mass drug administration may the key factor that has led to the drastic decline of schistosomiasis prevalence in Njombé. Other factors such as rapid urbanization and level of awareness through mass media were also considered as the major contributors. Limiting Contact with water bodies, provision of potable water, sustained mass treatment of at-risk populations, control of the snail intermediate host, are proposed measure to achieve schistosomiasis elimination in the study area.

5. LIMITATIONS

Three major limitations can be deduced from this cross-sectional survey. First, we collected and examined only one urine and stool samples which would have given a low sensitivity. Secondly, no snail host population structure and diversity using molecular biology techniques were carried out. Thirdly, children were recruited only from the six schools. The findings are, therefore, not generalizable to preschool, school-aged children not attending these primary schools and adults.

CONSENT AND ETHICAL APPROVAL

The protocol of the study was reviewed and approved by the Institutional Review Board of the University of Douala. Administrative authorization was obtained from the Regional Delegation of Basic Education for the Littoral Region. Informed assent and consent were obtained from children and parent/guardian of the children respectively. All the information obtained from each study participant was kept confidential. Children found positive for S. haematobium or S. mansoni were referred to Njombé Health District and treated with praziquantel according to the recommendation of the Cameroon Ministry of Public Health (adults, 50 mg/kg in a single oral dose, children ≤ 15 years old, 60 mg/kg in a single oral dose). Each participant was free to withdraw consent at any time.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. WHO. Schistosomiasis Fact Sheet N°115. 2014. World Health Organization. Geneva.
2. GBD 2017 DALYs and Hale Collaborators. Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease study. 2017. Lancet. 2018;392:1736–1788.
3. Davis A. Schistosomiasis, p 1425–1460. In Cook GC, Zumla AI (ed), Manson's tropical disease, 22nd ed. Saunders Elsevier, Edinburgh, United Kingdom; 2009.
4. Scott JS, De Leo GA, Wood CL, Sokolow SH. Infection with Schistosome parasites in snails leads to increased predation by prawns: Implications for human schistosomiasis control. Jl Exp Biol. 2015; 218:3962-3967.
5. Rollinson D, Knopp S, Levitz S, Stothard JR, Tchuem LA, Tchuente A, Garba KA, Mohammed N, Schur B, Person D, Colley G, Utzinger J: Time to set the agenda for schistosomiasis elimination. Acta Trop. 2013;128(2):423–444.
6. Ebai CB, Kimbi HK, Sumbele IUN, Yunga JE, Lehman LG. Prevalence and risk factors of urinary schistosomiasis in the Ikata-Likoko Area of Southwest Cameroon. Int J of Trop Dis & Health. 2017;17(2):2-16.
7. Tchuem Tchuenté LA, Dongmo NC, Ngassam RIK, Feussom GN, Dankoni, E, Kenfack, CM, Gipwe, NF, Akame, J, Tarini, A, Zhang Y, Angwafo III FF. Mapping of schistosomiasis and soil transmitted helminthiasis in the regions of Littoral, North-West, South and South-West Cameroon and recommendations for treatment. BMC Infect. Dis. 2013;13:602.
8. BUCREP (Bureau Centrale De Recensement et D'etudes de la Population). 2010 Census Results for Cameroon; 2010.
9. WHO. PCT Databank for Schistosomiasis. Available:<http://www.who. int/ neglected_diseases/ preventive_chemotherapy/ sch/en/>
10. CARBAP African Research Centre for Banana and Plantains. Climatic data for Mbanga, Njombe, Penja and Loum. Njombe-Cameroon; 2009.
11. Plan Communal de Developpement de Penja. Programme national de developpement participatif (PNDP) and Gic appui au developpement integral(ADI) ; 2012.
12. Swinscow TDV, Campbell MJ. Statistics at square one, 1-th edition. London: BMJ Books. 1997;2th Edition 2.344
13. NPCS/STH (2005), National Programme for the Control of Schistosomiasis and Soil Transmitted Helminthiasis stratégic Plan 2005 – 2010. 2005;92.
14. WHO Stool examination kit; Kato-Katz technique cellophane faecal thick smear; 1996.
15. WHO The prevention and control of schistosomiasis and soil transmitted helminthiasis. Report of a WHO Expert Committee. Geneva, WHO Technical Report; 2002. Series No.912.
16. Cheesbrough M. Clinical features and pathology of *schistosoma.* Medical Laboratory Manual for Tropical Countries (2nd Edition*).* 1:331. Cambridge University Press; 2002.
17. Ismail HAHA, Hong S-T, Babiker ATEB, Hassan RMAE, Sulaiman MAZ, Jeong H-G, Kong W-H, Lee S-H, Cho H-I, Nam H-S, Oh SN, Lee Y-H. Prevalence, risk factors, and clinical manifestations of schistosomiasis among school children in the White Nile River basin, Sudan. Parasit & Vectors. 2014;7:478.
18. Dabo A, Diarra AZ, Machault V, Touré O, Niambélé DS, Kanté A, Ongoiba A, Doumbo O. Urban schistosomiasis and associated determinant factors among school children in Bamako, Mali, West Africa. Infect Dis of Poverty. 2015;4:4.
19. Nguele KK, Kalu EO, Ukwe MC, Onyeuwu CN. A survey of freshwater snails: The intermediate hosts of schistosomiasis in bende L.G.A., Abia State Nigeria., Intl J Sci and Nature. 2004;3:879-882.
20. Mandahl – Barth G. Identification Key to East and Central African Freshwater Snails, World Health Organization. 1962; 27:135–15.
21. WHO Preventive Chemotherapy in Human Helminthiasis: Coordinated Use of Anthelminthic Drugs in Control Interventions: A Manual for Health Professionals and Programme Managers; World Health Organization: Geneva, Switzerland. 2006;1–62.
22. Kimbi HK, Wepnje GB, Anchang-Kimbi J, Tonga C, Ayukenchengamba B, Njabi C, Nono LK, Nyabeyeu NG, Lehman G. Active Case Detection and Prevalence of Urinary Schistosomiasis and Malaria in

Pupils of Kotto Barombi, Southwest Cameroon Using the CyScope® Fluorescence Microscope. Intl J Trop Dis & Health. 2015;8:1-12.
23. Kabuyaya M, Chimbari MJ, Manyangadze T, Mukaratirwa S. Efficacy of praziquantel on Schistosoma haematobium and re-infection rates among school-going children in the Ndumo area of uMkhanyakude district, KwaZulu-Natal, South Africa. Infect Dis Poverty. 2017;6:83.
24. Taha QH, Elshazali OH, Ahmed AI. Distribution of urinary schistosomiasis among school children at Elkeriab and Tayba Elkababish villages, East Nile Locality, Khartoum State, Sudan. J Pediatr Neonatal Care. 2019;9:117–119.
25. Tchuem Tchuente´ LA, Kuete´ Fouodo CJ, Kamwa Ngassam RI, Sumo L, Dongmo NC, Kenfack CM, Gipwe NF, Nana ED, Stothard JR, Rollinson D. Evaluation of Circulating Cathodic Antigen (CCA) Urine-Tests for Diagnosis of *Schistosoma mansoni* Infection in Cameroon. PLoS Negl Trop Dis. 2012;6.7:e1758.
26. M' Bra RK, Kone B, Yapi YG, Silué KD, Sy I, Vienneau D, Soro N, Cissé G, Utzinger J. Risk factors for schistosomiasis in an urban area in northern Côte d' Ivoire. Infect Dis Poverty. 2018;7:47-50.
27. Sady H, Al-Mekhlafi HM, Mahdy MAK, Lim YAL, Mahmud R, Prevalence and Associated Factors of Schistosomiasis among Children in Yemen: Implications for an Effective Control Programme. PLoS Negl Trop Dis. 2013;7(8):e2377.
28. Payne VK, Tathio S, Megwi L, Ngangnang GR, Yamsi C, Tanefo CJO, Nkouayep VR. Influence of some demographic factors on infection of schistosomiasis: The Case of Njombe-Penja Population, in the Littoral Region of Cameroon. Cent Afric J Public Health. 2019;3:113-119.
29. Forba FC, Kimengsi JN. An empirical analysis of the relationship between plantation development and Urbanization in the Mungo Corridor of Cameroon. GJEMPS. 2015;4:1001-1008.
30. Njunda AL, Ndzi EN, Assob JCM, Kamga LFH, Kwenti TE. Prevalence and factors associated with urogenital schistosomiasis among primary school children in barrage, Magba sub-division of Cameroon. BMC Public Health. 2017;17:618–622,4539-6.
31. Gordy MA, Kish L, Tarrabain M, Hanington PC. A comprehensive survey of larval digenean trematodes and their snail hosts in central Alberta, Canada. Parasitol Res; 2019.
32. Campbell SJ, J Stothard R, O'Halloran F, Sankey D, Durant T, Ombede DE, Chuinteu GD, Webster BL, Cunningham L, LaCourse EJ, Tchuem-Tchuenté LA. Urogenital schistosomiasis and soiltransmitted helminthiasis (STH) in Cameroon: An epidemiological update at Barombi Mbo and Barombi Kotto crater lakes assessing prospects for intensified control interventions. Infect Dis Poverty. 2017;6:49.
33. Tchouanguem HN, Fouelifack FY, Keugoung B, Fouelifa LD, Moyou RS. Current status of schistosomiasis in Santchou health area, (Santchou Health District, Cameroon western region). Pan Afri Med J. 2016;24:137.

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