

Original Research Article

Prevalence and Risk factors of Urinary Schistosomiasis in the Ikata-Likoko area of southwest Cameroon

ABSTRACT

Aims: This study aimed at determining the prevalence, parasite density and risk factors associated with urinary schistosomiasis (US) in the Ikata-Likoko area, Cameroon.

Study design: It was a cross sectional study

Study site and duration: The study was carried out in the Ikata-Likoko area, Cameroon from June to July 2014.

Materials and methods: The study included 516 participants of both sexes aged 2-76 years. A structured questionnaire was used to collect information on socio-demographic data, clinical history of the disease and environmental factors concerning potable water supply in the community. Urine samples were collected to detect and quantify *Schistosoma haematobium* eggs using the filtration method. (Indicate statistical parameter used for sample analysis)

Results: The overall prevalence and parasite density of US were 34.3% and 30.44 eggs/10mL of urine respectively. US prevalence was significantly ($V=0.252$, $P\leq.001$) highest in Mile 14 (48.3%) and least in Bafia (18/0%) while egg load per 10mL of urine was significantly ($H=8.283$, $P=.041$) highest in Bafia (50, range: 1-400) and least in Kikoko (20, range: 1-200). Risk factors associated with US included: locality (OR: 4.370 95%CI: 2.424-7.881, $P\leq.001$), haematuria (OR: 7.387 95%CI: 3.087-17.681, $P\leq.001$), river as source of tap water (OR: 1.364 95%CI: 0.623-2.985, $P=.001$), lesser number of used water bodies (OR: 1.137 95%CI: 0.397-3.255, $P=.041$). The presence of tap water (OR: 0.690 95%CI: 0.477-0.998, $P=.026$) was found to be protective against US.

Conclusion: Ikata-Likoko area is endemic for US. Provision of pipe borne water, and inclusion of all age groups in control strategies may reduce the prevalence of the disease in this area.

Keywords Urinary schistosomiasis, prevalence, risk factors, Ikata-Likoko, parasite density

1. INTRODUCTION

Schistosomiasis is the second most common parasitic disease on the globe [1]. Blood flukes of the genus *Schistosoma* are responsible for the disease which occurs in two forms: intestinal schistosomiasis caused by *S. mansoni*, *S. japonicum* and *S. intercalatum*; and urinary (urogenital) schistosomiasis (US) caused by *Schistosoma haematobium* [2, 3].

It is estimated that 20,000-200,000 people die of schistosomiasis each year [4]. Globally, up to 261 million people required treatment for schistosomiasis in 2013, but only 40 million received it [4]. WHO (2014) reported that, up to 3,308,582 people required treatment against the disease in Cameroon and 2,818,604 people were treated.

A study on primary school children showed an average prevalence of 9.3% urinary schistosome infection in the South West Region of Cameroon [5] although the prevalence could be higher where the disease foci exist. Studies in some foci in the same region reported prevalence values of 78% and 40.27% in Munyenge [6,7] and 43.3% in Kotto Barombi [8]. The Ikata-Likoko area is a locality in the Mount

Cameroon area where environmental and socio-economic characteristics are likely to favour the transmission of Schistosomiasis. The disease has been associated with a poor socio-economic status and is reported to occur in areas where people make constant contact with cercariae infested water bodies due to ready supply of pipe borne water [1]. People get infected when the infective cercarial larva shed by infected Bulinus snail host penetrates the skin during contact with water [9, 10].

So far the major control measure for the control of US in Cameroon is the current community directed strategy based on the distribution of praziquantel to school children as advocated by WHO and other non-governmental partners. However, this strategy usually leaves out individuals who are not of school going age and so individuals leaving in communities in foci of the disease without pipe borne water like the Ikata-Likoko area are continually exposed to infection.

Prevailing environmental conditions such as presence of streams especially near homes, climatic conditions such as high rainfall, occupations such farming and fishing as well as inaccessibility to health care services and a seemingly low level of education of the inhabitants of the Ikata-Likoko area could put them at risk of US. Although reports have been made on US in other foci around the Mount Cameroon area, none has specifically focussed on the Ikata-Likoko area. Against this background, the aim of this study was to determine the prevalence, parasite density and risk factors of US in the Ikata-Likoko area.

Findings from this study will be of additional value for the study area in particular (expunge) and the country as a whole and thus help the Health policy makers in the control strategies in the country especially in foci of the disease.

2. MATERIAL AND METHODS

2.1 Study area

The study was carried out in the Ikata-Likoko area which is comprised of four rural communities Ikata, Bafia, Mile 14 and Likoko of the Muyuka Health District of Southwest Cameroon. Mile 14 and Likoko communities make up one village, but are separated by a distance of about two kilometres. Ikata is located between longitudes 9.363 and 9.352, latitudes 4.329 and 4.328 and between 87m and 132m above sea level. Bafia is between longitudes 9.324 and 9.311, latitudes 4.350 and 4.363 and is 229m to 256m above sea level. Mile 14 is located between longitudes 9.302 and 9.292, latitudes 4.396 and 4.401 and between 157m and 168m above sea level. Likoko is located between longitudes 9.319 and 9.320, latitudes 4.399 and 4.393 and is between 108m and 116m above sea level. Access to these villages from Muyuka is through an untarred, stony road that is usually muddy and sometimes impassable in the rainy season. In the dry season, it is dusty with several potholes. The topography of the area is characterized by hills and valleys. Most of the valleys are riverbeds that overflow their banks in the rainy season. Rainfall averages 3126.7mm annually while temperatures vary between 23°C and 33°C with an annual average of about 26.2°C. Two major seasons exist in the area, the rainy (March to October) and the dry (November to February) seasons. The vegetation is mainly the tropical forest type. The main occupation here is farming with cocoa as the main cash crop. Each of the villages has a primary school. Bafia and Ikata have a secondary school and a government owned Integrated Health Centre (IHC) each. Bafia has another health centre put in place by the Cameroon Baptist Convention. The main religion practised is Christianity. Likoko and Bafia have pipe-borne water, though not all parts of the villages are connected to it, besides its supply is limited to part of the rainy season. All the villages have streams which are used by the populations for their daily needs even where tap water is available.

2.2 Study population

Participants in this study were inhabitants of Ikata, Bafia, Mile 14 and Likoko villages of the Muyuka Health District in the South West Region of Cameroon who had spent at least two months in the study area and were at least one year old.

73 2.3 Study design

74 This cross sectional survey was carried out between June and July 2014. After obtaining administrative
75 and ethical clearances, visits to the village authorities permitted us to explain the procedures, benefits of
76 the study as well as plan, dates and collection sites for the study. A structured questionnaire was used to
77 collect data on socio-demographic, clinical and risk factors of US. Urine samples were collected and
78 transported to the Malaria Research Laboratory of the University of Buea for parasitological analyses.

79 2.4 Ethical approval

80 An ethical approval was obtained from the University of Buea Faculty of Health Sciences Institutional
81 Review Board after an administrative authorisation had been obtained from the Regional Delegation of
82 Public Health for the South West Region, Cameroon. Authorisation was also obtained from the village
83 heads. Informed consent forms carrying information about the procedures were issued on the spot during
84 the study and only those who gave their consent were admitted into the study. Assent for minors was
85 approved by parents or legal guardians. All participants who were positive for US were freely treated with
86 praziquantel tablets except pregnant women who were referred to the Muyuka District Hospital for
87 adequate care.

88 2.5 Administration of questionnaire

89 A structured questionnaire was used to collect data on the socio-demography, clinical history of the
90 participants and factors that influence endemicity of US. Socio-demographic data included age, sex,
91 highest level of educational attainment, religion and profession. The clinical history comprised of signs
92 and symptoms of urinary schistosomiasis. These included, abdominal pains, urine colour, haematuria and
93 dysuria. Factors that influence the prevalence and endemicity of US were; supply of tap water, source of
94 tap water, site of bathing, number of water bodies used in the locality and distance from the nearest
95 stream used. A case report form was used to record clinical parameters and laboratory results.
96 Questionnaires were administered in English and exceptionally in Pidgin English where necessary.

97 2.6 Sample collection

98 Labelled 50mL containers were given to participants for the collection of urine samples. Urine collection
99 was done between 10am and 2pm which is the period corresponding with the peak excretion of
100 schistosome eggs [11]. Immediately after collection, the samples were tested for blood (haematuria)
101 using urine test strips (Medi test Combi 9). The urine containers were properly corked and transported in
102 cool boxes to the Malaria Research Laboratory of the University of Buea.

103 2.7 Laboratory analyses

104 Ten (10) mL of each urine sample were analysed for Schistosoma haematobium eggs using the syringe
105 filtration method [11]. Filtration was done by passing 10mL of urine through a filter (STERLITECH
106 Corporation USA) which retains the schistosome eggs. The filter was placed on microscope slide and
107 examined under x10 objective. The number of eggs counted was reported per 10ml of urine. Eggs
108 detected were tested for viability by adding a drop of methylene blue on every positive slide. Viable eggs
109 remained colourless while non-viable eggs are stained blue [11].

110 2.8 Statistical analysis

111 Data was entered into Excel version 2013 and analysed using IBM Statistical Package for Social
112 Sciences (IBM SPSS) version 20 (IBM Inc. 2012). Data was summarised into proportions and means.
113 Proportions were compared using the Cramer's V, the Mann-Whitney U test was used to compare mean
114 egg loads for two groups whereas the Kruskal-Wallis H test was used to compare mean egg loads of
115 more than two groups. The logistic regression model (LRM) was used to determine risk factors of urinary
116 schistosomiasis. The level of significance was set at $P < .05$.

3. RESULTS

3.1 Socio-demographic characteristics of the study population

From the four localities in the Ikata-Likoko area, 516 participants were admitted into the study (Bafia: 122, Ikata: 126, Likoko: 117, Mile 14: 151). Out of this 273 (53%) were females while 243 (47%) were males. The age range was 2-76 years with a mean age of 23.8±17.5 years. A majority of the participants (299, 57.9%) had completed primary school and just 3 (0.6%) had attained tertiary education. In terms of occupation, most of the participants (259, 50.2%) were pupils/students, while 23 (4.5%) were housewives (Table 1). Overall, (34.3%) of the participants where were positive for *S. haematobium* eggs with an overall mean egg load per 10mL of urine of 30.44 (range: 1-400). All eggs detected were viable. None of the participants had taken anti-schistosomal treatment before before the commencement of the study.

Table 1: Baseline characteristics of the study population

Characteristic	Category	Frequency/Value	Percentage (%)
Sex	Male	243	47
	Female	273	53
Age group (years)	<5	71	13.8
	5-15	151	29.3
	>15	294	57
Mean age±SD ^a (years)		23.8±17.5	
Prevalence of <i>S. haematobium</i>		177	34.3
Overall mean egg load/ 10 mL of urine		30.44 (range:1-400)	
Highest level of school attainment	No formal education and primary	382	75
	Secondary and tertiary	134	25
	Semi-skilled workers	30	5.8
Occupation	Babies/children	9	1.7
	Farmers	195	37.8
	Housewife	23	4.5

	Pupils and students	259	50.2
	Christianity	513	99.4
	Islam	1	0.2
Religion	None	2	0.4

a: standard deviation

3.2 Prevalence and density of *Schistosoma haematobium* with respect to socio-demographic factors

The prevalence of urinary schistosomiasis was comparable among all age groups ($V=0.03$, $P=.76$) in the study population. The mean egg load per 10 mL of urine was highest in the <5 years age group (40, range: 1-300) while that of the >15 years age group (25, range: 1-400) was the least, but the difference was not statistically significant ($H=4.07$, $P=.13$). Prevalence and parasite density were also comparable for gender, level of education and occupation.

With respect to localities, a significant statistical difference in prevalence ($V=0.252$, $P<.001$) was recorded and the highest prevalence of *S. haematobium* was recorded in Mile 14 (48.3%) while the least was recorded in Bafia (18%). On the contrary, the parasite density was significantly highest ($H= 8.283$, $P=.04$) in Bafia (50, range: 1-400) while the least was in Likoko (20, range: 1-200) as shown in Table 2.

Table 2: Prevalence and parasite density of *S. haematobium* in the Ikata-Likoko area of southwest Cameroon

Characteristics	Category	Number of participants examined	%Prevalence(n)	Egg load/10mL of urine(Range)
Age group (years)	<5	71	36.6(26)	40(1-300)
	5-15	151	35.8(54)	36(1-200)
	>15	294	33.0(97)	25(1-400)
Level of significance		$V=0.032$, $P=.765$		$H=4.07$, $P=.130$
Sex	Male	243	35.4(86)	33(1-400)
	Female	273	33.3(91)	28(1-300)
Level of significance		$V=0.022$, $P=.623$		$U=3721.50$, $P=.573$
Highest level of school attainment	No formal education and primary	382	34.6(132)	31(1-400)

	Secondary and tertiary	134	33.6(45)	30(1-200)
Level of significance		V=0.009, P=.838		U=2676.50, P=.321
Occupation	Semi-skilled worker	30	23.3(7) 7(23.3%)	15(4-50)
	Farmer	195	33.8(66)	25(1-400)
	Housewife	23	26.1(6)	30(5-50)
	Pupil/student	259	36.7(95)	34(1-300)
Level of significance		V=0.076, P=.564		H=4.407, P=.319
Locality	Bafia	122	18.0(22) 22(18.0)	50(1-400)
	Ikata	126	27.0(34) 34(27.0)	48(2-300)
	Likoko	117	41.0(48) 48(41.8)	20(1-200)
	Mile 14	151	48.3(73)	23(1-50)
Level of significance		V=0.252, P<.001		H=8.283, P=.041

V: Cramer's V test; H: Kruskal-Wallis test; U: Mann-Whitney U test.

Authors should review tables accordingly

3.3 Risk factors of Urinary schistosomiasis

Logistic regression analysis within socio-demographic, clinical and environmental factors showed the risk factors associated with urinary schistosomiasis in this area (Table 3). Mile 14 with the highest prevalence depicted locality as a risk factor of *S. haematobium* (48.3%) (48.3%, OR: 4.37, 95%CI: 2.42-7.88, $P \leq .001$). With respect to clinical factors, prevalence of US was significantly higher among individuals without lower abdominal pain (37.9%) (37.9%, OR: 0.640, 95%CI: 0.26-1.57, $P=.022$) than their counterparts with the pain (29.6%). Prevalence of US was significantly higher in participants with haematuria (100%) (100%, OR: 7.39, 95%CI: 3.08-17.68, $P=.000$) than those who did not present with haematuria (23.1%). With reference to environmental factors, individuals who did not have tap water within their vicinities had a significantly higher prevalence of US (38.1%) (38.1%, OR: 0.690, 95%CI: 0.47-0.99, $P=.026$) than those who did (29.8%). In like manner, the prevalence of US varied significantly with source of tap water as participants with the stream as source of tap water were the most infected with *S. haematobium* (100%) (100%, OR: 1.36, 95%CI: 0.62-2.98, $P=.001$). US prevalence was significantly higher among individuals who use ≤ 3 water bodies (35.3%) (35.3%, OR: 1.137, 95%CI: 0.397-3.255, $P=.041$) as compared with those who use more than 3 water bodies (32.8%).

Table 3: Risk factors of urinary schistosomiasis in the Ikata-Likoko area of southwest Cameroon

Factor	Category	Number of participants	Prevalence (n)	OR (95% CI)	P-Value (LRM)
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Socio-demographic factors					
Sex	Male	243	35.4% (86)	1.386 (0.624-	0.423
	Female	273	33.3% (91)	3.078)	
Age	<5	71	36.6% (26)	0.924 (0.437-	.837
	5-15	151	35.8% (54)	1.954)	
	<15	294	33.0% (97)		
Highest level of school attainment	No formal education and primary	382	34.6% (132)	1.037 (0.392-	.941
	Secondary and tertiary	134	33.6% (45)	2.742)	
	Semi-skilled worker	30	23.3% (7)		
Occupation	Farmer	195	33.8% (66)	0.903 (0.556-	.680
	Housewife	23	26.1% (6)	1.465)	
	Unemployed	259	36.7% (95)		
	Bank student	22	18.0%		
Locality	Ikata	126	27.0(34)	4.370(2.424-	≤.001
	Lykoko	117	41.0(48)	7.881)	
	Mile 14	151	48.3(73)		
Clinical factors:					
Dysuria	Yes	120	30.0% (36)	0.510 (0.169-	.262
	No	392	35.7% (140)	1.539)	
Lower abdominal pain	Yes	206	29.6% (61)	0.640 (0.261-	.022
	No	306	37.9% (116)	1.569	
Urine colour	Black	6	33.3% (2)	1.496 (0.951-	.081
	Colourless	12	33.3% (4)	2.354)	
	Brown	4	50.0% (2)		
	Red	64	39.1% (25)		
Haematuria	Yellow	429	33.6(144)	7.387(3.087-	≤.001
	Positive	60	100% (60)	17.681)	
	Negative	429	23.1% (99)		
Environmental factors					
Presence of tap water	Yes	235	29.8%(70)	0.690 (0.477-	.026
	No	281	38.1% (107)	0.998)	

Knowledge of source of tap water	Yes	218	30.7 (67)	0.801(0.065-	.863
	No	17	17.6 (3)	9.938)	
Source of tap water	Spring	97	42.3% (41)		.001
	Borehole	109	19.3% (21)	1.364 (0.623-	
	River	3	100% (3)	2.985)	
	Stream	9	22.2% (2)		
Number of water bodies used	≤3	380	35.3% (134)	1.137 (0.397-	.041
	>3	122	32.8% (40)	3.255)	
Site of bath	House	132	20.5% (27)	1.277 (0.233-	.576
	Stream	384	39.1% (150)	7.308)	
	<100	199	27.7(33)		
Distance to nearest stream used (m)	100-499	176	38.1(67)		.412
	500-1000	70	32.9(23)	1.344(.649-2.782)	
	>1000	81	35.8(29)		

4 Discussion

Urinary schistosomiasis like other neglected tropical diseases exerts a great burden on public health and affects especially populations with low socio-economic status in rural communities. It has a focal distribution due to prevailing environmental factors that favour the development of its snail intermediate host. Control measures could be more effective if the particularities of the disease in a focus are established.

The overall prevalence of *S. haematobium* in this study was 34.3% and the mean egg load was 30.44 (range: 1-400) eggs/10mL of urine. This prevalence is lower than those recorded in other parts of southwest Cameroon [7-8,12-14] (Provide the value). Only the studies by Ntonifor et al. [7] and Kimbi et al., [8] reported prevalence values less than 50%. The trend in the prevalence with respect to these studies shows a general decrease in prevalence over time. It is worth noting that in 2007, Cameroon launched a nationwide deworming program using praziquantel that targeted school children and it is done periodically. This might have helped to reduce the endemicity of the infection in the general population and consequently transmission rates. The mean egg load was higher in this study than in the previous studies. It is likely that exposed individuals make several contacts with the source of infection resulting in repeated infections and thus high egg loads.

With respect to sex, although the prevalence and egg load of US was higher in males (Provide value) than females (Provide value), the difference was not significant. The slightly higher prevalence in males could be due to the fact that they carryout fishing in the streams and equally accompany their fathers to fetch water from the streams and spray their cocoa. The contact with the streams exposes them more to infection with cercariae. This observation is different from that of other findings in the southwest of Cameroon [7,8] where prevalence was higher in females than in males (Provide value). Other studies in the country [5] and elsewhere including Geleta et al, [15] in Ethiopia and Sady et al [16] in Yemen have however reported similar results with higher prevalence in males (Provide value).

Although the difference was not significant, the highest prevalence and the highest mean egg load were however recorded among children <5 years (Provide value). Given that in the study area, streams are quite near houses and schools as is the case with Mile 14 and Ikata, children often go playing in the streams and are at greater risk of infection. Varied results have however been reported with respect to age, highest prevalence and infection intensities have not shown a particular pattern both locally and elsewhere. Locally, within south west Cameroon, Sama et al, [17] reported highest prevalence and parasite density

among children 10-14 years (Provide value); whereas Ntonifor et al [6] observed highest prevalence among children 9-12 years. Kimbi et al. [8] reported highest prevalence among children ≥ 11 years while children ≤ 6 years presented with the highest parasite density. Elsewhere, Oniya and Jeje, [18] in a study in Nigeria reported the highest prevalence among children 11-15 years, whereas Chipeta et al [19] in a study in Malawi reported highest prevalence and parasite density among children 6-15 years.

Individuals with no formal or primary education had higher prevalence and parasite density than their counterparts who had attained secondary or tertiary education though the difference was not significant. Current distribution of praziquantel by health authorities in the country targets only school children, leaving others out of this group with no possibility of receiving treatment and consequently an increase in prevalence among them.

Although there was no significant difference between participants of different occupations, the highest prevalence and mean egg load was observed in pupils and students (Provide value). The necessity for water in order to prepare for school and household chores may cause this group of individuals to be in greater contact with water on a daily basis [20]. This group of children is known to spend time on recreational activities such as swimming which exposes them to infection by cercariae [1]. Also, farmers who were the second most infected group had the highest egg load (up to 400 eggs/ 10 mL urine). It is known that most of the farmers in the area produce cocoa and use water from the streams to spray the cocoa which is the main cash crop in the area. This increased frequency of contact with the stream is likely to lead to an increased transmission rate and consequently an increase in the infection rate as well as the egg load. This observation is similar to that reported by Bala et al. [21] in Abama District in Nigeria.

With respect to localities, the prevalence of US was significant highest in Mile 14. This might have been as a result of the complete absence of tap water and health facility in the locality, leaving the inhabitants with the streams as the main source of water and self-medication or traditional healers as a source of health care. Reports from a study in Senegal by Senghor et al [22] also found a significant variation in US prevalence between localities.

Logistic regression analyses revealed that demographic, clinical and environmental factors were associated with US in the Ikata-Likoko area.

Demographically, village of residence notably Mile 14 was associated with US, this could be explained by the prevailing environmental characteristics that are peculiar in a locality including climatic conditions, presence of water bodies and closeness of water bodies to residents and schools.

Clinically, haematuria was associated with US. This is a common manifestation of chronic US and an indication that the detection of haematuria is a fair measure for the diagnosis of US as demonstrated by Ibironke et al. [23]. (Authors did not provide the value in Mile 14 to justify their claim and, also, relate it to other reference value to establish their claim).

The presence of tap water was a protective factor against US as individuals without access to tap water had a significantly higher prevalence of US than those without access to tap water. The absence of tap water could eventually expose inhabitants to cercariae since there is increased contact with the streams. Similar observations were made in some Nigerian communities by Ladan et al. [24] and in Niakhar District of Senegal by Senghor et al. [22] where significantly higher prevalence of US were reported among people with no access to tap water (Authors did not provide reference value of the quoted authors to justify their claim).

The prevalence of US varied significantly with the source of tap water with individuals using river as source of tap water showing significantly the highest prevalence as compared with other sources. Using river as the source of tap water in rural communities might have been the only source available or closest to the population and so they could also use it for their daily activities such as bathing, washing of kitchen utensils and clothes, fishing and swimming and they eventually eventually get exposed to the cercariae.

The significantly higher prevalence of US among individuals who use lesser number of water bodies could be explained by an increase activity in these water bodies due to fewer choices whereas with more water bodies the activity in each water body is likely to reduce as well as the contamination and transmission rates.

Some limitations of the study include the fact the analyses of these data depended on only one specimen per participant. Considering that the egg release rate of schistosomes is generally irregular [11], there is a possibility that some infections might have been missed. Some participants were unable to give up to 10mL of urine, this was compensated for by dividing the number of eggs in a positive case and multiplying the value by 10.

5Conclusion

Urinary schistosomiasis is endemic in the Ikata-Likoko area considering the high prevalence and its associated clinical manifestations recorded in this study. The relatively higher mean egg load recorded in this study than those reported in neighbouring areas gives a picture of a possible focus for the disease. The provision of tap water, health care facilities in all the villages and the distribution of praziquantel treatment to all age groups alongside community awareness campaign may significantly reduce the prevalence of the disease in this area. (Authors should include study limitation here)

INFORMED CONSENT

All participants gave their informed consent before being admitted into the study. Minors were admitted into the study only after the assent of their parents or legal guardians.

ETHICAL APPROVAL

Ethical approval was obtained from the University of Buea Faculty of Health Sciences Institutional Review Board after an administrative authorisation had been obtained from the Regional Delegation of Public Health for the South West Region, Cameroon.

REFERENCES

1. World Health Organisation. Schistosomiasis: Control and Preventive Chemotherapy. 2014; Accessed 05 January 2015. Available: <http://www.who.int/schistosomiasis/strategy>.
2. De Clercq D, Rollinson D, Diarra A, Sacko M, Coulibaly G, Landouré A, et al. Schistosomiasis in Dogon country, Mali: identification and prevalence of the species responsible for infection in the local community. Trans R Soc Trop Med Hyg. 1994;88(6):653-6.
3. Cunin P, Tchuem Tchuente LA, Poste B, Djibrilla K, Martin PMV. Interactions between Schistosoma haematobium and Schistosoma mansoni in humans in north Cameroon Trop Med Int Health 2003;8(12):1110–1117.
4. World Health Organisation. Schistosomiasis: A major public health problem. 2015; Accessed 08 February 2016. Available: <http://www.who.int/schistosomiasis/en/>.
5. Tchuem-Tchuente LA, Kenfack CM, Gipwe NF, Dankoni E, Tarini A, Zang Y. Mapping of Schistosomiasis and Soil transmitted Helminthiasis in Cameroon. BMC Infectious Disease 2013;13:602.
6. Ntonifor HN, Mbunkur GN, Ndaleh NW. Epidemiological Survey of Urinary Schistosomiasis in some Primary Schools in A New Focus Behind Mount Cameroon, South West Region, Cameroon. E. Afr Med J. 2012; 89(3):82-88
7. Ntonifor HN, Green AE, Bopda MOS, Tabot JT. Epidemiology of Urinary Schistosomiasis and Soil Transmitted Helminthiasis in a Recently Established Focus behind Mount Cameroon Int.J.Curr.Microbiol.App.Sci. 2015;4(3):1056-1066
8. Kimbi HK, Wepnje GB, Anchang-Kimbi J, Tonga C, Ayukenchengamba B, Njabi C, Nono LK, Nyabeyeu HN, Lehman LG. Active Case Detection and Prevalence of Urinary Schistosomiasis and Malaria in Pupils of Kotto Barombi, Southwest Cameroon Using the CyScope® Fluorescence Microscope. IJTDH. 2015;8(1):1-12. ISSN: 2278–1005

- 308 9. Brooker S. Spatial Epidemiology of human Schistosomiasis in Africa: Risk models, Transmission
309 dynamics and control. *Transactions of the Trans R Soc Trop Med Hyg.* 2007; 101(1):1-8.
- 310 10. Mas-Coma S, Valero MA, Bargues MD. Climate change effects on trematodiasis, with emphasis
311 on zoonotic fascioliasis and schistosomiasis. *Vet Parasitol.* 2009;163(4):264-80. doi:
312 10.1016/j.vetpar.2009.03.024.
- 313 11. Cheesbrough, M. *District Laboratory Practice in Tropical Countries, Parts 1 & 2* Cambridge
314 University Press. United Kingdom; 2014
- 315 12. Moyou SR, Tagni ZD, Kouamouo J, Enyong P, Ripert C. Epidemiologic and radiologic study of
316 Urinary bilharziasis in the focus of Barombi Lake (Meme Department), Cameroon. *Bull Soc Pathol Exot.*
317 1987;80(5):813-825.
- 318 13. Ndamukong KJN, Ayuk MA, Dinga JS, Nkuo-Akenji TN, Ndiforchu VA, Titanji VPK. Prevalence
319 and intensity of urinary schistosomiasis in primary school children of the Kotto Barombi Health Area,
320 Cameroon. *E Afr Med J.* 2001;78:287-289.
- 321 14. Nkengazong L, Njiokou F, Tenkeng F, Enyong P, Wanji S. Reassessment of endemicity level of
322 urinary schistosomiasis in the Kotto Barombi focus (South West Cameroon) and impact of mass drug
323 administration (MDA) on the parasitic indices. *J Cell Ani Biol.* 2009;3(9):159-164.
- 324 15. Geleta S, Alemu A, Getie S, Mekonnen Z, Erko B. Prevalence of urinary schistosomiasis and
325 associated risk factors among Abobo Primary School children in Gambella Regional State, southwestern
326 Ethiopia: a cross sectional study. *Parasites & Vectors.* 2015;8:215 doi 10.1186/s13071-015-0822-5
- 327 16. Sady H, Al-Mekhlafi HM, Atroosh WM, Al-Delaimy AK, Nasr NA, Dawaki S, et al. Knowledge,
328 attitude, and practices towards schistosomiasis among rural population in Yemen. *Parasites & Vectors*
329 2015;8:436. DOI: 10.1186/s13071-015-1050-8
- 330 17. Sama MT; Essame Oyono, Ratard RC. High Risk Behaviours and Schistosomiasis Infection in
331 Kumba, South-West Province, Cameroon *Int. J. Environ. Res. Public Health.* 2007;4(2):101-105.
- 332 18. Oniya MO and Jeje Bala O, Urinary schistosomiasis: Efficacy of praziquantel and association of
333 the ABO blood grouping in disease *Epidemiology Int. J. Biotechnol. Mol. Biol. Res* 2010;1(3):31-35.
- 334
- 335 19. Chipeta MG, Ngwira B, Kazembe LN. Analysis of Schistosomiasis haematobium Infection
336 Prevalence and Intensity in Chikhwawa, Malawi: An Application of a Two Part Model. *PLoS Negl Trop*
337 *Dis.* 2013; 7(3): e2131. doi:10.1371/journal.pntd.0002131
- 338 20. Anto F, Asoala V, Adjuik M, Anyorigiya T, Oduro A, Akazili J et al. Childhood Activities and
339 Schistosomiasis Infection in the Kassena-Nankana District of Northern Ghana. *J Infect Dis Ther.*
340 2014;2:152. doi:10.4172/2332-0877.1000152
- 341 21. Bala AY, Ladan MU, Mainasara M. Prevalence and Intensity of Urinary Schistosomiasis in
342 Abarma District Gusau, Nigeria: A Preliminary Investigation. *Science World Journal* 2012;7(2). Available:
343 <http://www.scienceworldjournal.org> ISSN 1597-6343
- 344 22. Senghor S, Diallo A, Sylla SN, Doucouré S, Ndiath MO, Gaayeb L, et al. Prevalence and intensity
345 of urinary schistosomiasis among school children in the district of Niakhar, region of Fatick, Senegal.
346 *Parasites & Vectors.* 2014;5 DOI: 10.1186/1756-3305-7-5

- 347 23. Ibironke OA, Phillips AE, Garba A, Lamine SM, Shiff C. Diagnosis of Schistosoma haematobium
348 by Detection of Specific DNA Fragments from Filtered Urine Samples Am. J. Trop. Med. Hyg.,
349 2011;84(6):998–1001 doi:10.4269/ajtmh.2011.10-0691
- 350 24. Ladan MU, Abubakar U, Abdullah K, Bunza MDA, Ladan MJ, Adamu. Urinary schistosomiasis in
351 selected villages around Gusau Dam Site, Zamfara State, Nigeria. Niger. J Basic Appl Sci. 2012;20:189–
352 194.