Asian Journal of Epidemiology

ISSN 1992-1462

OPEN ACCESS Asian Journal of Epidemiology

ISSN 1992-1462
DOI: 10.3923/aje.2023.8.15

Research Article
Epidemiology of Schistosomiasis in Galim, Bamboutos Division, West Region, Cameroon

[1]Yamssi Cedric, [2]Noumedem Anangmo Christelle Nadia, [3]Amaley Kueka Marie Leticia, [3]Gamago Nkadeu Guy-Armand and [3]Vincent Khan Payne

[1]Department of Biomedical Sciences, Faculty of Health Sciences, University of Bamenda, P.O. Box 39 Bambili, Cameroon
[2]Department of Microbiology, Hematology and Immunology, Faculty of Medicine and Pharmaceutical Sciences, University of Dschang, P.O. Box 96, Dschang, Cameroon
[3]Department of Animal Biology, Faculty of Science, University of Dschang, P.O. Box 067, Dschang, Cameroon

Abstract
Background and Objective: Schistosomiasis, the world's second-largest parasitic endemic, is a disease caused by worms of the genus *Schistosoma*. This study aimed to determine the prevalence and risk factors associated with schistosomiasis in the city of Galim. **Materials and Methods:** A cross-sectional study was conducted in the city of Galim from March to June, 2020. Urine and stool samples from 320 participants aged 5 to 75 years, from five, randomly selected neighborhoods (Menazoh, Tatah, Mifi, Urban Centre and Haoussa) were examined using the Kato-Katz qualitative and semi-quantitative method and the centrifugal technique respectively to identify and count *Schistosoma mansoni* and *Schistosoma haematobium* eggs. A semi-structured questionnaire was administered to participants to obtain socio-demographic data and risk factors. **Results:** The overall prevalence of schistosomiasis was 1.88%, with 1.25% for *Schistosoma haematobium* and 0.63% for *Schistosoma mansoni*. Infections concerning age, sex, neighborhood and occupation showed no significant difference. However, there was a significant difference between schistosoma infection with respect to the level of education ($X^2 = 8.22$, ddl = 3, P = 0.04). The overall parasite load was 9 eggs/10 mL of urine and 168 eggs per gram (Epg) of stools with an average of 2.25 eggs/10 mL of urine in females and 84 Epg of stools in males. Participants aged 10 to 20 and 20 to 35 years had high parasite loads of 3 eggs/10 mL of urine, respectively. Also, people who visited the Mévobo River (OR = 2.22) and contaminated water (OR = 67.78) to wash and/or bath had a high risk of contracting this disease. **Conclusion:** The overall prevalence of schistosomiasis observed in this region shows that the region is a low-risk area. This region requiring mass care and increased awareness campaigns to completely eradicate the disease.

Key words: Prevalence, risk factors, schistosomiasis, intensity, *Schistosoma mansoni*, *Schistosoma haematobium*, Cameroon

Citation: Cedric, Y., N.A.C. Nadia, A.K.M. Leticia, G.N. Guy-Armand and V.K. Payne, 2023. Epidemiology of schistosomiasis in Galim, Bamboutos Division, West Region, Cameroon. Asian J. Epidemiol., 16: 8-15.

Corres ponding Author: Yamssi Cedric, Department of Biomedical Sciences, Faculty of Health Sciences, University of Bamenda, P.O. Box 39 Bambili, Cameroon Tel : (237) 677413547

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Bilharzia, also known as schistosomiasis, is a neglected tropical disease caused by parasitic flatworms (hematophagous flukes) of the genus *Schistosoma*. The *S. intercalatum*, *S. haematobium*, *S. mansoni*, are present in Cameroon and are responsible for rectal, urogenital and intestinal schistosomiasis, respectively. Transmission occurs via the transcutaneous route when individuals come into contact with water invaded by the larvae. Individuals with this disease experience adverse physical conditions such as stunted growth, poor cognitive development, fatigue, physical discomfort, coughing or rashes and reduced work capacity or death if untreated. Schistosomiasis is the second most parasitic endemic disease in the world after malaria. It is responsible for more than 250 million cases of infections each year in 76 countries with approximately 800,000 deaths worldwide, including 200,000 cases and 80% of new infections in Sub-Saharan Africa due to inaccessibility of drinking water, lack of sanitation and poverty. In Cameroon, the disease is highly endemic but its distribution is uneven and its prevalence ranges from 1.7 to 55.5%. The development of hydroelectric dams, drainage channels and lack of drinking water contributes to the high prevalence of the disease[1]. In addition, the cost of caring for a patient is $0.16, estimated at $20 million worldwide[2].

Many studies have been done on the epidemiology of schistosomiasis. In Cameroon, for example, the work of Payne *et al.*[3] on 369 patients in the city of Njombé-Penja revealed that in this locality, the general prevalence of schistosomiasis was 20.1%. Despite considerable efforts to intensify control activities in all regions of the country, epidemiological data on this parasitosis are still poorly understood in some parts of the country. No studies on bilharziosis have been done in this high-risk city of Galim. Faced with this lack of information, it is therefore, necessary to determine the prevalence and risk factors in the city of Galim to ensure control and prevention.

MATERIALS AND METHODS

Study site: Galim is located about 22 km from Mbouda on the regional road Pk15 connecting the Division of Bamboutos and Noun via Kouoptamo. It covers an area of 513 km^2 for a population of 45335 and its geographical coordinates are situated between latitude 5°30 and 5°50 North of the equator and longitudes 10°15' and 10°35' East of the Greenwich meridian[4]. The climate is equatorial with 2 seasons: A long rainy season from (March to November) and a short dry season from (November to March).

Study design: The study was a cross- sectional study for over 3 months (from March to July, 2020) in five randomly selected neighbourhoods in the city of Galim.

Inclusion and exclusion criteria: Any person who has not received praziquantel for more than 6 months and who signed the informed consent form or whose parent sign were included. Were excluded any person not residing in Galim.

Sample size determination: Lorenz's formula was used to calculate the sample size (StatCalc of the EPI Info software). The minimal sample size was 320 participants.

Sample collection and parasitology examination: Two vials were given to the participants, one for stool and the other for urine. A social and clinical survey was conducted to look for risk factors associated with schistosomiasis. All these variables were mentioned in a questionnaire. The stool and urine samples were transported in a tightly sealed cooler and send to the laboratory of the District Hospital of Galim where stool samples were kept in 10% formaldehyde. Urine was stored with 2-3 milliliters of 10% formalin. The Kato-Katz method[5] and the centrifugation technique were used respectively for the analysis of feces and urine. The prepared slides were read under a microscope at objective 10X.

Parameters 1 g of stool was read per subject. As for the examination of urine by the centrifugation method, slides were observed using 40x objective. The studied parameters were: Prevalence and intensity of infection:

$$\text{Prevalence} = \frac{\text{Number of infected people}}{\text{Total number examined}} \times 100$$

Intensity = Σ of eggs of parasite counted by slide $\times$20 (50 mg perforated plate)[6].

Statistical analysis: The data collected was first recorded in the laboratory notebook and then entered into Microsoft Office Excel version 2010 software. They were then transferred to SPSS version 20.0 (Statistical Package for Social Sciences) software for statistical tests. The Chi-square test (X^2) allowed us to compare the prevalence according to sex, age, neighborhood, level of education, knowledge of the disease. Mann Whitney's test for intensities of infection and the Risk

Test allowed us to calculate the odds ratio in order to determine risk factors. The tests were statistically significant at $p \leq 0.05$ threshold.

RESULTS

Of the 320 subjects examined, 06 were infested with one of the schistosome species. The overall prevalence was 1.88% with 1.25% *S. haematobium* and 0.63% *S. mansoni*.

The prevalence of schistosomiasis with respect to gender and age group was shown in Table 1. From this Table, both sexes were sensitive to both species observed. *Schistosoma haematobium* infected females (1.25%) while, *Schistosoma mansoni* infected males (0.63%). However, there is no significant difference ($X^2 = 0.758$, ddl = 1, p = 0.528) on the prevalence will respect to gender.

No significant differences ($X^2 = 1.876$, ddl = 4, p = 0.758) were observed between the prevalence of schistosomiasis in this locality with respect to age group, but the two species of Schistosome observed were present in the age group 10 to 20 years and 35 to 50 years. Indeed, *Schistosoma haematobium* was observed in these two divisions of the population and had a prevalence of 2.326% in the age group (35-50) compared to 1.80% in the age group (10-20). As for *Schistosoma mansoni*, there was a prevalence of 2.326% in the age group (35-50) and 0.90% in the age group (10-20).

Table 2 shows the prevalence with respect to Neighbourhoods and level of education.

From this table, no significant differences ($X^2 = 3.191$, ddl = 4, $p \leq 0.526$) was recorded between the prevalence of Schistosomiasis with respect to neighbourhood. Schistosome infections was observed in three wards out of the five sampled. The Menzah District recorded the highest prevalence of 3.22%, while the Urban Centre and Mifi neighbourhoods had a zero prevalence each. A significant difference ($X^2 = 8.220$, ddl = 3, p = 0.04) was recorded between prevalence and level of educational. Illiterate people had a higher prevalence (7.14%) than those of secondary level of education (3.84%).

Table 3 shows that *Schistosoma* infection affect people with respect to job occupations. However, the house wife had the highest prevalence (5%). There is no significant difference between the prevalence of schistosomiasis with respect to job occupation (p = 0.9).

The average parasite load identified in this investigation for *S. haematobium* and *S. mansoni* was 9 eggs/10 mL and 186 Epg, respectively.

Table 4 shows the influence of age on the intensity of schistosomiasis. It appears from this table that the age group (20-35) had the highest average parasitic load (3 eggs/10 mL of urine) while the age group (35-50) had the lowest average (1 egg /10 mL of urine). However, there was no significant

Table 1: Prevalence of *S. haematobium* and *S. mansoni* with respect to sex and age

		Total number of positive cases (Prevalence (%))				
Parameter	Number examined	*S. haematobium*	*S. mansoni*	X^2	ddl	p-value
Sex				0.758	1	0.528
Female	161	4 (1.25)	0 (0)			
Male	159	0 (0)	2 (0.62)			
Age				1.876	4	0.758
5-10	70	0 (0)	0 (0)			
10-20	111	2 (1.80)	1 (0.90)			
20-35	72	1 (1.38)	0 (0)			
35-50	43	1 (2.32)	1 (2.32)			
50 et+	24	0 (0)	0 (0)			

Table 2: Prevalence of schistosomiasis with respect to neighborhood level of education, school level

Parameter	Number examine	Positive cases	Prevalence (%)	X^2	ddl	p-value
Quarters				3.191	4	0.526
Urban center	47	0	0			
Menazoh	93	3	3.22			
Mifi	59	0	0			
Tatah	42	1	2.38			
Haoussa	79	2	2.53			
Level of education				8.220	3	0.04
Illiterate	14	1	7.14			
Primary	146	0	0.0			
Secondary	130	5	3.84			
University	30	0	0.0			

Table 3: Prevalence of schistosomiasis with respect to job

Job	Number of examined	Number of positive cases	Prevalence (%)	p-value
Transporter	3	0	0.0	
Tailor	6	0	0.0	
Student	219	4	1.83	
Agro-pastoral activity	44	1	2.27	
Teacher	10	0	0.0	
Nurse	3	0	0.0	
Builder	7	0	0.0	
Mechanic	1	0	0.0	
Housewife	20	1	5.0	
Carpenter	2	0	0.0	
Fisher Men	5	0	0.0	
Total	320	6	1.8750	0.9

Table 4: Mean parasitic load of *S. mansoni* and *S. haematobium* with respect to age group

	Age (year)					X^2	ddl	p-value
Species	5-10	10-20	20-35	35-50	50 and +	8.35	4	0.40
S. haematobium	0 Eggs/10 mL	2.5 Eggs/10 mL	3 Eggs/10 mL	1 Eggs/10 mL	0 Eggs/10 mL			
S. mansoni	0 Epg	120 Epg	0 Epg	48 Epg	0 Epg			

Table 5: Different risk factors predisposing the population to schistosomiasis infections

Risk factors	Number examine	Number positive	Odd ratio	CI 95%	p-value
Water bodies					
Laundry	31	4	21.26	3.7-121.44	0.01*
Bathing	31	2	4.91	0.86-27.99	0.04*
Water use					
Streams	27	1	2.22	0.25-19.68	0.47
Rivers	13	4	67.78	10.9-419.2	0.01*
Level of education					
Illiterates	14	1	4.63	0.50-42.54	0.14
Secondary	130	5	7.56	0.88-65.48	0.03*
Age (years)					
5-10	70	0	0.98	0.96-0.1	0.12
10-20	111	3	1.91	0.38-9.61	0.43
20-35	72	1	0.69	0.08-5.97	0.73
35-50	43	2	3.32	0.59-18.77	0.15
50 and +	24	0	0.98	0.96-0.1	0.48
Sex					
Female	161	4	2.00	0.36-11.07	0.42
Male	159	2	0.50	0.90-2.77	0.42
Job occupation					
Learners	219	4	0.93	0.17-5.19	0.94
Agro-Pastoral	44	1	1.26	0.14-11.05	0.82
Housewives	20	1	3.1	0.35-27.93	0.29
Quarters					
Menazoh	90	3	2.49	0.49-12.56	0.25
Haoussa	79	2	1.23	0.22-6.86	0.62
Tatah	45	1	1.33	0.15-11.69	0.8
Disease knowledge					
Yes	51	0			
No	269	6	1.00	1.59-2.81	0.62

*p<0.05, CI: Confidence of interval and OR: Odds ratio

difference ($X^2 = 8.51$, ddl = 4, p = 0.74) observed between the average parasitic load of *Schistosoma haematobium* with respect to age group.

The mean parasitic loads for *S. mansoni* was recorded only in two age groups. The age group10-20 (120 Epg) was more parasitized compared to the age group 35-50 (48 Epg). There was no significant difference ($X^2 = 8.35$, ddl = 4, p = 0.40) between *S. mansoni* and *S. haematobium* with respect to age.

Table 5 shows that there was a high chance that people who do laundry in streams will be infected with schistosomes with a highly significant association (p = 0.01). Similarly, people who swim in streams were infested with schistosomes (OR = 4.91) and also showed a statistically significant association (p = 0.048). However, it is observed that there was a greater risk of being infested by laundry than swimming.

The number of people who visited streams (27) was higher than that of those who visited the river (13). Nevertheless, results showed that there were more people infected among river visitors (04) compared to those of streams (01). Results predicted that there was a higher risk of infection by the river (OR 67.78, $p \leq 0.001$) compared to streams (OR = 2.22, p = 0.47). There was more infection in high school students (05case). There was a significant association between the secondary level of education and schistosome infection (OR = 7.56, p = 0.03).

Participants in the age groups (10-20), (20-35) and (35-50) had cases of infestations. Those aged 10 to 20 years were the most infested (03 cases) but did not have a significant association (OR = 1.91, p = 0.43), followed by those aged 35 to 50 years (02 cases) that showed a strong association (OR = 3.32, p = 0.15) and those aged 20 to 35 years (01 cases). Despite the infestations observed here, however, there was no significant association between the age groups and Bilharziosis, confirming that these are not risk factors.

In terms of occupation, learners were the most infected (04 cases) in contrast to the Agropastoral is (01 case and Housewife (01 case) occupations. Housewife had a strong association (OR = 3.10, p = 0.29) in contrast to the Agro-pastoral (OR = 1.26, p = 0.82).

DISCUSSION

The overall prevalence of *Schistosoma* infections in this study was 1.88%, with 1.25% and 0.63% for *S. haematobium* and *S. mansoni*, respectively. These results showed that the low endemicity of urogenital and intestinal schistosomiasis as all prevalence were below 10%. The low prevalence obtained is strongly linked to the mass treatment campaigns with praziquantel organized by National Programme for the Control of Schistosomiasis and Intestinal Helminthiasis (PNLSHI) in Cameroon. The low prevalence of *S. mansoni* in this study was comparable to that obtained by Saoting *et al.*[7] in Maga (2.2%). Similarly, the low prevalence of *S . haematobium* was similar to that obtained by Dankoni *et al.*[2] in Kekem in West Cameroon.

During this study, both sexes were susceptible to Bilharziosis. However, there were no significant differences between *Schistosoma* infections with respect to sex (p = 0.52). Female had a high prevalence (2.48%) compared to males (1.25%). This could be explained by the fact that women, unlike men, engage in more activities related to (potentially infected) water points. These results were similar to those of Payne *et al.*[3], who obtained 10.3% prevalence in females and 9.5% in males. These results contradicted those of Dankoni *et al.*[2] on schoolchildren in the District of Taibong-Dziguilao in extreme North Cameroon they had a significant difference between infection of *Schistosoma* with respect to sex, with the prevalence of 5.85% and 5.81% for male and female, respectively. Similarly, the study of Bagayan *et al.*[8] on the prevalence of urinary Schistosomiasis among primary school students in the periurban environment of Ouagadougou had a higher prevalence among boys (5.66%) compared to girls (0%).

Infection due to schistosomes with respect to age group showed that participants aged 35-50 were most affected with a prevalence of 4.75%. Indeed, this result would be justified by the fact that participants in this age group as well as out-of-school subjects, unlike students, who do not receive regular and free treatments based on praziquantel. This result contradicted that of Kiran[9] in Nigeria, who showed that subjects aged 9 and 12 were the most at risk (50.93%) and that obtained in Mali by Bintou *et al.*[10]. Fifty-five point eight percent (50.80%) of the infected individuals were not more than 5 years old. However, despite the similarity of the age (adult) view, this prevalence remains slightly low compared to 5.7% recorded by Payne *et al.*[3] on the population of Njombe-Penja in Cameroon. Controversially, this prevalence was higher than 4.17% obtained in the age group 12-14 by Dankoni *et al.*[2] in his study on primary school pupils in Taibong-Dziguilao.

The present study also showed no significant difference (p = 0.05) in the prevalence of infections of *Schistosoma* according to neighbourhoods. Menazoh and Houssa were the most infected, with 3.22% and 2.53%, respectively. This could be justified by the fact that the inhabitants of these neighbourhoods preferentially used river water or streams for domestic use, which increased human-water contact on the one hand and ignorance of the disease and the route of transmission by the majority of the population on the other. A similar study by Sohkna[11] in rural Senegal (Niakhar) had high prevalence's in some neighbourhoods and low prevalence in others. The absence of a drinking water distribution network justified the high prevalence. On the other hand, a study in urban areas in Mélen (Yaounde-Cameroon) showed mostly low infestations in neighbourhoods. The authors justified this by the fact that urbanization effectively reduces transmission points and the creation of modern water points limit human-water contact[12].

Illiterate participants had a high prevalence (7.14%). Indeed, the lower the level of education, the higher the prevalence. Moreover, the differences observed between the levels of education were statistically significant (p = 0.04). This could be explained by the lack of practical knowledge of hygienic rules by illiterates. This observation was in line with that made by Anto *et al.*[13], who had 46.2% and 20.5%, respectively among illiterates and those with at least a level of education Al-Zabedi *et al.*[14] also found the same in Yemen, where children whose parents had no education (illiterates) were the most infected (38.2%) compared to parents who attended at least primary school (25.8%). On the other hand, studies in Njombé-penja[3] showed that subjects with no level of education did not have this infection, while those in primary (10.8%) secondary school (8.7%) were the most infected.

High prevalences were recorded among housewives (5%) and among those who were engaged in agropastoral activity (2.27%). This increased prevalence among housewives could be explained by the fact that they are permanently in contact with water points. This result was similar to that of Perez-Saez *et al.*[15], who found that housewives were the most susceptible to this infection. On the other hand, studies conducted by Amuta and Houmsou[16] had pointed out that farmers were most at risk of this infection. At the same time, Senghor *et al.*[17] had noticed that students were the most infested.

The mean parasitic load of bilharzian infection with respect to age group showed a predominance of *Schistosoma haematobium* for the age group 20 to 35 years (3 eggs/10 mL urine) and *Schistosoma mansoni* for the age group 10 to 20 years (120 Epg). On the other hand, studies by Amuta *et al.*[16] found that people age 10 to 14 were the most susceptible to *Schistosoma haematobium* infections. The variability in the number of eggs observed here could be explained by the fact that the low intensity recorded in adults aged 35 and over is due to the resistance to infection due to the development of immunity to this disease[18,19].

Differences in average parasitic loads were not statistically significant with respect to sex. The average parasitic load for *S. haematobium* and *S. mansoni* was therefore low below 100 eggs/10 mL and 100 eggs per gram. The mean intensity of *Schistosoma* infection with respect to sex showed that males had a higher parasitic load (84 Epg) than females (0 Epg). This finding does not support the observations made by Anto *et al.*[13], which noted that female individuals had a significant stool load (93.6 Epg) in contrast to males (60 Epg). In addition, these results also revealed a higher urinary parasitic load in females (2.25 eggs/10mL) compared to males with zero. These observations confirmed those obtained by Payne *et al.*[3], who found 1 egg/10 mL in females and 0 eggs/10 mL in males. They do not corroborate that of Ekpo *et al.*[20], who obtained rather 32 eggs /10 mL in males and 21.5 eggs/10 mL in females. The difference in the number of eggs was due to the fact that women harbor more worms, which increases the fertility rate of the latter unlike men[21].

According to the results of this study, several risk factors predispose populations to schistosome infection. Thus, a statistically significant difference (p = 0.05) was observed between those doing laundry and those swimming. Laundry (OR = 21.26, $p\leq 0.01$) and swimming (OR = 4.91, p = 0.05) in streams had a risk factor. A similar observation conducted by Ouldallahi *et al.*[22] in Senegal on intestinal parasitosis and schistosomiasis in school children on the Mauritanian shore mentioned that the activity likely to put schoolchildren in contact with water pools was bathing (13.6%). In contrast, the study conducted by Sousa *et al.*[23] but revealed a statistically significant association between swimming in pools with schistosome infection.

Similarly, the Mevobo River (OR = 67.77, $p\leq 0.001$) is a risk factor in contrast to streams (OR = 2.22, p = 0.47). This same observation was made in the Democratic Republic of Congo by Kabale *et al.*[24], who had shown that the risk of contracting bilharziosis increases with pond attendance, but also revealed a significant association (OR = 2.72) between the use of pond and schistosome infection.

Moreover, the level of education did not have an association with the disease. Illiterates participants (OR = 0.63) and those with a secondary school level (OR = 7.56) were the most infected as opposed to those with primary and university levels of education.

This study provide information on the epidemiology of Schistosomiasis in Galim, Bamboutos Division, West Region, Cameroon and creates awareness on how knowledgeable the population of Galim are and their attitudes towards Schistosomiasis.

The ministry of public health should sensitize the entire population on the risk factors of Schistosomiasis and it screening. The hospitals should take it upon themselves as a responsibility to educate people who come to the hospital for checkup and also sensitizing them on preventive measures of Schistosomiasis.

CONCLUSION

It appears that two species of Schistosome (*S. haematobium*, *S. mansoni*) caused Bilharziosis with an overall prevalence of 1.88% with 1.25% for urogenital Schistosome and 0.63% for intestinal Schistosome. However, considered neglected tropical diseases, the urinary and intestinal infections identified during current investigation pose a serious public health problem for the populations of Galim.

SIGNIFICANCE STATEMENT

Schistosomiasis is an important public health problem, particularly in areas where humidity, poverty and hygiene standards are high. Due to the use of praziquantel, a significant reduction has been demonstrated in Cameroon. However, there are still areas of high risk. Current study determines the health status of the Galim population with regard to schistosomiasis and showed the importance of mass treatment in the fight against schistosomiasis.

ACKNOWLEDGMENT

The author sincerely grateful to the Galim Health District Hospital.

REFERENCES

1. Njunda, A.L., E.N. Ndzi, J.C.N. Assob, H.L.F. Kamga and E.T. Kwenti, 2017. Prevalence and factors associated with urogenital schistosomiasis among primary school children in Barrage, Magba sub-division of Cameroon. BMC Public Health, Vol. 17. 10.1186/s12889-017-4539-6.
2. Dakoni, N., P. Saotoing, R. Tchawe, V. Koe, J.L. Ndikwe, A.M.N. Nloga and R.M. Somo, 2015. Epidemiological survey on schistosomiasis caused by *Schistosoma haematobium* and *Schistosoma mansoni* in primary schools in the Sub-Division of Taïbong-Dziguilao, Far-North Region Cameroon. J. Appl. Biosci., 90: 8397-8407.
3. Payne, V.K., S. Tathio, L. Megwi, G.R. Ngangnang, C. Yamsi, C.J.O. Tanefo and V.R. Nkouayep, 2019. Influence of some demographic factors on infection of schistosomiasis: The case of Njombe-Penja population, in the Littoral region of Cameroon. Central Afr. J. Public Health, 5: 113-119.
4. Raïssa, F. and N. Jacques, 2019. Persistence of *Tenia solium* amongst others human gastro-intestinal parasites in Bamboutos locality (West Region-Cameroon). J. Appl. Biosci., 144: 14813-14821.
5. Cools, P., J. Vlaminck, M. Albonico, S. Ame and M. Ayana *et al*., 2019. Diagnostic performance of a single and duplicate Kato-Katz, Mini-FLOTAC, FECPAKG2 and qPCR for the detection and quantification of soil-transmitted helminths in three endemic countries. PLoS Negl. Trop. Dis., Vol. 13. 10.1371/journal.pntd.0007446.
6. Lindholz, C.G., V. Favero, C. de Marco Verissimo, R.R.F. Candido and R.P. de Souza *et al*., 2018. Study of diagnostic accuracy of Helmintex, Kato-Katz, and POC-CCA methods for diagnosing intestinal schistosomiasis in Candeal, a low intensity transmission area in Northeastern Brazil. PLoS Negl. Trop. Dis., Vol. 12. 10.1371/journal.pntd.0006274.
7. Saotoing, P., R. Djonyang, D.D. Dereng and A.M.N. Nlôga, 2016. Epidemiological investigation of urinary and intestinal parasites among primary schoolchildren in the District Maga, Far North Cameroon [In French]. Int. J. Biol. Chem. Sci., 10: 344-354.
8. Bagayan, M., D. Zongo, B. Savadogo, A. Oueda, H. Sorgho, B.G. Kabre and J.N. Poda, 2014. Prevalence of urinary schistosomiasis in school in a suburban area in Ouagadougou: Case of Yamtenga (Burkina Faso) [In French]. Sci. Tech. Sci. Sante, 37: 93-100.
9. Singh, K. and D. Muddasiru, 2014. Epidemiology of schistosomiasis in school aged children in some riverine areas of Sokoto, Nigeria. J. Public Health Epidemiol., 8: 197-201.
10. Bintou, L.Y., A.S. Yaro, B. Sodio and M. Sacko, 2019. Persistence of urinary schistosomiasis in endemic areas subjected to repeatedmass treatments in Mali [In French]. Int. J. Biol. Chem. Sci., 13: 369-381.
11. Sokhna, C., O. Gaye and O. Doumbo, 2017. Developing research in infectious and tropical diseases in Africa: The paradigm of Senegal. Clin. Infect. Dis., 65: S64-S69.
12. Mewamba, E.M., A.A.Z. Tiofack, C.N. Kamdem, R.I.K. Ngassam and M.C.T. Mbagnia *et al*., 2021. Field assessment in Cameroon of a reader of POC-CCA lateral flow strips for the quantification of *Schistosoma mansoni* circulating cathodic antigen in urine. PLoS Negl. Trop. Dis., Vol. 15. 10.1371/journal.pntd.0009569.
13. Anto, F., V. Asoala, M. Adjuik, T. Anyorigiya and A. Oduro *et al*., 2014. Childhood activities and schistosomiasis infection in the Kassena-Nankana District of Northern Ghana. J. Infect. Dis. Ther., Vol. 2. 10.4172/2332-0877.1000152.
14. Al-Zabedi, E.M., F.A. Kaid, H. Sady, A.H. Al-Adhroey, A.A. Amran and M.T. Al-Maktari, 2014. Prevalence and risk factors of iron deficiency anemia among children in Yemen. Am. J. Health Res., 2: 319-326.
15. Perez-Saez, J., L. Mari, E. Bertuzzo, R. Casagrandi and S.H. Sokolow *et al*., 2015. A theoretical analysis of the geography of schistosomiasis in Burkina Faso highlights the roles of human mobility and water resources development in disease transmission. PLoS Negl. Trop. Dis., Vol. 9. 10.1371/journal.pntd.0004127.
16. Amuta, E.U. and R.S. Houmsou, 2014. Prevalence, intensity of infection and risk factors of urinary schistosomiasis in pre-school and school aged children in Guma Local Government Area, Nigeria. Asian Pac. J. Trop. Med., 7: 34-39.

17. Senghor, B., A. Diallo, S.N. Sylla, S. Doucouré and M.O. Ndiath *et al*., 2014. Prevalence and intensity of urinary schistosomiasis among school children in the District of Niakhar, Region of Fatick, Senegal. Parasites Vectors, Vol. 7. 10.1186/1756-3305-7-5
18. Woolhouse, M.E.J., P. Taylor, D. Matanhire and S.K. Chandiwana, 1991. Acquired immunity and epidemiology of *Schistosoma haematobium*. Nature, 351: 757-759.
19. Bradley, D.J., 1972. Regulation of parasite populations: A general theory of the epidemiology and control of parasitic infections. Trans. R. Soc. Trop. Med. Hyg., 66: 697-708.
20. Ekpo, U.F., A. Laja-Deile, A.S. Oluwole, S.O. Sam-Wobo and C.F. Mafiana, 2010. Urinary schistosomiasis among preschool children in a rural community near Abeokuta, Nigeria. Parasites Vectors, Vol. 3. 10.1186/1756-3305-3-58.
21. Dawet, A., 2012. Prevalence and intensity of schistosoma haematobium among residents of gwong and kabong in jos north local government area, Plateau State, Nigeria. Int. J. Biol. Chem. Sci., 6: 1557-1565.
22. Ouldabdallahi, M., M. Ouldbezeid, C. Diop, E. Dem and K. Lassana, 2010. Epidemiology of human schistosomiasis in Mauritania. The right bank of the Senegal River as model. [French] Bull. Soc. Pathol. Exot., 103: 317-322.
23. Sousa-Figueiredo, J.C., M. Betson, A. Atuhaire, M. Arinaitwe and A.M.D. Navaratnam *et al*., 2012. Performance and safety of praziquantel for treatment of intestinal schistosomiasis in infants and preschool children. PLoS Negl. Trop. Dis., Vol. 6. 10.1371/journal.pntd.0001864.
24. Kabale, B.N., J.J.B. Mashimango, J.P.B. Bajope, J.L.B. Kayeye, P.B. Cishibanji, H.N. Ntadumba and J.B. Cinyambiriri, 2014. Evolution of the prevalence of schistosomiasis due to *Schistosoma mansoni* and *Schistosoma haematobium* in the health Zone of Katana from 2001-2011 [In French]. Int. J. Innovation Appl. Stud., 7: 186-197.