

*Full Length Research Paper*

# **Prevalence and intensity of urogenital and intestinal schistosomiasis among primary school children in rural districts of Senegal**

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Schistosomiasis is a public health problem in Senegal with unevenly distributed prevalence. The purpose of this study was to assess the prevalence and intensity of *Schistosoma haematobium* and *Schistosoma mansoni* infections among primary school children in eight districts of Senegal. A cross-sectional survey including school children aged from 7 to 13 years were included and was conducted in 3 ecological areas. Urine and stool samples were collected from for detection of *S. mansoni* and *S. haematobium* using Kato-Katz method and urine filtration, respectively. One thousand one hundred and thirty-three (1133) children were enrolled with 51.73% of girls. Among them, 1123 provided urine and stool samples. The overall prevalence of *S. haematobium* infection was 25 and 74% of the children presented low infection intensity (1-49 eggs/10 ml). Ecological area 2 (Kafrine region) was more affected with 32%, whereas paradoxically ecological area 3 (Kolda and Ziguinchor) where transmission is permanent, had the lowest prevalence (13%). Regarding *S. mansoni* infection, the overall prevalence was 0.9% with 80% of low infection intensities (1-99 eggs/g stool) and all cases were observed in the ecological area 3. This study showed that schistosomiasis is still endemic in Senegal and revealed an evident need for systematic administration of school-based chemotherapy program using Praziquantel. Also, community engagement is needed to reduce transmission of the disease.

**Key words:** Urogenital schistosomiasis, intestinal schistosomiasis, primary school children, Senegal.

## **INTRODUCTION**

Schistosomiasis is ranked second after malaria in terms of parasitic disease of serious public health importance in subtropical and tropical countries especially in rural areas and among children (Engels et al., 2002; King, 2009).

Human schistosomiasis is one of the most important Neglected Tropical Diseases (NTDs). According to the World Health Organisation, these parasitic diseases are endemic in 78 countries with 200 to 300 million infected

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**Figure 1.** Map of Senegal showing the study sites. EA: Ecological area.

people and 732 million others at the risk of being infected (Chitsulo et al., 2000; Gryseels et al., 2006; Steinmann et al., 2006; WHO, 2019).

In children, schistosomiasis can cause anaemia, stunting and a reduced school performance of children. A review of the disease burden estimated that more than 200 000 deaths per year are due to schistosomiasis in sub-Saharan Africa and the burden of disease due to schistosomiasis is underestimated (WHO, 2019). The lack of epidemiological data may be a serious attempt in control programs.

In Senegal, these diseases are endemic with prevalence unevenly distributed throughout the country (Ndir, 2000). To control the harmful effects of this helminthiasis, a national schistosomiasis control plan was launched to reduce the harmful consequences of these diseases by implementing a National Schistosomiasis Control Program (NSCP) and thereby improve the health status of populations. The major strategy of the NSCP is mass drug administration (MDA) with Praziquantel in primary school children. Thus, a basic assessment of sentinel sites was carried out in the Senegal River Basin particularly in the districts of five regions: Louga, Saint Louis, Matam, Tambaounda and Kedougou. This baseline study was conducted prior to the MDA, in 2009 and 2010 in twenty-four districts of these regions in

collaboration with the department of medical school control of the Ministry of Education.

To extend MDA in all regions of the country, Thiès, Fatick, Kaffrine, Diourbel, Kolda and Ziguinchor were selected in order to obtain a national map of these parasitic diseases.

The objective of this study was to determine the prevalence and the intensity of schistosomiasis in school children in these regions.

## METHODOLOGY

### Study areas

This study was conducted in six regions from three ecological areas (EA) as the following (Figure 1).

EA1, with 3 regions, Thiès (14°50'N, 17°06'W), Fatick (14°21'N, 16°35'W) and Diourbel (14°38'N, 16°14'W), of the Sudano-Sahelian zone of Senegal with low to medium rainfall. In 2012, annual rainfall was between 414 and 917 mm. However, this area harbours temporary backwaters and ponds (ANSD Thiès, 2015a; ANSD Fatick, 2015b; ANSD Diourbel, 2015c).

EA2, with one region, Kaffrine (14°07' N, 15°32' W), located in the North-Sudanian zone with annual rainfall higher than in EA1, ranging between 800 and 1000 mm a year. The hydrographic potential of the region consists of two main rivers: the extension of the North Saloum River and the Baobolong Valley that runs from south-west of Niore to the east of the region for several kilometres.

The open water resources are limited to the presence of some ponds between June and November (ANSD Kaffrine, 2015d).

EA3 includes two regions, Kolda (12°52'N, 14°56'W) and Ziguinchor (12°34'N, 16°16'W) and is a North-Guinean zone of tropical forest with an average annual rainfall of 700 and 1300 mm.

Also, it is supplied by the Casamance and Kayanga-Géba Rivers. The dams of Ndiandouba and Anambé erected, respectively on these rivers have substantially transformed the area, which now has water permanently (ANSD Kolda, 2015e; ANSD Ziguinchor, 2015f).

### Study population

This prospective survey was conducted in March 2012. The target population was primary school children aged from 7 to 13 years in schools in selected villages.

Selection of study subjects was done using a stratified survey combined with a multi-stage random survey. The frames were constituted by the list of ecological areas (EA) with the districts concerned. The first degree was the list of the health facilities. The endemic villages were the second degree and schools in endemic villages were the third degree. In total, 8 districts, 11 health facilities, 26 endemic villages and 26 schools were drawn. A total of 1133 school children were enrolled in this study.

### Samples collection and laboratory analyses

Each student received two sterile, plastic universal containers (labelled) to collect fresh stool and urine samples. Samples collection was done between 10 am and 13 pm.

### Detection of microhaematuria

A dipstick (Siemens Hemastix) was carefully dipped into the urine for 5 s. The resulting change in colour of the strip was compared with manufacturer's colour chart. Colour intensity is proportional to the amount of blood in the urine and results were scored negative, +, ++, +++ or ++++ according to the manufacturer recommendations.

### Urine examination

For detection and quantification of *Schistosoma haematobium* eggs, the urine filtration technique recommended by the WHO was performed (WHO, 1991). It allows both detection of the parasite and quantifying the infection intensity by counting the number of eggs per 10 ml of urine. Standard 10 ml of the urine to be tested is forced through the device with a syringe. If eggs are present, they were unable to pass through a Millipore filter and be observed and counted under the microscope at the objective  $\times 10$  or  $\times 40$  (Feldmeier, 1993; Gyorkos et al., 2001).

### Stool examination

For diagnosis of intestinal schistosomiasis due to *Schistosoma mansoni*, the Kato-Katz thick smear method, standard method recommended by the World Health Organization (WHO) for both qualitative and quantitative diagnosis of intestinal schistosomiasis, was performed. Faeces were pressed through a mesh screen to remove large particles. A portion of sieved sample (25 mg) was then transferred to the hole of a template on a slide. After filling the hole, the template was removed and the remaining sample was

covered with a piece of cellophane soaked in glycerol. The glycerol cleared the faecal material around the eggs. The prepared slide was examined using optic microscope at objective  $\times 10$  or  $\times 40$  to estimate eggs per gram of faeces (Katz et al., 1972; Montresor et al., 1998).

### Data analysis

Determination of infestation intensity has been assessed using the WHO classification: Low infestation (1-99 eggs/g stool for *S. mansoni* and 1-49 eggs/10 ml of urine for *S. haematobium*); moderate infestation (100-399 eggs/g stool for *S. mansoni*) and massive infestation ( $\geq 400$  eggs/g stool for *S. mansoni* and  $\geq 50$  eggs/10 ml urine for *S. haematobium*) (WHO, 1991). Data were analysed using SPSS Statistics version 17 for Windows (IBM Corp., Armonk, USA). Frequencies and percentages were used to present categorical variables. Differences in proportions were tested using chi-square test, either for trend or for independence, as appropriate. The p-values less than 0.05 were considered statistically significant.

### Ethical approval

This study is part of the promotion of school health in Senegal and the protocol was approved by the ethics committees of the ministries of health and education, respectively. General information regarding the nature of the study and its objective was explained to teachers, parents/guardians, and schoolchildren. Confidentiality and anonymity were maintained throughout the study period.

## RESULTS

### Characteristics of the study participants

A total of 1133 primary school children were enrolled from eight districts. Among them, 10 children did not provided samples and 9 provided urine samples only. The final sample size (urine and stool) was 1114 (99.20%) subjects from whom 1123 provided urine samples. The median age of the study population was 10 years [7-13 year] and most of the children (78.9%) were aged between 7 and 10 years. The sex ratio was 0.93. Other characteristics of the study population are shown in Table 1.

### Prevalence of microhematuria by ecological area, region and district

The overall prevalence of microhematuria in this study was 20.3% [95% CI: 18.01-22.80] with a significant difference of the distribution across the districts ( $p < 0.001$ ). However, any significant difference by gender ( $p = 0.77$ ) and age-group ( $p = 0.16$ ) was observed.

Comparison by ecological area (EA) has shown that the highest prevalence was observed in EA2 with 32.9% followed by EA1 and EA3 with 18.91 and 11.38%, respectively. The distribution of microhaematuria according to the region showed the highest prevalence in Kaffrine 32.9% [95% CI: 27.8-38.5] and Diourbel 23.1%

**Table 1.** Characteristics of the study participants.

Ecological area	Region	District	N (%)	Sex (p<0.05)		Age group (p<0.05)	
				Male n (%)	Female n (%)	Male n (%)	Female n (%)
EA1	Thies	Popenguine	57 (5.1)	29 (50.9)	28 (49.1)	35 (61.4)	22 (38.6)
		Thiadiaye	164 (14.6)	80 (48.8)	84 (51.2)	93 (56.7)	71 (43.3)
	Diourbel	Bambey	117 (10.4)	72 (61.5)	45 (38.5)	58 (49.6)	59 (50.4)
	Fatick	Passy	106 (9.4)	51 (48.1)	55 (51.9)	45 (42.5)	61 (57.5)
EA2	Kaffrine	Kaffrine	197 (17.5)	92 (46.7)	105 (53.3)	87 (44.2)	110 (55.1)
		Mbirkilane	113 (10.0)	56 (49.6)	57 (50.4)	32 (28.3)	81 (71.7)
EA3	Kolda	Kolda	191 (17.0)	100 (52.4)	91 (47.6)	64 (33.5)	127 (66.5)
	Ziguinchor	Ziguinchor	178 (15.8)	62 (34.8)	116 (65.2)	55 (30.9)	123 (69.1)

**Table 2.** Prevalence and intensity of *Schistosoma haematobium* infection and microhaematuria by district, age-group and gender.

Parameter		<i>S. haematobium</i> infection				
		Examined (N)	Microhaematuria, n (%)	Infected, n (%)	Intensity	
					Light, n (%)	Heavy, n (%)
District	Popenguine	57	4 (7.0)	0 (0)	0 (0)	0 (0)
	Thiadiaye	164	33 (20.1)	54 (32.9)	47 (88.7)	6 (11.3)
	Bambey	117	27 (23.1)	35 (29.9)	23 (67.6)	11 (32.4)
	Passy	106	20 (18.9)	41 (38.7)	31 (75.6)	10 (24.4)
	Kaffrine	197	61 (31.0)	64 (32.5)	38 (59.4)	26 (40.6)
	Mbirkilane	113	41 (36.3)	35 (31.0)	26 (74.3)	9 (25.7)
	Kolda	191	11 (5.8)	17 (8.1)	14 (82.4)	3 (17.6)
	Ziguinchor	178	31 (17.4)	31 (17.4)	26 (83.9)	5 (16.1)
	P. value		< 0.001	< 0.001	0.013	
Age-group	[7 - 10]	952	200 (21.0)	244 (25.6)	181 (74.8)	61 (25.2)
	[11-13]	171	28 (16.4)	33 (19.3)	24 (72.7)	9 (27.3)
	P. value		0.16	0.07	0.79	
Gender	Male	542	112 (20.7)	143 (26.4)	100 (74.8)	41 (29.1)
	Female	581	116 (20.0)	134 (23.1)	105 (72.7)	29 (26.6)
	P. value		0.77	0.19	0.16	

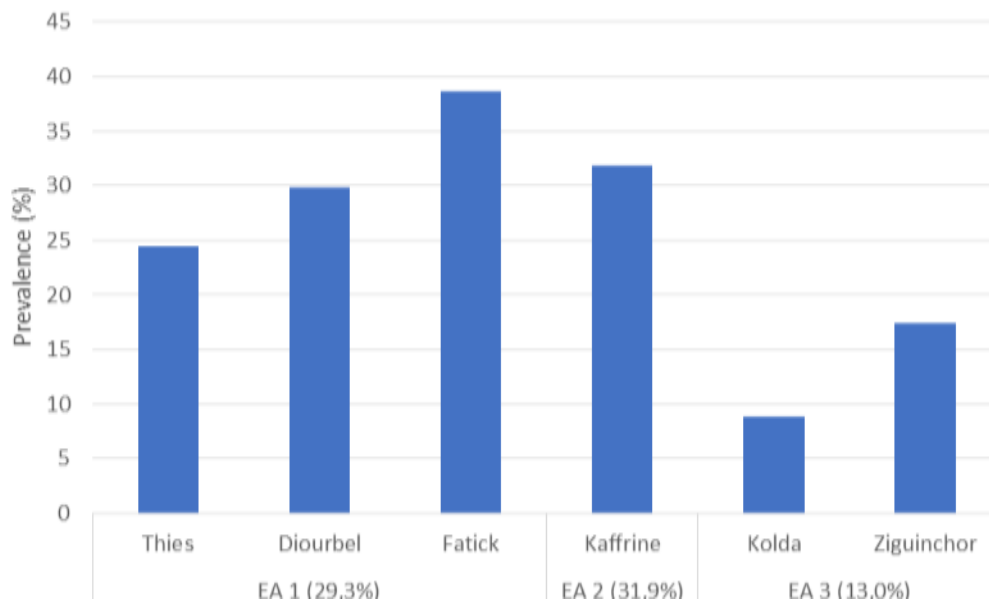
[95% CI: 15.8-31.8] followed by Fatick 18.9% [95% CI: 11.9-27.6], Ziguinchor 17.4% [95% CI: 12.2-23.8], Thies 16.7% [95% CI: 12.1-23.3] and Kolda 5.76% [95% CI: 2.91-10.07%]. According to the district, the highest prevalence was found in the district of Mbirkilane 36.3% [95% CI: 27.5-45.8] and the lowest one in the district of Kolda 5.8% [95% CI: 2.9-10.1] (Table 2).

#### Prevalence and intensity of urogenital schistosomiasis by ecological area and regions

Of the 1123 urine samples examined for *S. haematobium*, 277 [24.7%, 95% CI: 22.19-27.32] were infected. The

highest prevalence was observed in EA2 with 31.94% [95% CI: 26.8-37.5] followed by EA1 and EA3 with 29.3% [95% CI: 25.1-33.79] and 13.0% [95% CI: 9.8-16.9], respectively. By region, the highest prevalence was observed in Fatick with 38.7% [95% CI: 29.4-48.6] followed by Kaffrine 31.9% [95% CI: 26.8-37.5], Diourbel 29.9% [95% CI: 21.8-39.1], Thies 24.4% [95% CI: 18.9-30.6], Ziguinchor 17.4% [95% CI: 12.2-23.8] and Kolda 8.9% [95% CI: 5.3-13.9] (p<0.05) (Figure 2).

Among infected children, the prevalence of massive infection (> 50 eggs/10 ml) was 25.45% (n=70) while the low infection (1-49 eggs/10 ml) was 74.55% (n=205). The highest massive infections were observed in EA2 region of Kaffrine (35.35%) and district of Kaffrine (40.63%)



**Figure 2.** Prevalence of *S. haematobium* infection by region and ecological area.

(Table 2).

### Prevalence and intensity of urogenital schistosomiasis by district, gender and age

Regarding to the district, the prevalence was higher in three districts: Passy (38.68%), Thiadiaye (32.93%), and Kaffrine (32.49%). By gender, the highest prevalence (51.62%) and the massive infection intensity (58.57%) rate were observed in boys than girls with 48.38 and 41.43%, respectively although not statistically significant ( $p=0.19$ ). Children between 7 and 10 years old were more infected (88.09%) than children of 11-13 years age-group (Table 2).

### Prevalence and intensity *S. mansoni* infection

Of the 1114 stool samples examined, *S. mansoni* eggs were found in 10 samples corresponding to a prevalence 0.9% [95% CI: 0.46-1.70]. No significant difference between male and female school children was observed ( $p=0.45$ ). Comparison by age-group has shown that the highest prevalence rate was found among children between 7 and 10 years old (80%) ( $p=0.98$ ). All intestinal schistosomiasis cases were found in Kolda district with a prevalence of 5.23%. Among the 10 children positive for *S. mansoni*, 80% (8/10) of them had light infection intensity and 20% (2/10) moderate infestation. Light infection intensity was more observed in those aged between 7 and 10 year ( $p=0.001$ ). However, no significant difference was observed according to gender ( $p=0.23$ ).

## DISCUSSION

In order to formulate appropriate interventions, the Senegalese national schistosomiasis control program needs to get epidemiological data about the infection in different districts/regions. In line with this, this study was conducted in eight districts from three ecological areas of Senegal. The objective was to determine the prevalence and intensity of urogenital and intestinal schistosomiasis among school children in six regions in Senegal.

The results of the present study showed that urinary schistosomiasis was endemic in all EA with prevalence rates between 13 and 31.94%. Paradoxically, EA3 with presenting permanent watercourses has the lowest prevalence. Previous studies carried out in 2003 in the regions of Tambacounda, Matam and Saint-Louis showed prevalence of 24, 13 and 12%, respectively (Ndiaye et al., 2005), highlighting, the endemic nature of urinary schistosomiasis in Senegal.

By district, only Popenguine did not register a case of urogenital schistosomiasis. This finding can be attributed the fact that Popenguine, unlike other districts, is a semi-urban area where people have running water and have little contact with open water sources. The highest prevalence of *S. haematobium* infection was found in Passy district in the region of Fatick with 38.7%. Other study conducted on urogenital schistosomiasis in primary school children in 2007 reported overall prevalence rate of 30.2%. When compared with the aforementioned study conducted in the same study area, prevalence of urogenital schistosomiasis remains still high (Seck et al., 2007). In fact, Fatick is characterized by the presence of a relatively dense hydrographic network mainly

comprising the Sine (30 km) and Saloum (120 km) Rivers. Also, the district of Passy is a rural area and most of the villages depend on open water for their needs. As well, same practices were observed in Thiadiaye and Kaffrine districts, which may explain the high prevalence rates noted in these localities.

When grouping children by age, all the age groups studied had infection and the overall prevalence of urinary schistosomiasis was similar in 7-10- and 11-13-years age groups. By district, increase of prevalence with age was only noted in district of Bambey and Thiadiaye. This finding agrees with the report of Senghor et al. (2014) in Niakhar. A similar trend was also reported in others African countries such as in Burkina Faso where Poda et al. (2001) found an increase of the prevalence with age (Poda et al., 2001). In the other districts (Kaffrine, Kolda, Mbirkilane, Passy, Ziguinchor), the highest prevalence rates were recorded in the 7-10 years group with no significant difference. Studies conducted elsewhere have reported similar results, for example in Kenya, schistosomiasis infection was lower in older children (Ndyomugenyi and Minjas, 2001; Satayathum et al., 2006).

By infection intensity of *S. haematobium*, light infections (1-49 eggs/10 ml) were predominant with nearly 75%. And this trend was observed in all districts. This may be indication that all the pupils of the different schools are similarly exposed to the different streams.

This study also revealed a non-statistically significant higher prevalence in males compared to the females which agrees with the findings from other reports in Senegal (Thiam, 1993; Ka, 2002) and in other countries in Africa (El-Gendy et al., 1999; Satayathum et al., 2006; Rudge et al., 2008; Ugbomoiko et al., 2010; Nanvya et al., 2011). Boys are more likely to be infected because they have more water-contact compared to girls who stay most at home because of housework. However, this result does not agree with the reports by Opara et al. (2007) in Nigeria, Dabo et al. (2011) in Mali, and Ahmed et al. (2012) in Central Sudan who found similar prevalence in boys as well as in girls.

Regarding intestinal schistosomiasis due to *S. mansoni*, the overall prevalence is less than 1% and all 10 cases were found in Kolda district located in the south of the country. No statistically significant difference was noted in the distribution according to age, sex and infection intensity. Indeed, in Senegal the focus of intestinal schistosomiasis is located in the north where the first cases were isolated in 1990 (Talla et al., 1990). Thus, in 2003 Ndiaye et al. (2009) reported a prevalence of 20% in school-children in Richard Toll department at the north (Ndiaye et al., 2009). However, malacological surveys carried out from 1980 to 1994 in Kolda identified *S. mansoni* (Ndir, 2000). This could explain these rare cases observed in Kolda district. However, higher prevalence rates of *S. mansoni* infection were reported in Guinea and Mauritania, two bordering countries of Senegal, with 9.9 and 3.3%, respectively (unpublished

data).

## Conclusion

This survey showed that urinary schistosomiasis is present in all selected districts with unequally distributed prevalences. On the other hand, intestinal schistosomiasis with *S. mansoni* is only found in Kolda district with a low prevalence. These results showed that the fight against schistosomiasis needs to be intensified with regular mass treatments combined with increased awareness of an improvement in the availability of drinking water.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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