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Prevalence of intestinal schistosomiasis infections among school children in Danane, Western Côte D'Ivoire

Pulchérie Christiane Marie Kiki-Barro[1,3]*, Abibatou Konaté[1], Kondo Fulgence Kassi[1,2], Kpongbo Etienne Angora[1], Henriette Vanga-Bosson[1], Vincent Djohan[1], Akoua Valérie Bédia-Tanoh[1], Assohoun Jean Sebastien Miézan[1], William Yavo[1] and Eby Ignace Hervé Menan[1,2]

[1]Department of Parasitology, Mycology, Animal Biology and, Zoology, Felix Houphouët-Boigny University, BPV 34, Abidjan, Côte d'Ivoire.
[2]Laboratory of Parasitology and Mycology of the Diagnosis and Research Centre on AIDS and the Others Infectious Diseases, 01 BPV 13, Abidjan, Côte d'Ivoire.
[3]Laboratory of Parasitology-Mycology of National Institute of Public Health, BPV 47, Abidjan, Côte d'Ivoire.

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Intestinal schistosomiasis is very common in children and cause significant morbidity. Danané is located in the west of the Côte d'Ivoire which is an area where intestinal schistosomiasis transmission is established. The Ministry of Health of Côte d'Ivoire which have acceded to the global goal of eliminating these diseases as a public health problem, has adopted a five year strategic plan in 2011. The mass drug administration campaigns are one of the key elements of this strategic plan. The present study therefore examined the prevalence of *Schistosoma mansoni* among school children in Danané, Côte d'Ivoire. A cross-sectional study was undertaken in schools between November 2016 and February 2017. In total, 510 children, aged between 4 and 15, were included. Single stool samples from each child were collected and processed using the Kato-Katz method to diagnose schistosomiasis. Of the sample, 52 (10.2%; IC 95%: 7.9-13.1) were infected with *S. mansoni*, with intestinal schistosomiasis prevalence ranging from 3.3 to 26.7%, depending on the school. Possible associated factors were also examined, revealing that age over 9 years (p=0.015), living in urban areas (p=0.001), and the tendency to defecate outside at school (p<0.001) were factors that associated with intestinal schistosomiasis prevalence. In summary, this study has revealed that intestinal schistosomiasis is still moderately prevalent among school children in Danané, despite the national control program. Therefore, school-based interventions in urban areas that focus on prevention through education are recommended in this region.

Key words: Intestinal schistosomiasis, *Schistosoma mansoni*, children, schools, Côte d'Ivoire.

INTRODUCTION

Schistosomiasis is a particular problem due to its high prevalence and morbidity among children (WHO, 2013). Approximately, 207 million people are estimated to be infected by schistosomiasis (Steinmann et al., 2006), with a further 700 million at risk across 76 countries.

Schistosomiasis is also the second most commonly fatal parasitic disease (behind malaria) and is responsible for 280,000 deaths across Africa per year (van der Werf et al., 2003). Africa is by the far the most severally affected continent, possessing more than 90% of reported cases

(CDC, 2011). Among schistosomiasis, intestinal schistosomiasis is reported to be widespread and important in sub-Saharan Africa (WHO, 2013). Intestinal schistosomiasis, also known as intestinal bilharzia, is an infectious disease caused by *Schistosoma mansoni*, a parasitic worm in fresh water. The transmission to humans is led from snails infected (CDC, 2011). Praziquantel remains the drug of choice for treatment of schistosomiasis.

S. mansoni is endemic to 81 of the 83 sanitary districts in Côte d'Ivoire and has been a focus of intensive control efforts (Assaré et al., 2015; Chammartin et al., 2014). The department of Danané (Figure 1) is in the transmission zone of human schistosomiasis, which occurs in the western parts of the country. The city is located in the western part of the country, 681 km north of the coast. The climate of this mountainous region is typically hot and humid, with a rainy season lasting 7 to 9 months. During the rainy season, rainfall can reach 1676 mm, leading to particularly rich vegetation growth. The region is also irrigated by the Cavally and Ban rivers, in addition to various seasonal waterways. The primary deworming campaign began in 2012 and targeted school children aged from 4 to 15. Since then, there is a lack of assessment of the impact of this campaign due to lack of updated data about the prevalence or associated factors for schistosomiasis among this target population. To address this, the present study assessed the prevalence of *S. mansoni* infections in school children in the city of Danané, Côte d'Ivoire. In addition, detailed patient notes were collected via a questionnaire to determine various biological, behavioral, and socioeconomic characteristics. This combined approach revealed the current *S. mansoni* prevalence in this region of Côte d'Ivoire and also identified several associating factors that can be used to better target preventive strategies and may have implications for other soil-transmitted helminths.

Ethical consideration

The study was reviewed and approved by the relevant primary education inspectors in Côte d'Ivoire. The objectives and procedures were explained to participants in the presence of the teachers. Children that tested positive for infection were treated with 40 mg/kg praziquantel.

MATERIALS AND METHODS

Study design, area, and population

Between November 2016 and February 2017, a cross-sectional study was performed among primary school-aged children in the educational department of Danané, Côte d'Ivoire.

The study examined primary school children aged from 5 to 15 years old. All school children present during the investigation period and who lived in the department for at least 3 months prior to the start of the study, regardless of gender, were included. However, school children who had been dewormed within 3 weeks of the start of the study were excluded.

Sample size determination and sampling technique

The educational department of Danané included 306 primary schools, with 41,497 school children registered in the 2014-2015 school year [Department of strategies, planning and statistics (DSPS), 2014-2015]. To calculate the minimum number of school children to be included, sample size and power calculations were performed using Epi Info version 7 (CDC, Atlanta, GA, USA) to identify a theoretical prevalence of 50% with 5% precision and an α (type 1) rate less than 5%. This calculation resulted to a sample size of 384.16 school children. For the study, the size has been increased to 510.

The total number of classrooms to be assessed was set at 60. Each primary school typically has six classrooms, with each classroom corresponding to a level of study (forms 1 to 6). Each of the classroom levels in each school to ensure all age groups were represented was sampled.

The number of school children selected per classroom was obtained by dividing the previous number determined using sample size calculation by 60. School children were selected randomly per classroom. Finally, 10 schools were randomly selected for sampling from the list of the schools submitted by the Department of Strategies, Planning and Statistics (DSPS), 2014-2015.

Data collection and processing

Survey Questionnaire

Data were collected using a standardized questionnaire form. This contained questions concerning the age, gender, classroom, deworming history, origin of the pupil (either rural or urban), certain behaviors (for example defecating habits, visits to rivers), and the socio-economic status of the mother. The survey also included functional signs related to various stages of schistosomiasis, such as itching, headaches, stomach pain, or diarrhea.

Sample collection and laboratory procedures

Feces samples were collected from school children directly in plastic pots and analyzed using the Kato-Katz method. A single stool sample was collected for each child. This technique was used to identify *S. mansoni* eggs and the presence of other helminths, including roundworms, whipworms, hookworms, and *Taenia* sp.). Briefly, this technique involves cleaning helminth eggs from stool under wet cellophane that has previously been soaked with a reactive compound consisting of malachite green and 50% glycerin. The cleaning of eggs is obtained through the action of glycerin. Each sample was assessed at 10× then at 40x magnification using light microscopy. Observations were made 1 h and 24 h after

*Corresponding author. E-mail: kikipcm@yahoo.fr. Tel: +22507584947.

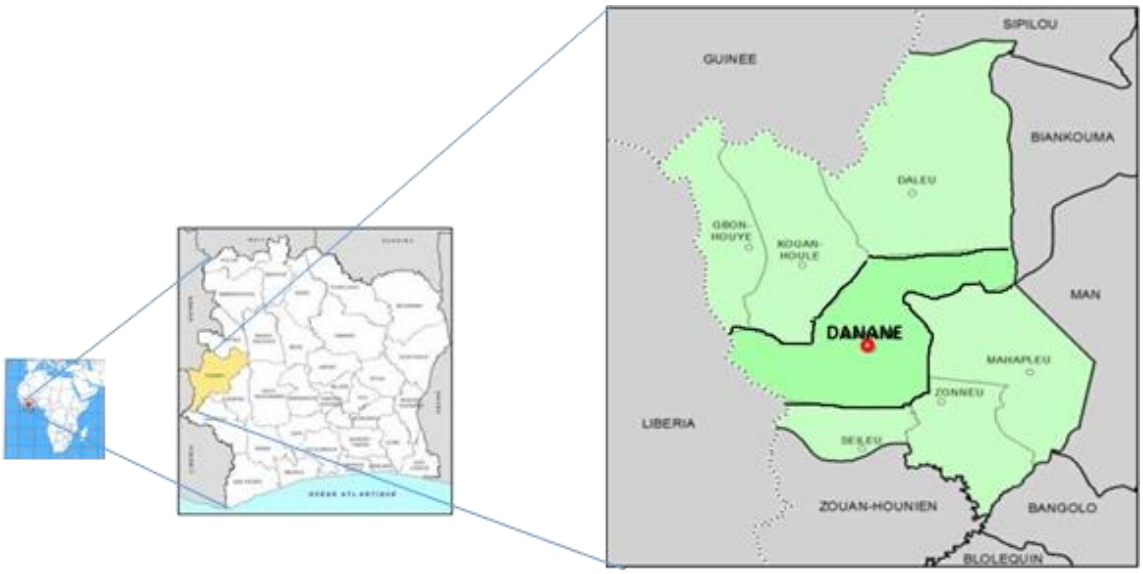

Figure 1. Map of Danané Department , 7° 16′ 00″ north, 8° 10′ 00″ western (RGPH, 2014).

staining to allow for better discrimination between hookworm and *S. mansoni* eggs.

Data management and analysis

Data were analyzed using Epi Data 3.1 (CDC) and SPSS 22 (IBM, Armonk, NY, USA). The proportions of the different modalities were estimated with 95% confidence intervals to estimate prevalence. Any associations between questionnaire answers and the occurrence of intestinal *S. mansoni* were evaluated using χ^2 tests. The statistical threshold of significance was set at $p<0.05$.

RESULTS

A total of 510 schoolchildren, aged between 5 to 15 years old, were included in the study. Most of the pupils (57.5%) were male with an average age of 8.9 years (±2.08 SD). Participants from 5 to 9 years were predominant (65.1%). More than two third of the schoolchildren (70.1%) lived in rural areas and the majority of them (92.3%) stated that they had been dewormed less than 6 months before the start of the study. Approximately, 63.9 and 71.8% of the schoolchildren' mothers were illiterate and homemakers, respectively. Finally, 73.9% of the households obtained drinking water from wells (Table 1).

Of the children examined, 52 (10.2%) were infected with *S. mansoni*, although the prevalence varied depending on the school and ranged from 3.3 to 26.7%. In addition, there was one school in which *S. mansoni* was not detected (Table 2). Most infections were found in urban areas, with significant difference at the threshold of $p<0.05$ ($p=0.001$). Children with age over 9 years ($p=0.0157$) and school children living in urban areas ($p=0.001$), were each significantly more likely to be infected by *S. mansoni*. Behaviorally, defecation outdoors when at school ($p<0.001$) also significantly associated with the incidence of parasites. However, *S. mansoni* infection prevalence did not significantly associate with gender ($p=0.97$), deworming history ($p=0.24$), lower mother educational rates ($p=0.20$), behaviorally such as defecation outdoors when at home and contact with water flows ($p=0.09$) (Table 3). Of the 510 school children examined, 10 (2.0%) were infected with *Trichiuris trichiura*, 10 (2.0%) with hookworm eggs, and 4 (0.8 %) housed *Ascaris lumbricoides* eggs.

Clinically, a large proportion of school children stated they had stomach pains (30.0%), diarrhea (16.7%), and constipation (16.7%) at the time of the investigation. However, only two cases of *S. mansoni* were detected in children reporting stomach pains, and one case was found in each of the group of school children reporting diarrhea and constipation (Table 4).

DISCUSSION

The prevalence of *S. mansoni* identified in this study (10.2%) was lower than that of two prior studies carried out in western Côte d'Ivoire. The first was performed in the city of Man between 2004 and 2005, and reported 51.4% prevalence (Matthys et al., 2007), although the study focused on farmers. The second took place in 2007 in Biankouman and reported a prevalence of 35.5% among school children (Adoubryn et al., 2012). Despite the lower prevalence reported in this study, it is still a moderate level that represents a serious morbidity risk to schoolchildren of the region. This morbidity is largely due

Table 1. Socio-demographic characteristic of school children in Danane, western Côte d'Ivoire, 2016.

Variable	Characteristics	Frequency	Percentage
Gender	Male	393	57.5
Age (in years)	5-9	332	65.1
	10-15	178	34.9
Deworming history (in months)	< 6	472	92.5
	> 6	38	7.5
Home	Rural area	362	71.0
	Urban area	148	29.0
Mother's school level	Not in school	325	63.7
	In school	185	36.3
Mother's activity	Housewife	366	71.8
	Liberal activity	110	21.6
	Farmer	26	5.1
	Civil servant	8	1.6
Household drinking water	Faucets	109	22.4
	Wells	377	77.5

Table 2. *Schistosoma mansoni* infection prevalence per school, department of Danané, Western, Côte d'Ivoire, 2016.

Area	*PPS surveyed	Examined	Positive	Prevalence (%)
Rural	Protestante 1	72	9	12.5
	Gouezepleu	74	3	4.1
	Gopoupleu 2	72	12	16.7
	Gniampleu 2	71	3	4.2
	Kedere	72	0	0.00
Urban	Gningleu 1	30	8	26.7
	Blessaleu 3	31	8	25.8
	Commerce 1	27	5	18.5
	Houphouet ville 3	31	3	9.8
	Moribadougou 2	30	1	3.3
Total		510	52	10.2

*PPS, Primary Public School.

to diarrhea, appetite suppression, weight loss, growth delay, malnutrition, anemia, cognitive issues, hepatomegaly, and even death in severe cases (King and Dangerfield-Cha, 2008; Stephenson et al., 2000). The lack of treatment may explain the higher prevalence rates observed in earlier studies as mass distribution of praziquantel has only been used in schools since 2012. During this study, various school directors stated that deworming days are that are normally organized by teachers but under the guidance of the Ministry of Health. The most recent mass treatment in Danané was just one month prior to the beginning of the study. However, teaching staff also stated that they are often faced with treatment refusal by many school childrens, perhaps explaining the continued elevated prevalence in the city. Typically, the potential side effects of praziquantel were provided as justification for refusing treatment (Adoubryn et al., 2012). A high *S. mansoni* prevalence was also demonstrated in a study in Senegal that found 21.8% prevalence rate in the delta of the Senegal River. This was also despite several mass treatments programs using 600 mg praziquantel, suggesting the phenomenon

Table 3. Relation between socio-demographic characteristics and prevalence of intestinal schistosomiasis (%) among primary school children in Danané, western Côte d'Ivoire, 2016.

Variable	Prevalence of intestinal schistosomiasis			p-value
	Yes (%)	No (%)	Total (%)	
Child gender				
Male	30 (10.2)	263 (89.8)	293 (57.5)	0.97
Age (in years)				
5-9	26 (7.8)	306 (92.2)	332 (65.1)	0.015*
10-15	26 (14.6)	152 (85.4)	178 (34.9)	
Deworming history (in months)				
< 6	46 (9.8)	425 (90.2)	471 (92.4)	0.24
> 6	6 (15.8)	32 (84.2)	38 (7.5)	
Home				
Rural area	27 (7.5)	335 (92.5)	362 (71.0)	0.001*
Urban area	25 (16.9)	123 (83.1)	148 (29.0)	
Mother's school level				
Illiterate	29 (8.9)	296 (91.1)	325 (63.7)	0.20
Litterate	23 (12.4)	162 (87.6)	383 (75.1)	
Faecal matter evacuation / houshold				
Outdoors	8 (6.3)	119 (93.7)	127 (24.9)	0.09
Latrine	44 (11.5)	339 (88.5)	383 (75.1)	
Faecal matter evacuation/school				
Outdoors	6 (2.8)	212 (97.2)	218 (42.7)	< 0.001*
Latrine	46 (15.8)	246 (84.2)	292 (57.3)	
Contact with water flows				
Yes	23 (8.2)	259 (91.8)	282 (55.3)	0.09
No	29 (12.7)	199 (87.3)	228 (44.7)	

*Significant difference.

Table 4. Declared clinical symptoms, Danané, West of Côte d'Ivoire, 2016.

Symptom	Frequency (n)	Proportion (%)	*S. Mansoni* cases n (%)
Stomach pain	9	30.0	2 (22.2)
Nausea	7	23.3	1 (14.3)
Diarrheas	5	16.7	1 (20)
Constipation	5	16.7	1 (20)
Vomiting	4	13.3	1 (25)
Total	30	100	6 (20)

is not unique to Côte d'Ivoire (Abdellahi et al., 2016).The present study noted that there was variation in *S. mansoni* prevalence between schools, confirming the heterogeneous distribution of the disease in the region. This could be due to the focal repartition of schistosomiasis (Booth et al., 2004) that depends on local hydrography (Beck-Wörner et al., 2007; Mugono et al., 2014). Hydrography may be particularly relevant in Danané as the city is crossed by many rivers. The proximity of these waterways to homes would favor

contact between people and water, exposing children to intestinal schistosomiasis. However the present study revealed that intestinal schistosomiasis is not highest among school children who have high level contact rate with permanent water. This finding could be due to activities such as water collection usually causes a relatively small fraction of the total exposure to schistosomes, while other activities such as recreational swimming, bathing, and laundry are often more important (Grimes et al., 2015; Khonde et al., 2016; Nyati-Jokomo and Chimbari, 2017). Several studies have noted that intestinal schistosomiasis is highest among children whose parents have high levels of contact with water (Alemu et al., 2016; Ekpo et al., 2010; Odogwu et al., 2006). An alternative explanation of this finding is periodic deworming effect. Differences in the prevalence of *S. mansoni* have also been noted between regions. For example, further south of Danané in the district of Taabo, a study was carried out in 2011 among the inhabitants of two villages and seven camps (Schmidlin et al., 2013). This surveillance project found a much lower prevalence than our study (1.3%) that was hypothesized to be due to the launch of an integrated intestinal parasite control approach that worked within the framework of the health surveillance system of southern Côte d'Ivoire health demographic surveillance system (HDSS) (Schmidlin et al., 2013). Two other studies have also noted a lower prevalence *S. mansoni* in Côte d'Ivoire compared to ours. The first examined six cities across the south-west of the country between 1999 and 2001 and found a prevalence of 2.6% in schools (Evi et al., 2007). The second study was carried out in 2005 in urban schools in Divo and reported a prevalence of 6.1%. However, this study results are broadly consistent with data from rural Divo gathered in 2005 (12.0% prevalence) (Kassi et al., 2008) and Tiassalé (9.3% prevalence) collected in 2007 (Menan et al., 2008). Some studies have also reported higher *S. mansoni* prevalence. For example, in the Agneby region in the south-east of Côte d'Ivoire (Adoubryn et al., 2006), the prevalence among school children was 20.6% in 2001. Further afield, *S. mansoni* prevalence in Kenya has been found to be much higher than Côte d'Ivoire (60.5%). This large difference has been linked to the lack of anti-helminth control programs in this region of Kenya (Odiere et al., 2012). In the present study older children are significantly more infected than younger at the $p<0.05$ threshold; we did observe a general trend of an increasing likelihood of intestinal *S. mansoni* infection with age, supporting several studies (Adoubryn et al., 2006; Alemu et al., 2016).

In this study, the lack of significantly association between *S. mansoni* infection and school children gender may be explained by the fact that males and females are subject to the same infestation risk. Males were not slightly more in contact with water than females. Additionally, hygiene school levels in Danané remain poor, leading to increased rates of infection. This appears magnified by the fact that schistosomiasis significantly associated with various hygiene-related habits, such as defecating outdoors at school ($p<0.001$). These school children would therefore be closely involved with maintaining contaminated areas and this factor will likely need to be addressed to improve control measures (Schmidlin et al., 2013).

Finally, the prevalence of *S. mansoni* in many schools was roughly comparable to that of other soil-transmitted helminths. For example, the prevalence of various helminths in China in 2002 were 0.20% *Ascaris lumbricoides*, 1.08% *T. trichura*, and 2.5% ankylostomes. This may be due to similar control programs aiming to combat intestinal parasite infections via sanitary education (Jia et al., 2012). However, during the study in Danané, a general inadequacy in the control measures being applied was noticed. This included the distribution of praziquantel and access to clean water and latrines. In addition, the latrines that are available are typically poorly maintained, unhygienic, and regularly not functional. Due to this, school children often prefer to defecate outdoors, resulting in further contamination and the generation of permanent biotopes. This may be a contributing factor in explaining the continuing moderate prevalence of *S. mansoni* despite control efforts and should be considered when establishing policies going forward. Increased use of sanitation should reduce open defecation in and around the school compound, and might therefore be expected to reduce transmission of schistosomiasis (Grimes et al., 2016).

Conclusion

This study found moderate prevalence of *S mansoni* infection among scholar children aged 4 to 15 years old in Danané. Age, living areas, and certain hygienic behaviors all are associated with higher intestinal schistosomiasis prevalence. Stomach pains and diarrhea were not found to be pathognomonic signs of schistosomiasis but could constitute orientation elements. Therefore, control efforts targeting school-aged children should be based on a program of sensitization, sanitary education, and periodic assessment of prevalence to control the transmission of schistosomiasis in the study area. The distribution and monitored administration of praziquantel is also recommended.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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