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Prevalence and Spatial Distribution of Schistosomiasis and Soil-transmitted Helminthiasis in Rural Areas of the Agneby-Tiassa Region (Southern Côte d'Ivoire)

Effoh Kouassi Jean Luc[1,*], Beourou Sylvain[1], Tuo Karim[1], N'guessan Tiacoh Landry[1], Ako Ako Aristide Berenger[1], Yao Serge Stephane[1], Koffi Attoumbré Clément[1], N'docho Tanguy Assi Fiacre[1], Koffi-Didia Adjoba Marthe[2]

[1]Department of Parasitology-Mycology, Institut Pasteur Abidjan Cote d'Ivoire
[2]Institut of Tropical Geography Felix Houphouet Boigny University of Cocody Cote d'Ivoire
*Corresponding author: effohkouassi6@gmail.com

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Abstract A parasitological survey was carried out in the region of l'Agneby-Tiassa (South-East of Ivory Coast) from February to May 2022, in order to make a checking and establish a spatial spreading of schistosomiasis and soil transmitted helminthiases in rural areas in the region of Agnéby-Tiassa among pupils. The stools and urine of 312 pupils aged 8 to 18 years old were analyzed. Each stool's sample was subjected to direct microscopic examination in physiological water, of an enrichment according to the simplified method of Ritchie and a qualitative technique of concentration of Kato. Urine examination was performed on the centrifugation pellet obtained after centrifugation at 2000 revolutions per minute (rpm) for ten minutes. This research revealed the persistence of schistosomes and soil transmitted helminthiasis in this region. We can note that 35% of the stools were positive for *Schistosoma mansoni* eggs, or soil transmitted helminthiasis and protozoa. 25% of urine was positive for *Schistosoma haematobium* eggs. The prevalence was higher in Taabo (31.48%) conceming the schistosomes. As for soil –transmitted helminthiasis, it was higher than in Agboville with a rate of 36.49% and *Schistosoma hematobium* was globally predominant in the region. Boys were significantly more infected than girls and older children were more infected than younger children. This distribution seemed to be linked to the behaviours and the activities of the subject groups.

Keywords: *prevalence, spatial, schistosomiasis, helminthiasis, Agneby-Tiassa*

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1. Introduction

Neglected Tropical Diseases (NTDs) are considered diseases of populations living in poor, low economic income areas where health facilities are lacking [1]. They cause high morbidity and are classified under two groups. They can be visible and/or hidden. These include neglected tropical diseases with case management (NTDs) and neglected tropical diseases preventable by preventive chemotherapy (PTCs) [2]. There are more than 100 of which only six are targeted for chemoprevention: geohelminths (*Ascaris, Trichuris, Ankylostoma, Strongyloides*); *Lymphatic Filariasis; Foodborne Trematode; Schistosomiasis; Trachoma and Onchocerciasis* [1]. Our research focuses on two diseases because of their morbidity and serious consequences over the population. It's about soil-transmitted helminthiasis and schistosomiasis.

Soil-transmitted helminthiases (*Hookworms, Ascaris lumbricoides, Trichuris trichiura, Strongyloides Stercoralis)* affect more than 314 million people in the woeld (Children and Women of childbearing age). In Africa, more than 52 million people are inffected [3]. As for schistosomiasis, it is a parasitic disease transmitted by Schistosomes responsible for urinary schistosomiasis (*Schistosoma haematobium*) and intestinal schistosomiasis (*Schistosoma mansoni*) in human's bodies. [4].

Researches point out that more or less 200 million people are affected by Schistosomiasis in the world and particularly in Africa where it is a real public health problem [1].

To prevent and control these diseases [5]. Advocates five public health strategies which are: expanding chemoprevention; intensifying case detection and management; improving vector control; implementing appropriate veterinary public health measures; and ensuring safe water, sanitation and hygiene.

Chemotherapy plays an important role in the control of these diseases. This has led Who to recommend monitoring the efficacy of Praziquantel in community-based control programs and to propose a protocol for periodic evaluation of resistance to anthelmintic treatments, particularly for schistosomiasis [3]. In addition, some studies have revealed a high frequency of adverse events, sometimes severe, that have provoked hospitalization when treating schistosomiasis infestation.

In Côte d'Ivoire, the results of parasitological surveys have shown that schistosomiasis and soil-transmitted helminthiasis are endemic in certain regions and are even spreading out. The national master plan for the control of neglected tropical diseases has recognized this disease as a public health problem in Côte d'Ivoire.

Indeed, schistosomiasis is highly endemic, with distinct dealing areas [6]. (The two main areas of distribution identified [1] since 2000 are the region of Agnéby in the south of the country and the “18montages” region in the west. The other intestinal helminthiases are equally distributed throughout the country, with high prevalence’s depending on the epidemiological context according to [7].

It is within this framework that this study is even in the region of Agneby-Tiassa. Its general objective is to establish a spatial dealing of soil-transmitted helminthiasis and schistosomiasis in the Agneby-Tiassa region. Specifically, it is a question of firstly determining the prevalence rate, then evaluating the epidemiological profile, and finally showing the co-infection of soil-transmitted helminthiasis and schistosomiasis in the Agneby-Tiassa region.

2. Material and Method

2.1. Site of Research

This research was conducted in the region Agnéby-Tiassa. Indeed; located in the forest south of Côte d'Ivoire and encompassing the southern tip of the ″V″ baoulé savanicole; Agnéby-Tiassa, is one of the regions at high risk of schistosomiasis and soil-transmitted helminthiases. [8]. It covers an area of 9080 km^2 and has 606,852 inhabitants (general population and housing census; 2014) distributed in four departments (Agboville, Tiassale, Sikensi, Taabo) and 16 sub-prefectures. Agnéby-Tiassa is bordered to the north by the regions Moronou and Belier, to the south by the Grands-Ponts region, to the east by the Mé region, and to the west by the regions Grands-Ponts, Gôh and Lôh-Djiboua. The relief is generally flat with some elevations in places. The hydrographic network is dominated by the Bandama, which crosses the departments of Taabo and Tiassalé from north to south. Its main tributary is the N'Zi. There are also several intermittent streams such as the Agnéby.

The exploitation of the activity’s reports of the national program of the control of neglected tropical diseases of 2019 formed the basis of the research. This literature search was complemented by a field visit during the period study. At the level of the Health and Demographic Surveillance System (HDSS) in Taabo, the data archives of the rural localities in terms of control of these different diseases were consulted.

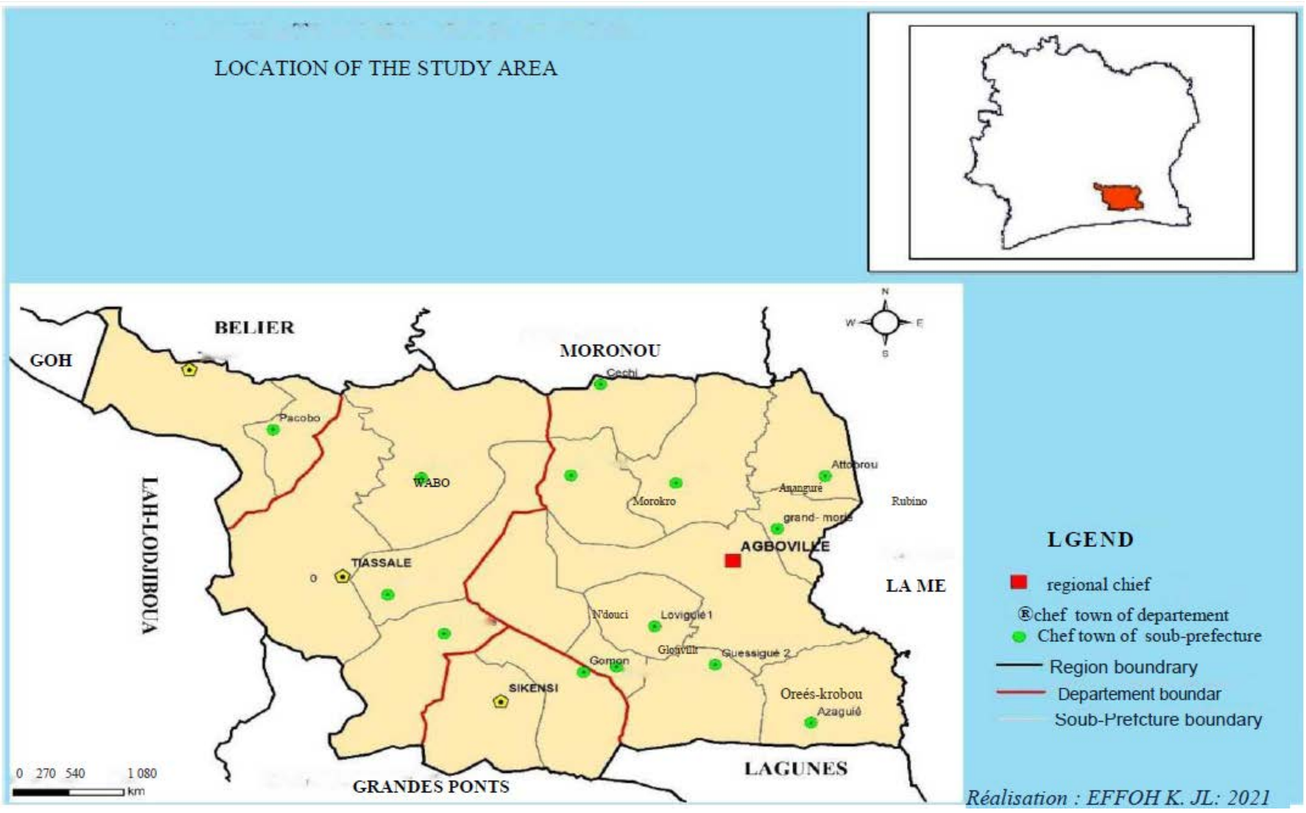

Figure 1. Map of the Agnéby-Tiassa region / SOURCE: Administrative map of Côte d'Ivoire BNETD. 2020

2.2. Study of the Population

It is about an analytical cross-sectional survey made in 18 villages of Agneby-Tiassa region.

The period of the survey (seeking for bibliography and data collecting) lasted from February to May 2022.

~ Inclusion criteria

Child registered in a (public) primary school of the chosen villages for our survey during the school academic year 2020-2021. Any child less or equal to 15yers old

~ Exclusion criteria

Any student who refuses to join the study will be excluded.

2.3. Determining the Size of the Sampling

The Agnéby-Tiassa region is shaped with 175 villages (35 villages in the district area and 140 villages in the rural one).

For the choice of villages, we selected 1 non-communal village per sub-prefecture at random, which gave us 18 villages on which the study was conducted.

After the selection of 18 villages and based on the general population and housing census (RGPH), 2014. A total of 389426 rural inhabitants were identified. By the proportionality coefficient. 20 individuals were interviewed in preference to pupils because of their availability and vulnerability to these pests, and to facilitate the collection of samples and the filling out of survey forms.

To determine the sample size, the sampling technique as proposed by Bernoulli was chosen. It involves three parameters: representativeness, homogeneity and precision. Thus the formula for calculating the sample size is as follows:

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

With

n = size of the sample to be interviewed; t = reduced deviation corresponding to the 95% confidence level; p= proportion of the total target population for our study; e= width of the range expressing the margin of error.

Thus, $n = 1,96^2 x \frac{0,6(1-0,6)}{0,05^2} = 368.7936$ *soit* 369.

The size thus found corresponds to that of the Krejcie and Morgan sample size estimation table at a 95% confidence level and a margin of error of ± 5%.

The children in our sample were selected by forming 18 clusters of 20 students using the two-stage cluster sampling procedure, resulting in a final sample of 369 pupils.

2.3.1. Data Collection

The day before sampling, each child received a survey sheet and two 125ml plastic Petri dishes. The survey form had several items including dependent and independent variables.

Two clean 125 ml jars are given to each student with a survey form to collect their urine, stool and fill out the form.

Samples (urine and stool) are collected the next day with forms filled out by the children and parents

The jars of stool and urine are kept in a cooler covered with ice accumulator in order to maintain them in a fresh state. They are transported within 6 hours to the Parasitology-Myco laboratory at the Institut Pasteur of Cote d'Ivoire.

A total of 312 stool and urine samples were collected and conformed to our study

- Methods of analysis

For each stool sample, the following tests were performed:

A direct microscopic examination, a concentration technique (Ritchie's method) and the KATO technique

-Direct microscopic examination

This is an essential step in the parasitological examination of stools.

~ Operating mode

A drop of saline is placed on a clean and degreased slide. A small amount of fecal matter taken from different parts of the stool is spread on the slide using a hair pick. The spread is covered with a slide and observed at 10x magnification and then at 40x magnification.

2.3.2. Concentration Technique (Ritchie Method)

The stool was diluted in 10% formalin solution, sieved and left to settle for a few seconds; then the supernatant was emulsified with an equal volume of ether, centrifuged at 1500 rpm for 3 minutes, and finally the pellet was examined between slide and cover slip.

2.3.3. The KATO Technique

It is an easy to perform coprological technique that gives excellent results in the study of nematodes

Cellophane squares of 25 x 25 mm are left to soak in diafix for at least 24 hours.

~ Operating mode

On the slide, the mold is placed, then with the spatula, the saddle is removed to fill the mold. The mold is then removed so that only a cylindrical fragment of the stool weighing about 50 mg remains on the slide. This quantity of stool is then covered with the cellophane slide previously soaked in the diafix solution. The preparation is turned over on a blotting paper placed on a flat surface.

Using the thumb, a steady pressure is applied until the sample covers an area approximately equal to the surface of the slide. The blotting paper absorbs the excess liquid in the same time. The preparation is allowed to light up for 15-20 minutes before reading at x l 0 magnification and then at x 40 magnification.

Urine was examined by direct microscopy. Each sample was tested according to the filtration method [9]. It was centrifuged at 1500 rpm for 3 minutes and examine the pellet between slide and slide

3. Results

1. Spatial distribution of overall helminth and schistosomiasis prevalence in the villages study.

Of 244 stool samples examined, 32 contained at least one helminth egg or one Schistosomiasis mansoni egg. This gives an overall prevalence rate of 13.11%.

Out of 251 urine samples examined, 72 contained at least one *Schistosomiasis hematobium* egg, for a prevalence rate of 28.7%.

The results in Figure 2 show that all the villages studied reported at least one case of parasites during the year 2022, only one village did not report a single case of *Schistosomiasis*, that of Taabo-village.

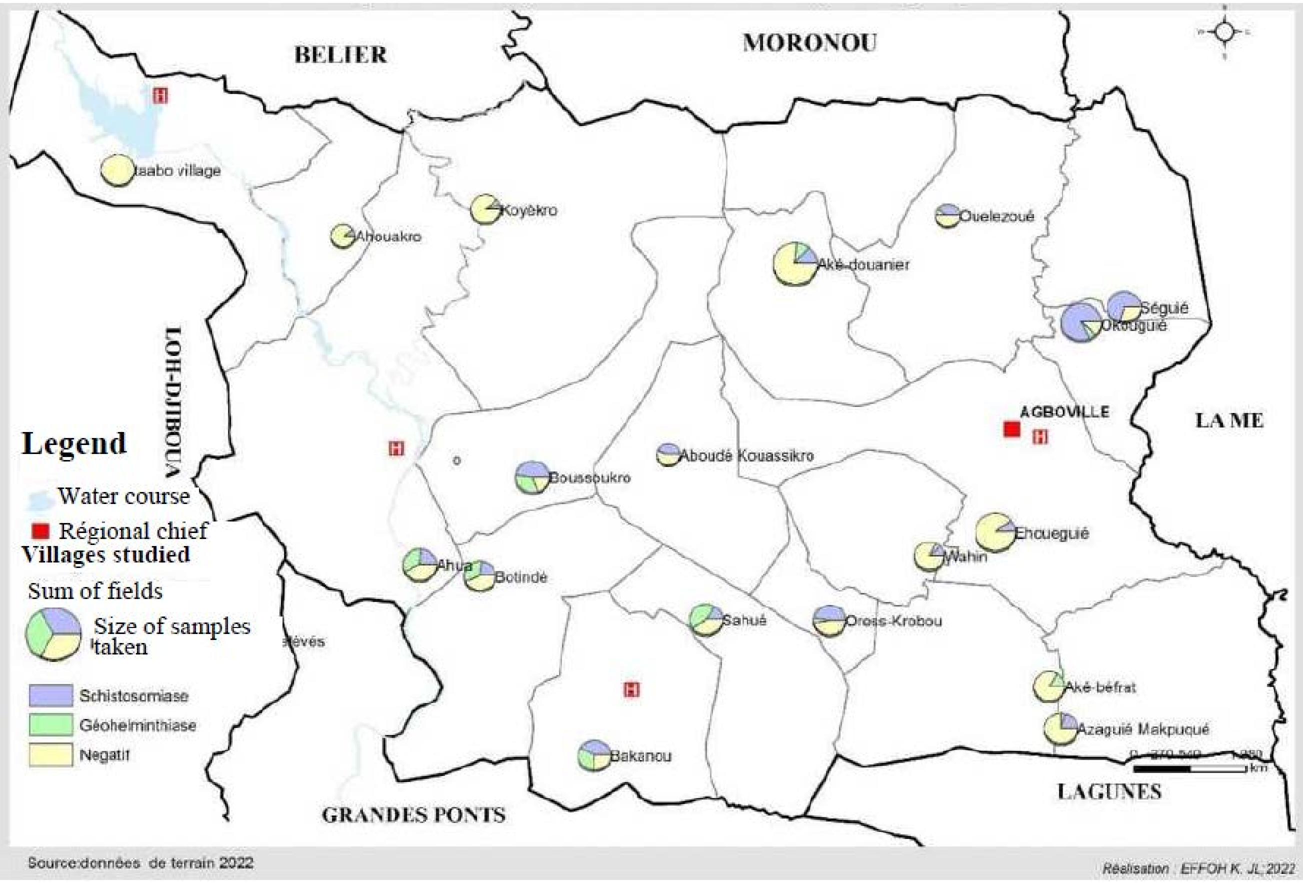

Figure 2. Distribution of examined subjects, parasites and prevalence of parasitosis according to villages

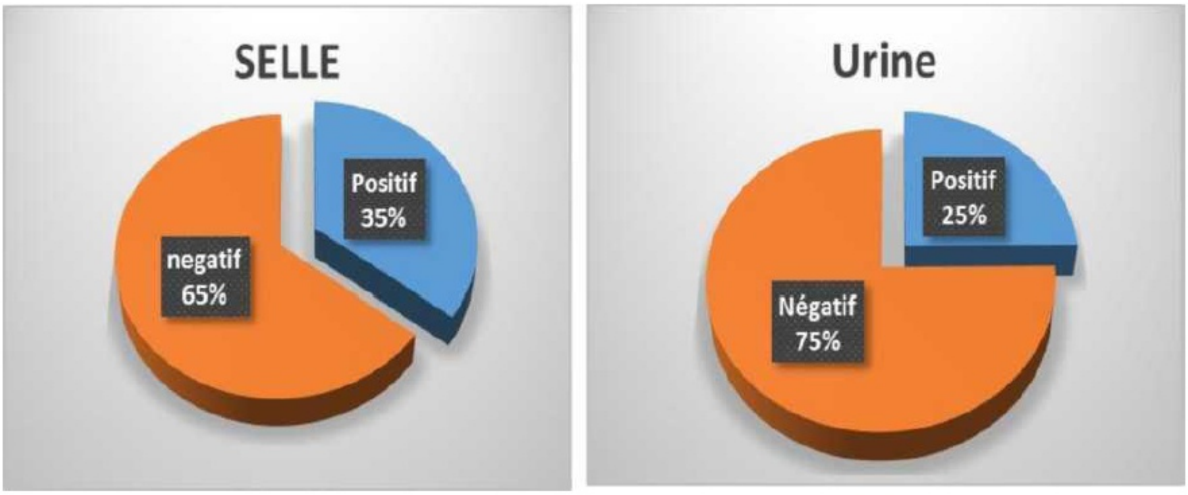

Figure 3. Results of the analysis of the collected stool and urine (**Sources:** our field surveys February to May 2022)

Table 1. Overall result of the stool analysis according to the parasites found

Type of pests	Number of positive saddles	percentage
Schistosomiasis. mansoni	23	7,4
Larvae of anguillules	1	0,3
Dicrocoelium dentriticum	3	0,9
Egg of trichocephalus	4	1,2
Ascaris egg	4	0,2
Intestinal Trichomonas	3	0,9
Entamoeba coli	60	19,4
Endolimax nana	4	1.3
Intestinal Giardia	12	3,8

Sources: Our field surveys February to May 2022.

Figure 3 shows us that 9 parasites were identified in the samples collected during our study. *Entamoeba coli* kytes have the highest prevalence rate of 19.4%. *Schitosomiasis mansoni* (one of the parasites in this study) comes in second place with a prevalence of 7.4%. As helminths our analyses showed the presence of eelwoms lava (1/312echantillions), *Dicrocoelimn dentriticum* eggs (3/312echantillions), *ascaris* eggs (4/312echantillions), *intestinal trichomonas* (3/312echantillions) and *whipworm* eggs (4/312echantillions).

2. Distribution of examined, parasitized and prevalence of helminths and schistosomiasis by village

By analyzing the results of Figure 4, we note that schistosomiasis has a higher proportion than helminths in the villages of Aboudé-kouassikro, Boussoukro, Ehoueguié, Okouguié, Oress- krobou, Ouélézoué, Seguié and Bakanou, i.e. 9/18 villages. On the other hand, 7/18 villages (Wahin, Ahua, Koyékro, Azaguier-makouguier, Batindé, Sahué, Aké befiat and Aké-douanie) have a higher proportion of helminth, the villages of Taabo-villages and Ahouakro tested negative to the two diseases studied during this period.

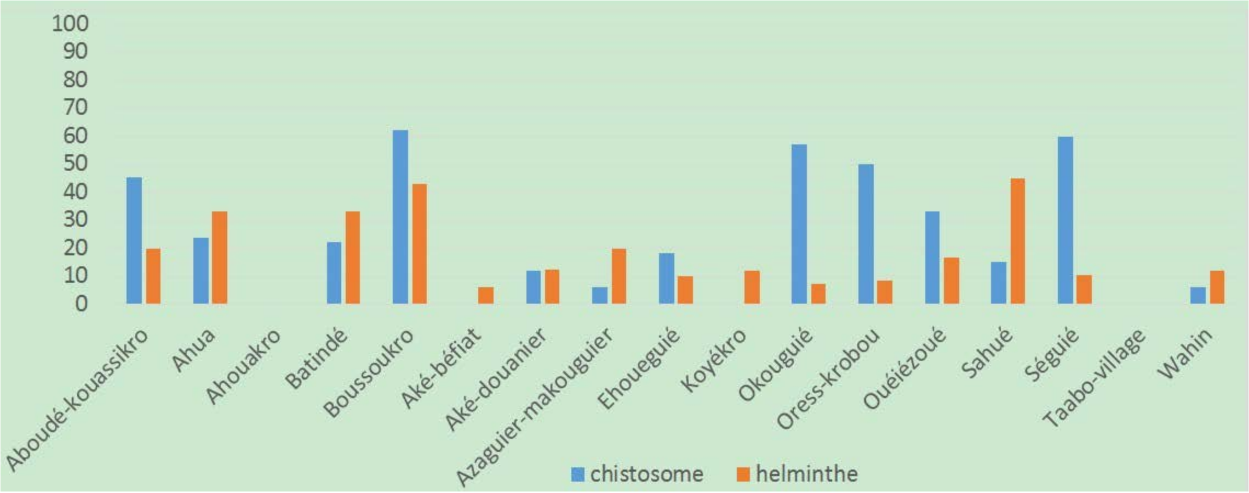

Figure 4. Comparison of the prevalence of schistosomiasis and helminthiasis in the villages studied (Source: *our field surveys February to May 2022)*

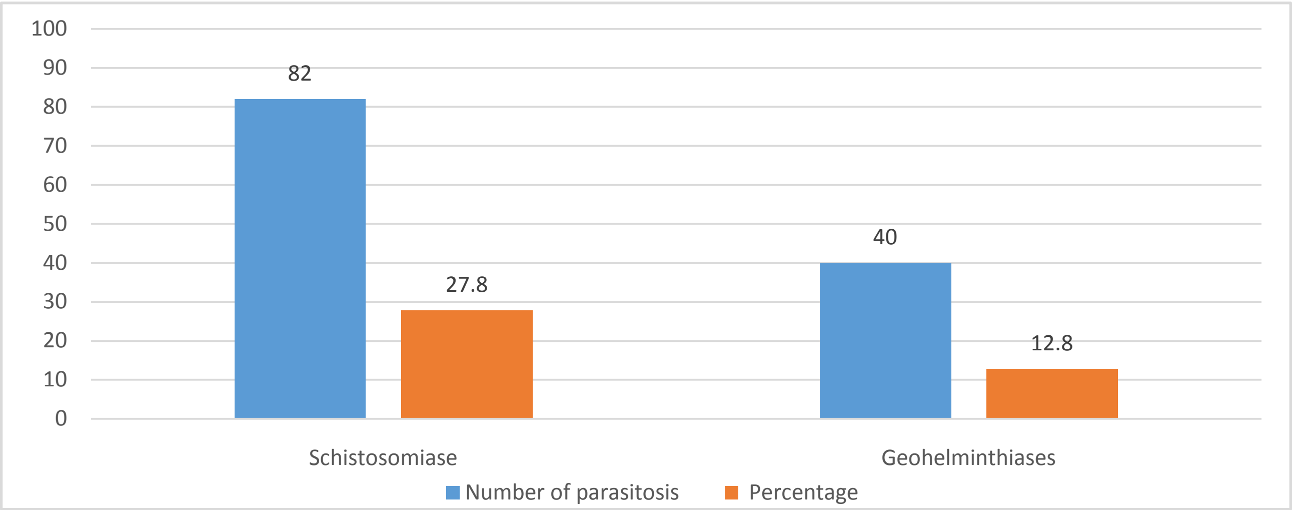

Figure 5. Classification according to the types of parasitosis in the samples (**Source:** *Our field surveys February to May 2022)*

The results of Figure 5 show that among the 312 samples; 12.8% (40/312) are positive for *helminths*; 27.8% for *schistosomes* (82/312).

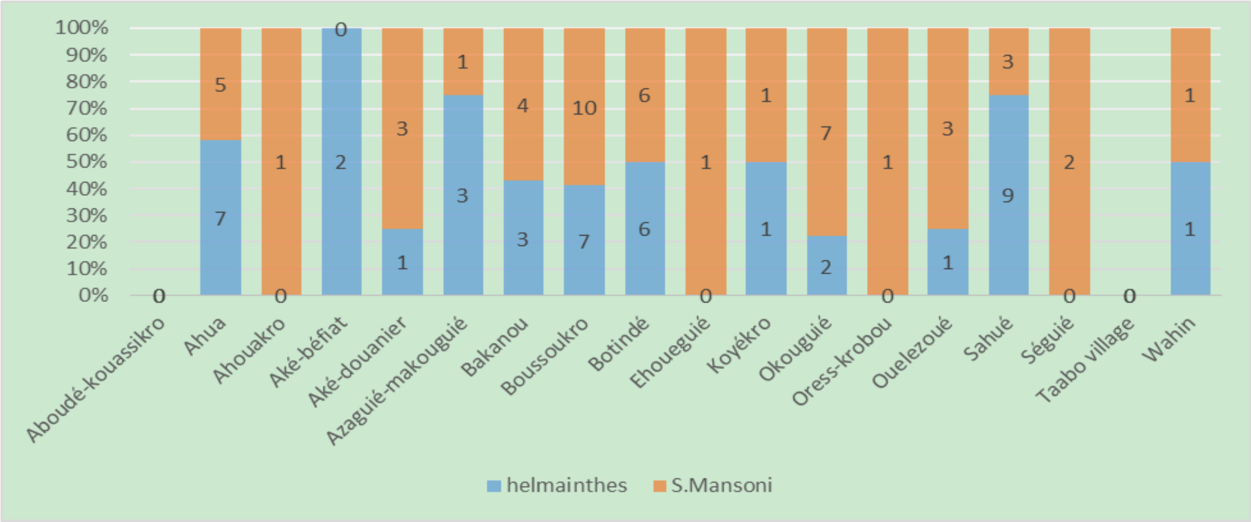

Figure 6. Distribution of parasites found according to villages (**Source**: Our field surveys February to May 20)

The results in Figure 6 show that 10/18 are affected by the parasites studied. Four villages (Ahouakro, Ehoueguié, Oresse-krobou Séguié) are affected only by schistosomiasis. In the village of Ake-befiat only helminths were identified. The results of the examination of samples from two villages (Aboudé-kouassikro and Taabo-village) showed no signs of the two diseases studied during the period of our survey.

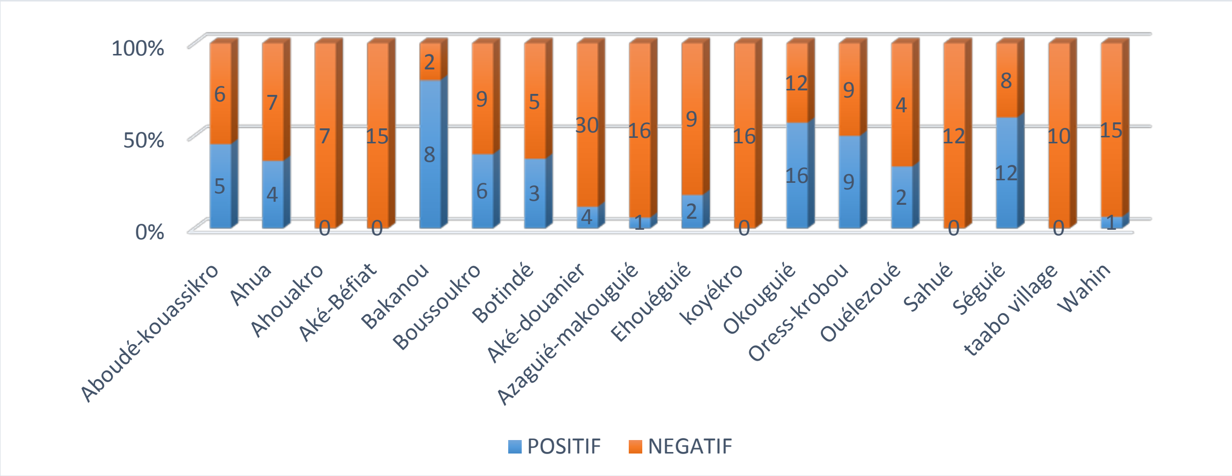

Figure 7. Proportion of positive urine samples by village (**Source**: Our field surveys February to May 2022)

The results of Figure 7 show that schistosomiasis haematobium is identified in nine villages out of 18 villages surveyed. The village of Ahouakro, Sahua, akebefiat, and Taabo-village are not affected by schistosomiasis haematobium.

3-The overall prevalence rate of helminths and schistosomiasis in the Agneby-Tiassa region

The prevalence rate of *schistosomiasis* calculated in Figure 8, shows us that the entire region is impacted by *schistosomiasis.* The lowest prevalence is in the department of Tiassalé, which is 11.13%. The department of Taabo has the highest prevalence rate with 31.48% followed by the department of Sikensi 23% and the department of Agboliville 20.04%.

Unlike *schistosomiasis*, the department of Tiassalé has the highest risk of *geoheminthiasis* with a prevalence rate of 34.84%. The department of Taabo is in second place with a prevalence rate of 26.49%. As for the department of Sikensi, the prevalence (24.31%) is slightly lower than that of Taabo, and the department of Agboville has a prevalence of 11.33%, the lowest in the region.

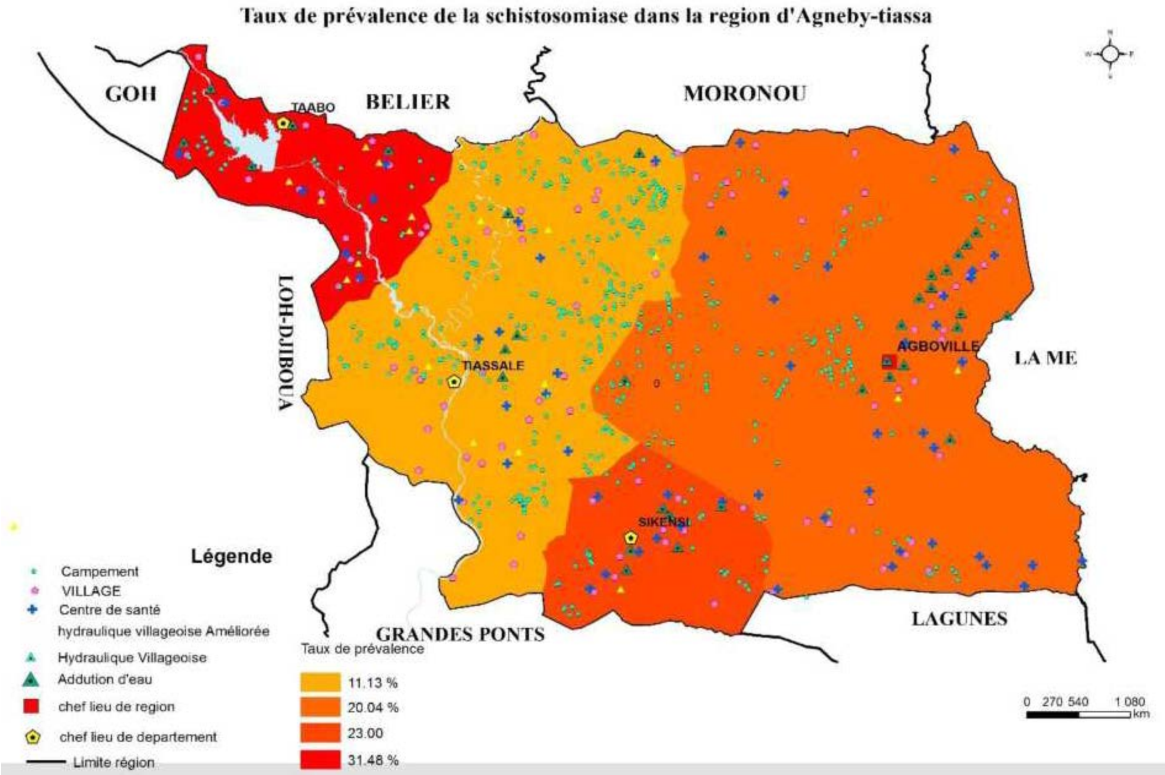

Figure 8. Prevalence rate of *schistosomiasis* in the region by department

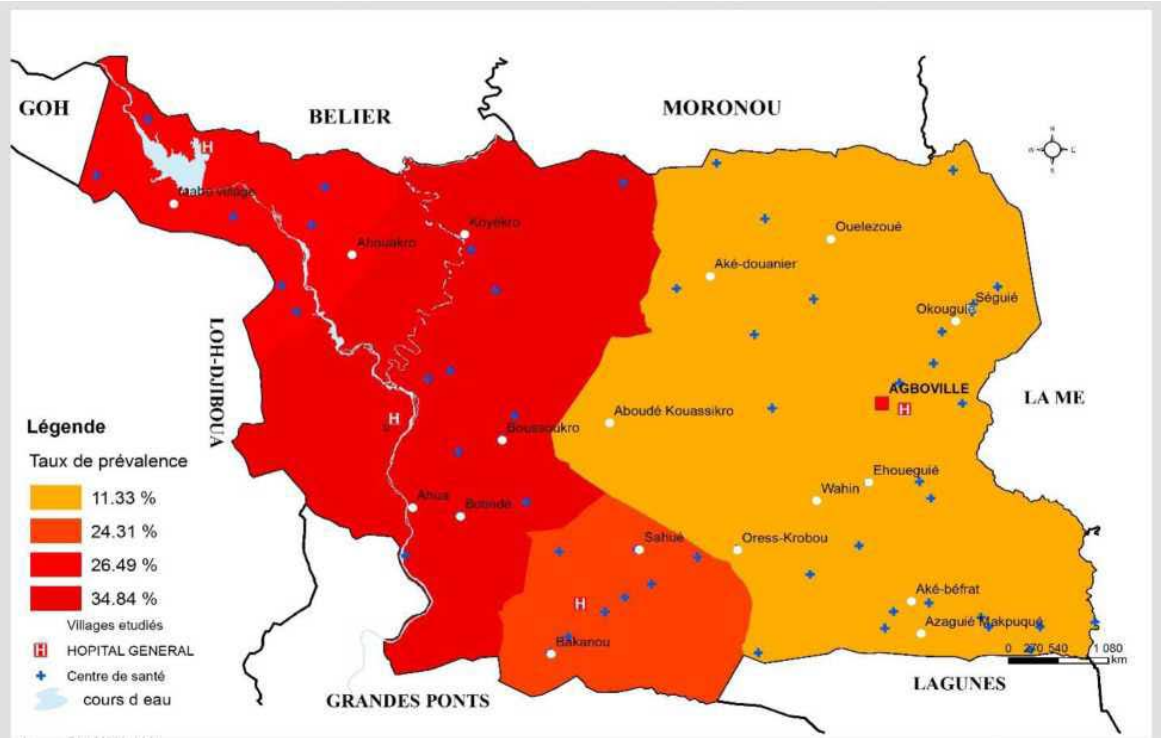

Figure 9. Prevalence rate of *geohelminthiasis* in the region by department

4. Discussion

This research highlighted the prevalence rates of *Schistosomiasis* in the study area. This prevalence was for *urogenital Schistosomiasis* 24.9%, *intestinal Schistosomiasis* 5.4% and 4.1% for *soil-transmitted helminthiases.* These results are comparable to those observed by *Aboubrin et al* (2005). They revealed a 30% prevalence of *Schistosomiasis* in this region with the presence of both species. They are also comparable to the results of [10] who showed that the prevalence of intestinal sail-transmitted *helminthiasis* was 37.5% in Côte d'Ivoire. These results highlight the need for further investigations to identify relevant hygiene determinants for the long-term control of intestinal helminths and schistosomiasis

The research revealed that the village of Taabo-village and koyékro; located near waterways are not a high prevalence area. In contrast, previous studies have shown the opposite results in central and northern Côte d'Ivoire [6].

A previous research in some localities around the Taabo's dam in the villages of Ahondo, Taabo village and Léléblé revealed similar endemicity for *Schistosoma haematobium* (Nicaise and al 2013). In contrast, high endemicity of *Schistosoma haematobium* was observed in the localities of Oressse- krobou, Okouguie and Seguié (villages far from waterways) in our study.

As early as 1970, Paille Rets et al. showed the predominance of *Schistosoma haematobium* (34.7%) over *Schistosoma mansoni* (9.1%) in Agboville with 5% of mixed infection. Similarly, Carrié noted, again in 1970 in Adzopé, prevalences of 26.8% and 7.4% respectively for *Schistosoma haematobium* and *Schistosoma mansoni* and an overall prevalence of 34% for the sub-prefectures of Adzopé and Agroville. The results of this study are in line with those found by [11] in their studies in Malaysia where they found that the rate of parasite development and survival depends on environmental factors such as humidity and temperature. Similarly, Brooker and Michael *(2000)* pointed out that in South America and sub-Saharan Africa, environmental variables would influence the transmission success and spatial pattern of these infections.

Our results, combined with those of various previous studies, allow us to confirm that the region Agnéby- tiassa is a proven focus of *bilharzian* and *helminth* endemic in Côte d'Ivoire. Other foci exist, notably in the center where [6] reported a prevalence of 53% and 73% for *Schistosoma haematobium* respectively in Kossou and Taabo.

The comparison of our results with those established 20-30 years ago allows us to note that bilharzia has not regressed much in the Agneby-Tiassa region despite the few campaigns of deworming of the rural populations. As for helminths, we note a regression in the prevalence of intestinal helminthiasis. This could be explained by the increase in the literacy rate of the population, which has as a corollary the good understanding of health education through the media, especially of the risk of faecal peril, the sanitation efforts undertaken by the local communities, the deworming campaigns with *Albendazole* carried out sporadically by the National Institute of Public Hygiene (However, it must be recognized that the rate of 36.46% is still high and should encourage us to redouble our efforts in the fight against faecal peril and intestinal helminthiasis.

The predominance of *Schistosoma haematobium* is the consequence of the presence of a network of waterways to which the artificial lake has been added and the hygienic behaviors of children. Indeed, this lake can be compared to a dam that modifies the ecology with implantation of *Schistosoma haematobium* [12]. Furthermore, *Schistosoma haematobium* has become predominant in the area. The passage of this dominant species of *Schistosoma haematobium* has been observed in different regions following the modification of their ecology by the construction of dams [1].

In our case, we can't put forward such an explanation, because such developments have not been made in the region.

The remarkable prevalence of *Schistosoma haematobium* around some villages can be easily explained by the fact that children easily release urine into the water when bathing. Regarding the prevalence of *Schistosoma mansoni*, we can nevertheless suggest that the existence of intermediate mollusc host sites, such as ponds, permanent waterways and artificial lakes, is low. In fact, *planorbes* generally live in permanent sites and their actual presence in ponds and the frequent soiling of these water points by children's feces are factors in maintaining the schistosome cycle and perpetuating the bilharzian disease. Children, less subject to rules of modesty, are becoming increasingly rare with the high average standard of living of their parents, they do not have the propensity to relieve themselves in any environment and especially in their play areas and therefore near water points causing a low risk of pollution of surface water. School children play a central role in the transmission and eradication of *schistosomiasis* and *geoheminthiasis because* of the importance of their contact with infested waters and unhealthy places.

5. Conclusion

This work based on the collection of stool and urine samples from 312 children found a prevalence rate of 35.5% and confirmed that Agnéby-Tiassa is a bilharzia and helminthiasis endemic zone. This result is in line with the overall prevalence of the disease in Côte d'Ivoire. This survey confirms this reality and reveals the persistence of the disease in the region.

In addition, they contribute to the perpetuation of poverty by compromising the intellectual development and growth of children and reducing the work capacity and productivity of adults. Combating them is therefore critical to sustaining the progress made by child survival programs, improving the work capacity of communities, and increasing their opportunities for economic development in this region.

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