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Sociodemographic and Economic Factors Associated with Urinary Bilharzia in the Municipalities of Sô-Ava, Aguegues and N'Dali in Benin

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Abstract

Introduction: This research, conducted in the municipalities of Aguégués, Sô-Ava, and N'dali in Benin, focused on identifying socio-demographic and economic factors associated with urinary bilharzia in 415 school-aged children from 8 to 14 years. Using urine test strips and filtration techniques, the study found prevalences ranging from 11.88% to 34.53% across the municipalities. **Method:** Epidemiological data (urine) were collected and examined with test strips to assess the presence of terminal haematuria: the prevalence of infestation and parasite density was quantified using the filtration technique. Socio-demographic and economic factors were recorded using a questionnaire to assess the correlation with disease. **Results:** Prevalences of 34.53% (N = 48 out of 139), 13.53% (N = 18 out of 133) and 11.88% (N = 17 out of 143) respectively for the municipalities of Aguégués, N'dali and Sô Ava were calculated. The study showed that the variables "age", "sex", "religion" and "socio-professional" activity were not significantly correlated with bilharziasis ($p > 0.05$) and it appears that these factors are not related to bilharziasis in the surveyed households. While age, sex, religion, and socio-professional activity showed no significant correlation with bilharziasis, factors like agriculture, fishing, and place of residence were statistically significant in relation to the disease.

Conclusion: The findings suggest that these socio-demographic and economic factors impede the elimination of schistosomiasis in the examined areas.

Keywords

Schistosomiasis, Prevalence, Sociodemographic and Economic Factors, Municipalities, School-Aged Children

1. Introduction

Urinary bilharzia, or schistosomiasis, is a widespread disease in sub-Saharan Africa and is the second most neglected tropical disease in terms of prevalence and public health importance after hookworm disease [1] [2]. Indeed, soil-transmitted helminthiasis is the most tropical negated disease, but the particular complexity of the transmission of schistosomiasis puts it in the spotlight because of its parasites living in certain types of freshwater snails with the infectious form of the parasite known as cercariae which emerges from the snail into the water. It commonly occurs in poorer communities that don't have access to clean water or adequate sanitation. An estimated 779 million are at risk of the disease of whom 106 (13.6%) million live in irrigation schemes or in close proximity to large dam reservoirs [1].

In fact, better access to water and sanitation facilities is an essential condition for reducing various diseases and infant mortality, which is inseparable from a general improvement in health [3]. The number of people exposed worldwide is estimated at 600 million, of whom more than 200 million are infected and nearly 280,000 people die each year from complications, 97% of whom are in Africa, south of the Sahara [2].

In addition, numerous studies carried out in Benin and Ghana on schistosomes and by many researchers reveal the presence of bilharzia in several regions that have been declared endemic zones and whose situation requires epidemiological surveillance [4] [5] [6]. Schistosomiasis is characterized by haematuria as a classic sign.

As a result, water, which is a vector for disease transmission and which normally constitutes an indispensable factor for the survival of man and his environment, becomes an obstacle to economic and social progress when it favours the spread and extension of certain water-borne diseases and, in the context of this study, bilharzia in particular, which is a crucial public health problem.

Because of its importance and usefulness in human life, water is both a strategic resource and the basic element necessary for a healthy economy [7]. The quality of the water supplied is at stake in an economic competition between large industrial groups for what some call "blue gold" [8]. One of the elements that affect health is polluted water, which causes illnesses that alter human health due to its degradation and poor management. [9] [10]

Dianou D., in showing the environmental impact of development projects

implemented in endemic areas by the public authorities, highlighted the effect of intestinal parasitosis in the Sourou hydro-agricultural complex area in Burkina Faso, which favoured an increase in the prevalence of bilharzia [11]. In addition, other factors such as the erection and commissioning of large dams like the Diama dam in Senegal favoured the appearance of the first case of *Schistosoma mansoni* infection in Richard Toll and its spread [12]. It goes without saying that major works by their nature have a socio-demographic impact that causes significant population growth by attracting immigrants who generally have little previous contact with bilharzia [13].

In most of Benin's municipalities, from north to south, epidemiological data and malacological studies on bilharzia reveal the presence of *S. guineensis*, *S. mansoni* and *S. haematobium* with a high prevalence estimated at 96% in several endemic areas [14] [15] [16] [17] [18]. This means that the causes of bilharzia are of several kinds and that it therefore hinders development at the economic, social and even demographic levels, with economic losses that may even have an impact on the social fabric [19]. The numerous preventive campaigns and mass treatments that have been carried out in West Africa are sufficient proof of this [20]. Following the example of West African countries and the recommendations of the WHO, Benin is working to combat schistosomes through screening campaigns and mass treatments in areas considered endemic [6]. By considering the situation analysis of schistosomiasis in sub-Saharan Africa, we need to base on what has already been done as efforts and review new strategies by improving drinking water and infrastructure sanitation according to the level of the communities' problems. It means for the governments in general and in particular the Ministry of Health, the Ministry of Environment and the Ministry of Social Affairs to pool their efforts in anticipation of health development goal. The context of the epidemiological situation in Benin motivated a study on the determination of socio-demographic and economic factors related to bilharzia. The general objective is to study the socio-demographic and economic factors associated with urinary bilharziasis in the municipalities of Sô-Ava, Aguégués and N'dali. It is broken down into three specific objectives which aim to 1) Determine the prevalence of urinary bilharziasis in the municipalities of Sô-Ava, Aguégués and N'dali; 2) To inventory the socio-demographic and economic factors associated with urinary bilharziasis in the municipalities of Sô-Ava, Aguégués and N'dali; 3) To analyse the impact of socio-demographic and economic factors on the occurrence of urinary bilharziasis in the municipalities of Sô-Ava, Aguégués and N'dali.

2. Methods

2.1. Study Setting and Geographical Location

The study was conducted in three (3) municipalities of Benin located in three (3) territorial divisions, namely the regions of Atlantique, Ouémé and Borgou (**Figure 1**). A demographic estimate puts the population of the municipality of

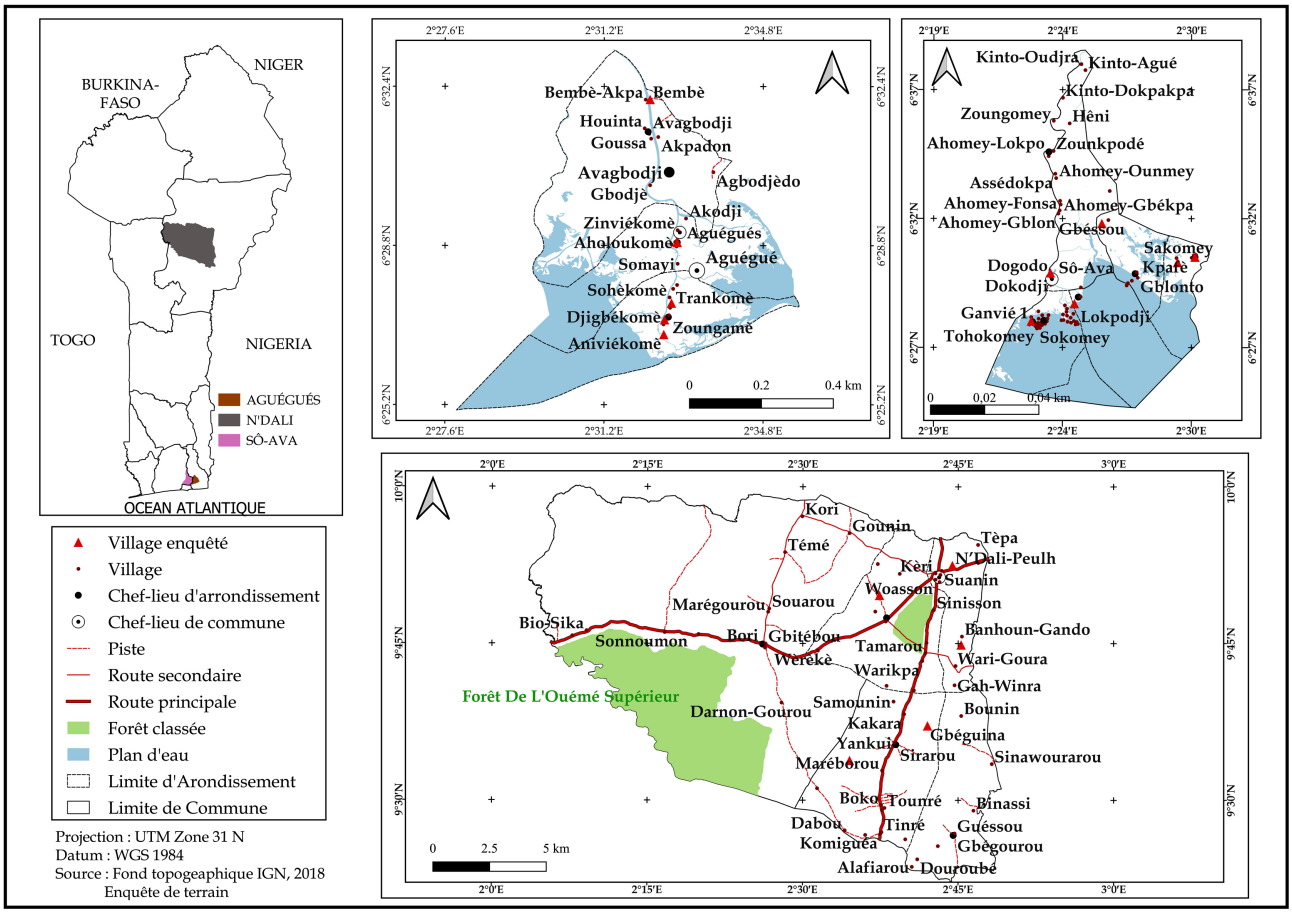

Figure 1. Study areas showing the different collection sites Source: Field AHAMIDE Josias 2022.

Sô-Ava at 118,547 inhabitants spread over 69 villages and town districts. The municipality of Aguégués has 44,562 inhabitants (according to the 4th RGPH) and is subdivided into 23 villages spread over the 3 arrondissements which are: Avagbodji, Houédomè and Zoungamè.

Finally, N'Dali is one of the eight (8) municipalities of the Region of Borgou with a surface area of 3748 km^2 and is composed mainly of two sociolinguistic groups: the Bariba (60%) and the Fulbe (22.5%). There is also a significant colony of Otamari (5.6%), Yom Lokpa (3.8%), Yoruba and Dendi, which represent 2.8% and 1.9% respectively.

2.2. Selection of Sites

This study targets populations consisting of households in the municipalities of Sô-Ava, Aguégués and N'dali. The choice of the study localities is motivated by their endemic character according to the epidemiological data of the national master plan for integrated tropical disease control [6]. The selection of the collection sites was made by a probabilistic choice with the random drawing of schools among all the schools in each municipality. The study is cross-sectional, descriptive, and analytical in nature and was conducted from May to July 2022.

2.3. Sampling

A total of 415 subjects (children) residing in the municipalities of Aguégués (139), Sô-Ava (143) and N'dali (133) were selected in primary public and private schools using a two-stage clustering technique. A sampling interval was used to select a maximum of 16 SAC and a minimum of 14 school-aged children at random with 4 children per class, including 2 boys and 2 girls aged between 8 and 14 years and distributed among classes from Primary three to Primary six. In the first cluster, schools and districts are selected by random probability sampling. In the second cluster, school children (primary target) are selected at random from the schools. The parents or guardians (secondary target) of the selected children are made up of health workers, local elected officials, administrative and technical staff of water, supply and management structures, local authorities, traditional chiefs, and community relays selected by a reasoned choice.

However, it should be noted that all selected children should meet the following inclusion criteria: 1) be aged from 8 - 14 years by living in the three municipalities of Aguégués, Sô Ava, N'dali; 2) be enrolled in a public or private school; 3) have been a permanent resident for at least the last twelve (12) months; 4) have received parental or guardian consent with evidence of "informed consent" signed or their own informed consent. Haematuria was assessed by determining the amount of eggs in the urine.

2.4. Urine Collection for Bilharzia Screening

Children are given water and exercise (fast walking, running, jumping) to move the eggs to the bladder [21] [22] [23]. A 10 ml sample of urine is collected in a sterile bottle from all selected pupils. The urine is then examined in the laboratory with test strips that show the presence of a microscopic haematoma characteristic of genital schistosomiasis. The sample is then passed through a 13 mm diameter millipore filter (20 um Sefar AG, Switzerland) which retains any schistosome eggs which are then counted under a binocular microscope. The test and reading are performed extemporaneously [24] [25] [26].

2.5. Data Collection Tools

- Quantitative data (epidemiological data)

A socio-demographic and economic information questionnaire (age, gender, parents' socio-professional status, level of education, etc.) is digitised using Kobocollect software version 2021.2.4 assisted by a GPS

- Qualitative data

An interview guide is used for resource persons: health workers, administrative and technical staff, officials in charge of water governance, elders, local elected officials and education officials.

Dependent variable: Presence of bilharzia with yes/no (nominal) modalities

Independent variable: Socio-demographic and economic factors:

[Age (continuous/categorical); Sex (nominal); Educational level (ordinal); Level

of prosperity (ordinal); Type of belief (nominal); Household income (continuous/categorical); Socio-occupational status of parents (nominal); Educational level (ordinal)].

2.6. Statistical Analysis of Data/Variables

A descriptive analysis was performed through the means and frequencies of the different variables under study with the Student's t-test on the one hand and the Chi-square test on the other hand using SPSS version 20 software to analyze the relationship between each explanatory variable and the prevalence of urogenital bilharziasis. Then, the binary logistic regression model was developed with the software STATA version 2015 to identify the explanatory factors of the persistence of urogenital bilharziasis in children. The results were interpreted at the 5% threshold.

3. Results

The data collection was carried out in accordance with the methodology defined for the data collection.

3.1. Socio-Demographic Characteristics of Respondents

The socio-demographic characteristics are presented by the description of the socio-demographic profile surveyed on the one hand, and on the other hand, the socio-community living conditions that reflect the realities experienced by the populations in the study localities. (Table 1)

Table 1. Socio-demographic profile and socio-community living conditions of respondents.

Variables	Modalities	Absolute frequencies	Relative frequencies (%)
Municipality	Aguégués	139	33.49
	N'dali	133	32.05
	Sô-Ava	143	34.46
Class	Primary 3	92	22.17
	Primary 4	115	27.71
	Primary 5	113	27.23
	Primary 6	95	22.89
Gender	Female	208	50.12
	Male	207	49.88
Age group	[8 - 10]	189	45.54
	[11 - 12]	189	33.01
	[13 - 14]	37	21.45
Children's use of the marigots	No	110	26.51
	Yes	305	73.49

Continued

Frequency of children's use of the marigot per week	[1 - 6]	47	15.41
	[7 - 15]	258	84.59
Nature of the head of household	Non Indigenous	19	4.58
	Indigenous	396	95.42
Ethnicity of the head of the household	Other	11	2.65
	Fon	6	1.45
	Goun	135	32.53
	Idatcha	4	0.96
	Nagot	3	0.72
	Peulh	116	27.95
	Toffin	140	33.73
Availability of drinking water	No	12	2.89
	Yes	403	97.11
The nearest drinking water point to the Household	Drilling	289	70.6
	Soneb	114	28.43
	Less than 500 m	329	83.51
Class Distance from the nearest drinking water point to the household	More than 500 m	74	16.49
Attendance at the nearest alternative source	No	12	2.89
	Yes	403	97.11
Estimated cost of drinking water for the household	Cheaper	97	23.37
	Too expensive	318	76.63
Existence of a latrine	No	303	73.01
	Yes	112	26.99

The study population made up of children is distributed among the three age groups [8 - 10], [11 - 12] and [13 - 14] in proportions of 45.54%, 33.01% and 21.45% respectively. Indigenous heads of households (95.42%) are much more important than non-indigenous heads of households (4.58%). Out of 100%, only 26% have latrines while 73.01% do not. A proportion of 76.63% said that water is very expensive, while 23.37% said they were able to afford it. A very high proportion of children go to the watercourses (73.49%) and 84.59% of children go to the watercourses on a daily basis (7 and 15 times a week). The nearest drinking water source is less than 500 m away for 83.51% and more than 500 m away for 16.43% of respondents. The availability of drinking water is confirmed in 97.11% and denied by 2.89% of the study population. The borehole is the drinking water point used by 70.6% of the respondents, as opposed to 28.43% of people who use water from the Soneb.

3.2. Prevalence of Bilharzia

The distribution of the prevalence of bilharzia is shown in the study population by municipality, age group, sex, class and religious affiliation. (Table 2). Children in the municipality of Aguégués are significantly more infested with 35.25% (N = 49) of positive cases; 13.53% (N = 18) of positive cases for N'dali and 11.89% (N = 17) of positive cases for Sô Ava ($p < 0.05$) (Table 2). The prevalence of bilharzia infection in households in the three study municipalities was not statistically significant by gender, class, age or religion. (Table 2). N = number of volunteers; positive = parasite subjects; p = prevalence (in %). (Table 2)

Table 2. Distribution of bilharzia prevalence.

	Municipalities								p-value associated with Student's test
	Aguégués		Sô-Ava		N'dali		Total		
	Positive/n	P (%)	Positive/n	P (%)	Positive/n	P (%)	Positive/n	P (%)	
Distribution by municipality	49/139	35.25	17/143	11.89	18/133	13.53	84/415	20.24	0.0001***
Distribution by gender									
Female	26/69	37.68	07/75	9.33	09/64	14.06	41/207	19.81	0.096
Male	23/70	32.86	10/68	14.71	09/69	13.04	43/208	20.67	
Total	**49/139**	**35.25**	**17/143**	**11.89**	**18/133**	**13.53**	**84/415**	**20.24**	
Age Distribution									
[8 - 10]	27/74		06/46		10/69		42/189	22.22	
[11 - 12]	20/57		10/76		07/56		37/189	19.57	0.942
[13 - 14]	02/08		01/21		02/8		5/37	13.51	
Total	**49/139**		**17/143**		**19/133**		**84/415**	**20.24**	
Distribution by class									
Primary 3	07/30	23.33	04/36	11.11	04/26	15.38	15/92	16.30	
Primary 4	13/37	35.13	05/33	15.15	07/45	15.55	25/115	21.74	0.764
Primary 5	17/44	38.63	05/37	13.51	02/32	6.25	24/113	21.24	
Primary 6	11/28	39.29	04/37	10.81	05/30	16.67	20/95	21.05	
Total	**48/139**	**34.53**	**18/143**	**12.59**	**18/133**	**13.53**	**84/415**	**20.24**	
Distribution by religion									
Animism	00/02	0.00	01/18	5.56	00/02	0.00	01/22	4.55	
Christianity	45/120	37.5	14/110	12.72	05/42	11.90	64/272	23.53	0.817
Islam	4/17	23.53	02/15	13.33	13/89	14.61	19/121	15.70	
Total	**49/139**	**35.25**	**17/143**	**11.89**	**18/133**	**13.53**	**84/415**	**20.24**	

3.3. Impact of Socio-Demographic and Economic Factors on the Occurrence of Urinary Bilharzia in the Municipalities of Sô-Ava, Aguégués and N'dali

The results of the Pearson Chi-square test are presented with a distribution of the prevalence of bilharzia according to the place of residence, level of education, age, religion, sex and socio-occupational category. (Table 3)

The Pearson correlation test conducted indicates that there is a strong correlation ($p < 0.005$); between place of residence, education level and the presence of Bilharzia in the household (Table 3). This implies that the environments in which schools are located and the living conditions are not well available to good hygiene. Indeed, they are risk factors and could facilitate the spread of the disease and as long as they exist, the distribution of schistosomiasis will depend on them.

Moreover, the results of the "logit model" estimation test are also characterized by the highlighting of the variables "place of residence", "agriculture" and "fishing" as the main activities, all of which are significant at the 1% threshold (p = 0.000) for an efficient estimation result. (Table 4) and the model shows that these professional activities and the place of residence represent associated factors of the transmission of schistosomiasis and the reduction of prevalence depends on them.

Finally, the Pearson test carried out is not statistically significant ($p > 0.005$) for the variables gender, age, religion, socio-professional activity of the child's parent and shows the absence of correlation between them and the presence of Bilharzia in the household. (Table 3). This means that the spread of bilharziasis does not depend on these variables of our study's population Therefore, it appears that those associated factors have an impact on the resurgence on bilharziasis but not statistically significant.

4. Discussion

This research work has elucidated the main social, demographic and economic

Table 3. Results of the Pearson Chi-square test.

Variables	Value	Ddl	Asymptotic significance (bilateral)
Presence of Bilharzia* Location	123.727[a]	86	0.005**
Presence of Bilharzia* Level of Education	324.908[a]	215	0.0001***
Presence of Bilharzia* sex	45.176[a]	43	0.381
Presence of Bilharzia* Age	257.443[a]	387	1.000
Presence of Bilharzia* Religion	59.671	86	0.986
Presence of Bilharzia* Socio-occupational category	59.671[a]	86	0.986

Table 4. Results of the estimation of the logit model.

Variables	Odds Ratio	Standard errors	$p > \|z\|$
Place of residence	0.444	0.081	0.000***
Gender	0.910	0.241	0.723
Age	0.752	0.162	0.188
Religion	1.156	0.692	0.606
Agriculture	0.340	0.124	0.003***
Fishing	3.473	1.237	0.000***
Level of education	1.075	0.113	0.486
Logistic regression			
Number of observations = 415			
Log likelihood = -185.359			
	LR chi^2 (6) = 44.17		
	prob > chi^2 = 0.000		
	Pseudo R^2 = 0.65		

*Significant at 10%; **Significant at 5%; ***Significant at 1%.

factors associated with the persistence and resurgence of schistosomiasis in potentially endemic areas. Indeed, the study revealed that urinary bilharziasis is present in the three localities surveyed, namely the municipalities of Aguégués, Sô-Ava and N'dali, with prevalences in unevenly distributed proportions of 34.53%, 11.89% and 13.53% respectively, depending on the type of municipality, gender, age group, religious affiliation, socio-professional activity and level of education.

4.1. Socio-Demographic Factors in the Municipalities of Aguégués, N'dali and Sô Ava

Out of the 415 children participating in the study, the oldest children affected were 14 years old, while the youngest were 8 years old, with an average age of 11. The affected children come from parents belonging to all the socio-occupational categories encountered, but in varying proportions. As many boys as girls are affected by the disease and in a higher proportion among boys than girls. The study thus highlighted the persistence of bilharzia in the municipalities of Aguégués, Sô Ava and N'dali with a highly significant statistical difference ($p<0.005$) confirming the conclusions of the mapping of the National Master Plan for the Integrated Control of Neglected Tropical Diseases [5] and the results of certain studies carried out in the South and North of Benin [15] [16] [17] as well as those of other West African countries such as Togo [27], Burkina Faso [28], Côte d'Ivoire [29] and Ghana [30]. Despite the reduction in prevalence compared to data from previous studies in Benin [5] [15] [17], the disease remains predominant in the region of Aguégués, particularly in the village of

Kindji with a rate of 75.53%. The different prevalences calculated with an average of 20.24% for the three municipalities illustrate the presence of bilharziasis as in Yemen in a young population composed of children of school age less than or equal to 15 years with a prevalence of 31.8% [31]. Ibikounlé *et al.* showing the evidence of this epidemiological situation during a malacological survey in Péhunko in Benin in 2014 proved the existence of schistosomiasis with an overall prevalence of infestation of 29.40% for distribution of 36.67% (N = 769) of boys significantly higher than girls found positive in a proportion of 22.08% (N = 816) (Z = 6.111; $p < 0.05$) [18]. Thus, the situation of Kindji village sufficiently testifies to the results of the epidemiological data considering the notorious insufficiency of socio-sanitary infrastructures in certain localities and moreover the problems of accessibility to drinking water characterized by the numerous distances travelled by the populations to brave watercourses and/or shallows often barefoot or rarely with very poor quality shoes. Overall, our study did not show a statistically significant difference ($p > 0.05$) in bilharzia infection for all the age groups considered, which contrasts with the data from the work of Ibikounlé *et al.* carried out in the south and north of Benin, whose results are statistically significant (Z = 4.193, $p < 0.05$); (Z = 3.002, $p < 0.05$) for children aged 7 to 8 years on the one hand and those aged 10 years and less on the other hand whose urine filtration revealed them to be more affected by *S. haematobium* [15] [16] [17]. Elias Asuming-Brempong *et al.* in their study in Pakro, Ghana corroborated Ibikounlé's findings with children aged 10 - 14 years and 11 - 15 years having a very high prevalence of *S. haematobium* positive children [30] as opposed to those aged 16 - 20 years. This suggests that there is a spillover effect of younger children escaping parental control and being influenced by older children through recreational bathing activities that expose them to schistosomiasis-inducing mollusc beds. The study also showed that the disease is not significantly related to age or sex ($p > 0.05$), which is not in line with the work of Ibikounlé *et al.* carried out in Péhunco where boys are significantly more affected with 36.67% (N = 769) against 22.55% (N = 816) of girls ($Z = 6.111$; $p < 0.05$) [17]. This gap obtained in our study with regards to age and sex could be explained on the one hand by the behaviour of children which varies from one locality to another according to the social category and the standard of living of the parents with regard to age, and on the other hand, the non-significance of the disease with regard to sex would be linked to the management of mothers to mobilise their daughters in the exercise of domestic work which forces them to be less interested in bathing activities than the boys. This is what emerges from the work of Koukounari A. from Burkina Faso *et al.*, which reinforces our point of view on the vulnerability of young people, like adults, to schistosomiasis, the transmission of which is not significantly linked to age or sex, let alone to the child's class [28]. Adounbryn KD. From Côte d'Ivoire [29], Salem Ould Ahmed CB, *et al.* from Mauritania [31], in supporting this idea, also concluded that boys and girls practising the same bathing and fishing activities, whatever their age,

are all exposed to schistosomiasis in the same way.

With regard to the availability of drinking water and the distance people travel to look for water, the study showed a highly significant statistical difference ($p < 0.0005$). These results are supported by Expédit W. *et al.* who also mentioned the difficulties encountered by the populations of Toffo in accessing drinking water where 50% of the inhabitants resort to water sources located in an unhealthy environment and 13% use water from the Aguè and Kpomè rivers for domestic use, which are responsible for water-borne diseases such as schistosomiasis, acute respiratory infections, malaria and even cardiovascular diseases [32]. This justifies the humanitarian actions carried out by certain non-profit organisations, including Emmaus International and the Association des Usagers Acteurs de l'Eau et d'Assainissement à Nokoué (AUAEAN) in Sô Ava, by providing villages with socio-sanitary infrastructures. Danielle M. Cribb *et al.*, in a study on the impact of schistosomiasis control interventions, emphasised the need to improve drinking water supply, sanitation and behavioural hygiene in order to reduce the prevalence of bilharzia in endemic areas [33]. However, the results reported by Hany Sady *et al.* contrast with those obtained in this study. According to the authors, the provision of safe water sources to populations living in endemic areas still does not have a statistically significant effect ($p > 0.05$) and therefore cannot have a positive impact on beneficiaries [34]. Indeed, his respondents stated that the presence of supposedly potable water pumping stations even in their immediate environment did not prevent them from regularly going to streams and rivers which, although located quite far from their homes, gave them more satisfaction. This explains the significantly (41.6%; 95% CI = 33.3, 50.4) higher prevalence of infection among children living near a stream and/or spring and/or pond who engage in swimming activities [34]. This situation would raise the issue of objectivity in assessing the real needs of the populations and taking into account the parameters relating to the gender approach representing the best actor in household water supply and particularly communication with all stakeholders before the implementation of community development projects. Finally, the study showed non-significance ($p > 0.05$) of bilharzia transmission in relation to religion but contrasts with the results of Bagayan M. *et al.* who showed a significant difference according to religion and place of residence ($p < 0.001$) [35]. This statistical difference obtained in our study would be rooted on the one hand in the professional activities that are mostly common to almost all the communities encountered in our study localities and on the other hand in the way of life to which people living in precarious conditions specific to vulnerable populations who are exposed to neglected tropical diseases are subjected.

4.2. Logistic Regression Showing the Association between Risk Factors (Place of Residence and Work Activities) and the Occurrence of Bilharzia

The results of the estimation of the logit model for the association of risk factors

related to schistosomiasis identified a strong correlation ($p < 0.005$) between the disease and the place of residence of the households surveyed. The work of Soro Pewonheta during a survey in the town of Korhogo supported by that of M'bra *et al.* carried out on the erection of a dam where different activities are carried out by the populations in relation to bathing, fishing and hydro-agricultural activities provide sufficient proof of this [36] [37]. The association between risk factors and schistosomiasis is clearly demonstrated by the logistic regression showing the correlation of dependent variable (bilharzias) and the independent variable (place of residence). Stefano Catalano *et al.* has added to this observation by highlighting the ecological and social factors whose intersection in certain geographical areas explains the contribution of rodents to the zoonotic transmission of *S mansoni [38]*. Furthermore, the results of bilharzia infection in relation to the child's level of education are statistically significant and are in line with those of Ibikounlé *et al.*, who showed a high significance ($Z = 4.193$, $p < 0.05$); ($Z = 3.002$, $p < 0.05$) for *S. haematobium* infection. This shows that younger children with a low level of education are more exposed than older children [16] [18], which raises the issue of health education in schools. Clearly, the more educated children are, the lower the risk of schistosomiasis infection. This risk is further reduced when the child is educated about behavioural hygiene, particularly about schistosomiasis, with the support of parental education. Finally, the study showed that the professional activity carried out by the populations surveyed was not statistically significant ($p > 0.005$) with the occurrence of bilharzia. Our results are contrary to the opinions of Kouassi Konan *et al.* in Gagnoa and Yapi, whose work shows a significant statistical difference with professional activity [39] [40], which would seem to suggest a variability in the sites of contamination and/or the nature of the molluscs responsible for the transmission of bilharzia. Finally, it should be noted that the factors impacting on the occurrence of the disease are illustrated as "place of residence", "agriculture" and "fishing" and are significantly associated in the municipalities of Sô-Ava, Aguégués and N'dali with respective probabilities of 0.000, 0.03 and 0.0000. Indeed, the results of the Pearson Chi-square test showed statistically that the socio-professional activity is not significant to the presence of bilharzia in the household, however it appears that the binary logistic regression model highlighting the association between risk factors and the occurrence of bilharzia proved that the variables "agriculture" and "fishing" represented by the professional activity present a much higher risk and are strongly significant ($p < 0.005$) *as* well as the variable "place of residence" at the 1% threshold ($p = 0.000$). This is what the study underlines by showing that children whose parents fish have 0.34 times (odds ratio = 0.34) more risk of being infected. The logistic regression shows that the risk is multiplied by 3 in children whose parents practice fishing (odds ratio = 3.473) and can be explained by the fact that fishing is the main economic activity that promotes permanent contact with contaminated water. These results are strongly supported by Hany Sady *et al.* who showed in their

study a significantly higher prevalence of infection in children who lived near a stream or pond (41.6%; 95% CI = 33.3, 50.4) and engaged in swimming activities [34].

5. Conclusion

The study of socio-demographic and economic factors associated with bilharzia carried out in the municipalities of Sô Ava, N'dali and Aguégués revealed the persistence of the disease in all the localities surveyed. It is true that periodic mass treatments have led to a considerable reduction in the prevalence rate in the endemic areas compared to the previous data from the base mapping. It is therefore necessary to maintain the course of chemotherapy which, however, remains an insufficient weapon considering the practices and behaviors observed among the populations in relation to lifestyle which are not in line with the elimination of the disease. Clearly, it would seem appropriate to take stock of the knowledge, attitudes and practices of adults on the use of and relationship with water, which could undoubtedly have an impact on the persistence and resurgence of bilharzia. We can finally conclude that socio-demographic and economic factors related to bilharzia do not facilitate the elimination of schistosomiasis in the study areas. A household knowledge-attitude-practice (KAP) survey is needed to provide more information.

6. Limitations of the Study

This research work does not pretend to describe all aspects that contribute to the contamination of rivers with schistosome eggs but aims to identify economic factors associated with the persistence and resurgence of schistosomiasis in potentially endemic areas. In spite of all the advantages of this study, it seems necessary to point out the limitations that in one way or another could have an impact on the collection process. These include errors related to non-compliance with certain instructions given by the interviewers, which could lead to some bias. Errors related to the administration of the questionnaires by the interviewers during the collection of information. Finally, there were errors related to the difficulty of collecting socio-demographic information simultaneously from children and their parents, who leave very early and sometimes very late to attend to their professional duties.

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Declarations

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I declare on my honor that I have never received since the beginning of the activities in the framework of this research till now any funding. In any case, all the investments are made with the funds of the PhD. student in Public Health that I am

Ethical Approval

The study required the approval of the National Committee for Ethics and Health Research (NCEHR) and free and informed consent is signed by all school children and the parents or guardians of the school children. Treatment with Praziquantel chemotherapy is given to all enrolled children regardless of the outcome.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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