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Epidemiology of *Ascaris lumbricoides* and *Trichuris trichiura* infestations in students at the University Félix HOUPHOUËT-BOIGNY in the south of Ivory Coast

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ABSTRACT: Helminthiasis is a major public health problem in Africa, particularly in Côte d'Ivoire. This study was conducted at the University Félix HOUPHOUËT-BOIGNY in southern Côte d'Ivoire. It aims to assess the epidemiological status of *Ascaris lumbricoides* and *Trichuris trichiura* infections in students at the University Félix HOUPHOUËT-BOIGNY. The survey involved 226 students sampled in 03 university courses. Stool samples were taken. Feces were analysed by the Mini-Flotac method with an flotation solution consisting of analytical salts (NaCl) with a density of 1.2. The results of stool analysis revealed a prevalence of 23.45% for *Ascaris lumbricoides* infection and 16.81% for *Trichirus trichiura* infection, respectively. The prevalences of *Ascaris lumbricoides* and *Trichirus trichiura* infections did not differ significantly by sex and age group. All infested students had a low infestation density (100 %) for *Ascaris lumbricoides* and *Trichirus trichiura* infections. A questionnaire was sent to the students to collect information on the transmission of *Ascaris lumbricoides* and *Trichirus trichiura* infections. The main factors of transmission, including toilet attendance and toilet cleaning, were incriminated. This study assessed the level of endemicity of *Ascaris lumbricoides* and *Trichirus trichiura* infections at the university and will help to consider appropriate means for the control of these parasitic diseases.

KEYWORDS: Côte d'ivoire, Helminthias, infection, students, University.

1 INTRODUCTION

In sub-Saharan Africa, intestinal helminthiases are pathologies due to digestive germs, which are very widespread. They represent a major public health problem, particularly in areas where hygiene conditions are precarious [1]. The organization of several forums on Water, Hygiene and Sanitation (WASH) (Marrakech in 1997, The Hague in 2000, Kyoto in 2003, Mexico City in 2006 and Senegal in 2012) testifies to the magnitude of this problem in developing countries [2]. According to the report of the WHO/UNICEF Joint Programme on Water, Hygiene and Sanitation (WASH), it is estimated that there are more than 2.5 billion people in the world, including 550 million in sub-Saharan Africa, who do not have access to minimum hygiene conditions [3], [4], [5], [6]. Risks to human health are undoubtedly the most serious and widespread problem. Every year, about 3.5 million people die from gastrointestinal diseases, especially in developing countries [7], [8]. The health of a population is therefore closely linked to the quality of sanitation and hygiene services [9].

In developing countries, poor hygiene and lack of basic sanitation are the basis for many diseases, especially gastrointestinal diseases [4], [10], [11] [12]., [13]. These are the same causes of absenteeism from school and work, and thus of low educational attainment and significant economic and income losses in a developing country [4], [14]. They represent an enormous burden for these countries [15], [16]. Indeed, the physical environment and the degree of cleanliness of training structures have an impact on the health and well-being of learners. If this environment does not have acceptable sanitation and hygiene conditions such as good hand-washing and toilet facilities, diseases develop and spread rapidly. It becomes a high-risk space for learners, increasing their vulnerability to disease [17]. Yet the provision of hygiene and sanitation facilities could reduce these gastrointestinal diseases by up to 90% [17], [18] [19]., [20].

In a context of poor hygiene and sanitation denounced by some authors among students at the University Félix HOUPHOUET-BOIGNY [21], [22]), it seemed appropriate to assess the prevalence, intensity and epidemiological profile of intestinal helminthiases at the University Félix HOUPHOUET-BOIGNY. The objectives were to:

1) Determine the prevalences of *Ascaris lumbricoides* and *Trichuris trichura* infections;
2) To determine their parasitic loads and intensities;
3) Compare the level of endemicity of *Ascaris lumbricoides* and *Trichuris trichura* infections.

2 METHODOLOGY

2.1 PRESENTATION OF THE STUDY AREA

The study took place from 27 February to 15 March 2020 at the University Félix Houphouët-Boigny (Fig. 1) of Cocody in the district of Abidjan (Côte d'Ivoire). It is the main University of Côte d'Ivoire. It is located between 5° 20 and 5° 38 north latitude and 3° 48 and 3° 49 west longitude. It has 60,000 students, according to the 2016 census [18]. The climate is equatorial [23] characterized by two rainy seasons (A small one from September to October, a large one from April to July) interspersed by two dry seasons (A small one from July to August, a large one from November to March). The temperature oscillates between 25 and 33°C, with a high rainfall of more than 1500 mm of rain per year [24].

2.2 DATA COLLECTION METHODOLOGY

2.2.1 DATA COLLECTION

The investigation began with a presentation of the study on the WhatsApp, Messenger and Facebook groups of students and in amphitheater. The registration of the participants which consisted of collecting their names and phone numbers via WhatsApp and Messenger. Stool samples were collected over a period of February 13-29, 2020 depending on student availability. After labeling each individual's stool jar, they were asked to make the stool and transfer a portion to the jar. Early the next morning, the stool samples were collected at the study site and placed in a cool place. The stool samples were transported under room temperature conditions to the laboratory and stored at 37°C. For a given sample, 2 g of stool was stored in a tube containing 2 ml of 5% formalin for further analysis 7-14 days later. Each participant was given a barcode number to identify their biological sample. In order to identify potential factors for transmission of intestinal helminths, namely *Ascaris lumbricoides* and *Trichurus trichiura* infections, a questionnaire was administered to individuals who had participated in the parasitological surveys.

2.2.2 SAMPLE ANALYSIS

To prepare the Mini-Flotac solutions, the contents of each stool tube were transferred to the conical Flotac collector. The 40 ml volume of the analytical salt solution (Flotation Solution: FS) was added to the stool [25], [26]. The conical Flotac collector was tightly closed and lightly shaken for 1 min to facilitate dissolution and homogenization of the stool suspension in the flotation solution. A precision tip grafted onto the side trunk of the conical collector allowed the transfer of the stool solution into each chamber of the Mini-Flotac apparatus. The prepared Mini-Flotac solutions were left to stand for 10 minutes to allow the eggs of the parasites to rise to the surface of the solution by the principle of flotation of eggs with a density lower than that of the flotation liquid [27] The preparation time before microscopic analysis was estimated at 12 minutes. Two minutes to prepare the sample, then 10 minutes to wait for the eggs or oocysts to rise to the surface. Then 5-7 minutes are needed for microscopic reading.

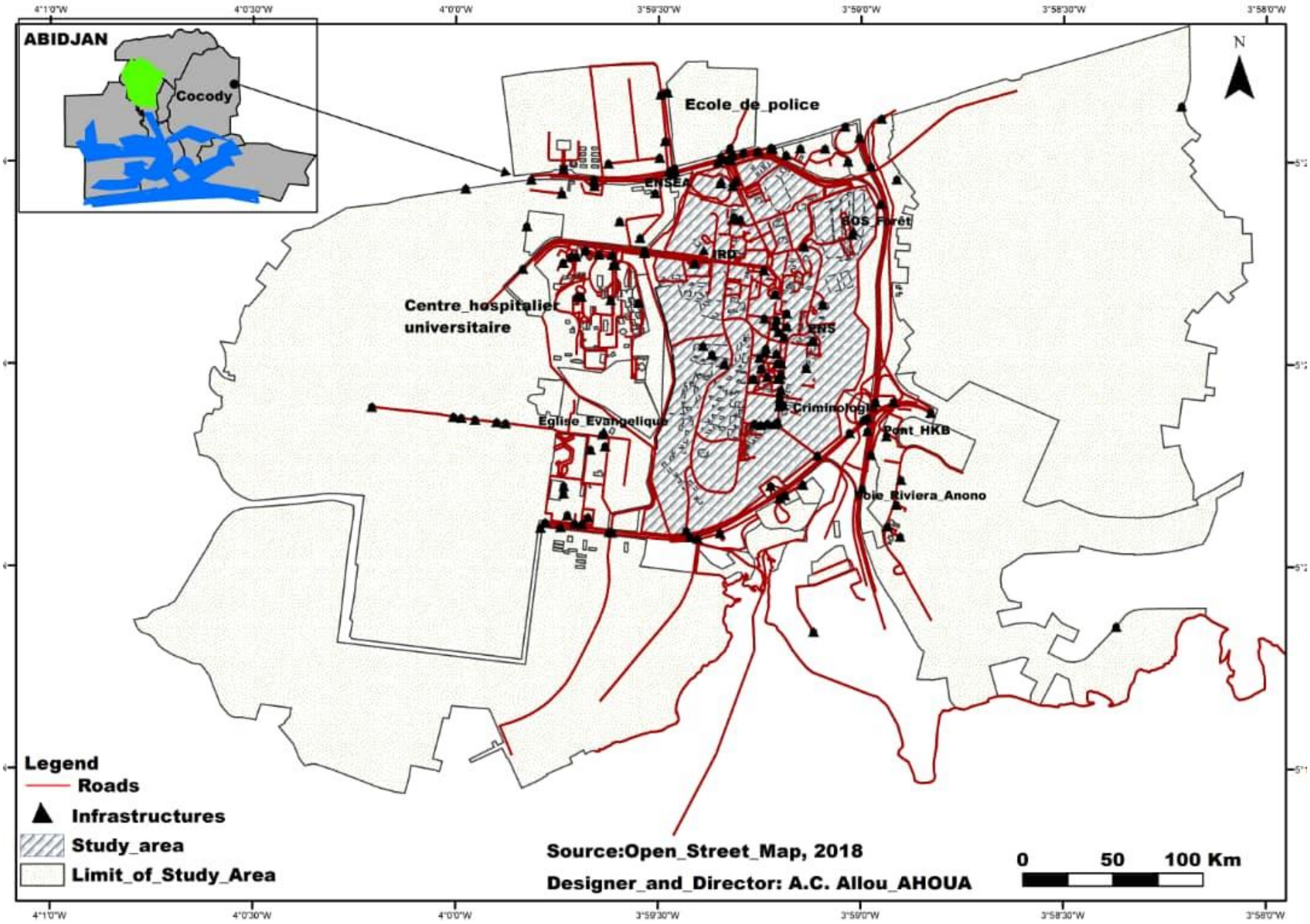

Fig. 1. Presentation of the study area

The search for and count of parasite eggs in stool solutions was carried out under an optical microscope by an experienced biologist. The results of the Mini-Flotac reading are recorded on a card. The faeces were treated as follows for the basic technique of the Mini-Flotac (analytical sensitivity = 10 eggs or cysts per gram of faeces). The multiplication factor is 10 for the flotation solution (the dilution ratio is 2: 40 and 2 chambers of 1 ml are examined). The number of OPGs in the sample was obtained by multiplying the number of eggs counted by the multiplication factor.

2.3 DATA MINING

EXCEL software was used to enter the data collected and to produce the figures and tables. The Chi-square test was used to compare the observed differences to measure the degree of significance of the frequency differences. This type of analysis was performed with R software version 3.3.3. The prevalence of infection is the proportion of positive samples out of all samples tested. It was determined for the parasite species *A. lumbricoides* and *T. trichura*. Infection intensity is the number of eggs of a parasite in one gram of stool (OPG). The average egg intensity of the parasite species was calculated using the geometric mean. The parasite load (OPG) was stratified according to WHO recommendations [28] into mild, moderate and heavy infection. The ranges of these infection classes vary considerably from species to species:

- For *A. lumbricoides* the ranges [1-4999], [5000-49999], and ≥50000 OPG, defeat mild, moderate, and severe infections, respectively;
- For *T. trichiura* the intervals [1-999], [1000-9999], and ≥ 10000 OPG define them;

Binomial logistic regression was used to determine the transmission factors of *Ascaris lumbricoides*. For this, *Ascaris lumbricoides* infection was defined as the dependent variable. The independent variables were environmental factors. The dependent variable and the independent variables were analysed in a univariate analysis. The strength of the association was measured by Odds Ratios (OR).

3 RESULTS

3.1 ASCARIS LUMBRICOIDES INFECTION

The parasitological survey was conducted on 226 students (157 males and 69 females), ranging in age from 18 to 26 years. Of the 226 students registered and examined, 53 were carriers of *Ascaris lumbricoides* eggs, i.e. a prevalence rate of 23.45%. Boys (18.14%) are more parasitized than girls (5.30%) (Table 1). Overall, all infected students have a mild infection (Table 2).

Table 1. Prevalence of Ascaris lumbricoides infection by sex and age group

	Age group (Year)			Sex		Total
Indicators	**18 - 20**	**21 -23**	**24 -26**	**Male**	**Female**	
Number reviewed	27	107	92	157	69	226
Number of Positives	7	27	19	41	12	53
Prevalence of *Ascaris lumbricoides* (%)	03, 09	11.94	08.40	18.14	05.30	23.45

Table 2. Categories of intensity of A. lumbricoides infection in students

	Group A: *(*N=57*)*		**Group B*:* *(*N=76*)***		**Group C: *(*N=93*)***	
A. lumbricoides	n *(%)*	OPG	n *(%)*	OPG	n *(%)*	OPG
Low intensity	14 *(*24,56*)*	101.42	15 *(*16.12*)*	178	24 *(*25.80*)*	119.16
Moderate intensity	0 *(*0*)*	NA	0 *(*0*)*	0 *(*0*)*	0 *(*0*)*	NA
High intensity	0 *(*0*)*	NA	0 *(*0*)*	0 *(*0*)*	0 *(*0*)*	NA
Total	14 *(*24.56*)*	101.42	15 *(*16.12*)*	178	24 *(*25.80*)*	119.16

Group A: Biosciences; Group B: STRM; Group C: Modern Letters; OPG: Average number of eggs obtained from infested individuals

3.2 TRICHIRUS TRICHIURA INFECTION

A total of 38 of the 226 students examined are carriers of Trichirus trichiura eggs. This corresponds to a prevalence of *Trichirus trichiura* infection of 16.81%. The prevalence of *Trichirus trichiura* was higher than that of female students (11.94% versus 4.86%) (Table 3). There were no significant gender differences. However, the parasite load of infested students was 100% for low infestations, (Table 4).

Table 3. Prevalence of Trichirus trichiura infection by sex and age group

	Age group (Year)			Sex		Total
indicators	**18 - 20 s**	**21 -23**	**24 -26**	**Male**	**Female**	
Number reviewed	27	107	92	157	69	226
Number of Positives	04	21	13	27	11	38
Prévalence of *Trichirus. trichiura* (%)	01.76%	09.29%	05.75	11.94	04.86%	16.81%

Table 4. Intensity category of Trichirus trichiura infection in students

	Group A: *(*N=57*)*		**Group B: *(*N=76*)***		**Group C: *(*N=93*)***	
T. trichiura	n *(%)*	Na_OPG	n *(%)*	Na_OPG	n *(%)*	Na_OPG
Low intensity	9 *(*15.78*)*	32.22	14 *(*18.42*)*	46.42	15 *(*16.12*)*	33.33
Moderate intensity	0 *(*0*)*	NA	0 *(*0*)*	0 *(*0*)*	0 *(*0*)*	NA
High intensity	0 *(*0*)*	NA	0 *(*0*)*	0 *(*0*)*	0 *(*0*)*	NA

Group A: Biosciences; Group B: STRM; Group C: Modern Letters; OPG: Average number of eggs obtained from infested individuals

3.3 COMPARAISON INFECTION ASCARIS LUMBRICOIDES ET TRICHURIS TRICHURA

Fig. 2 shows that the prevalence of *Ascaris lumbricoides* infection in males is higher than in females, the same finding for *Trichirus trichiura.*

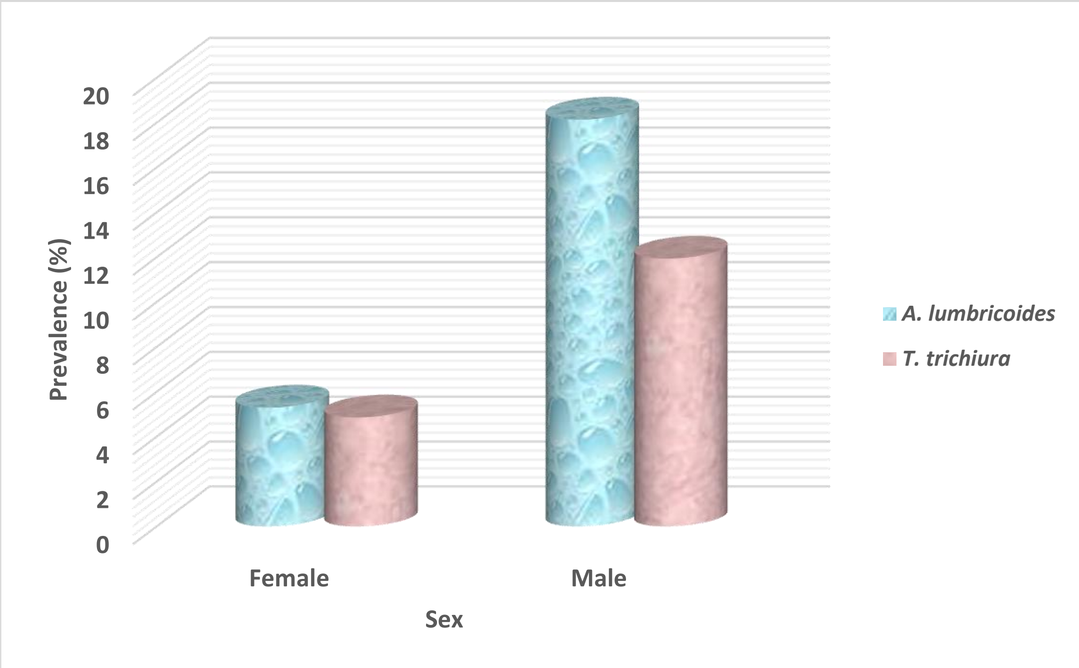

Fig. 2. Prevalence of A. lumbricoides and T. trichura infections by sex

But this difference is not significant neither for Ascaris lumbricoides (X^2 = 1.575; df = 1; p-value = 0.2095) nor for Trichirus trichiura (X^2 = 0.0015; df = 1; p-value = 0.9686).

In terms of age, the 21-23 year age group has the highest prevalence rates for *Ascaris lumbricoides* and *Trichirus trichiura* (Figure 5). The lowest rates are observed in the 18 to 20 year age groups. However, statistical analysis shows that there is no significant difference between the age groups for both *Ascaris lumbricoides* (X^2 = 0.6829; df = 2; p-value = 0.7107) and *Trichirus trichura* (X^2 = 1.1558, df = 2, p = 0.5611).

With regard to the university stream, the LLC (Languages, Literatures and Civilizations) stream had the highest prevalence rates for *Ascaris lumbricoides* and *Trichirus trichiura* (Fig. 4). The lowest rates are observed in the SVT (Life and Earth Sciences) stream. However, statistical analysis shows that there is no significant difference between the age groups for both *Ascaris lumbricoides* (X^2 = 5.6134; df = 2; p-value = 0.064) and *Trichirus trichiura* (X^2 = 0.7129, df =2, p = 0.7001).

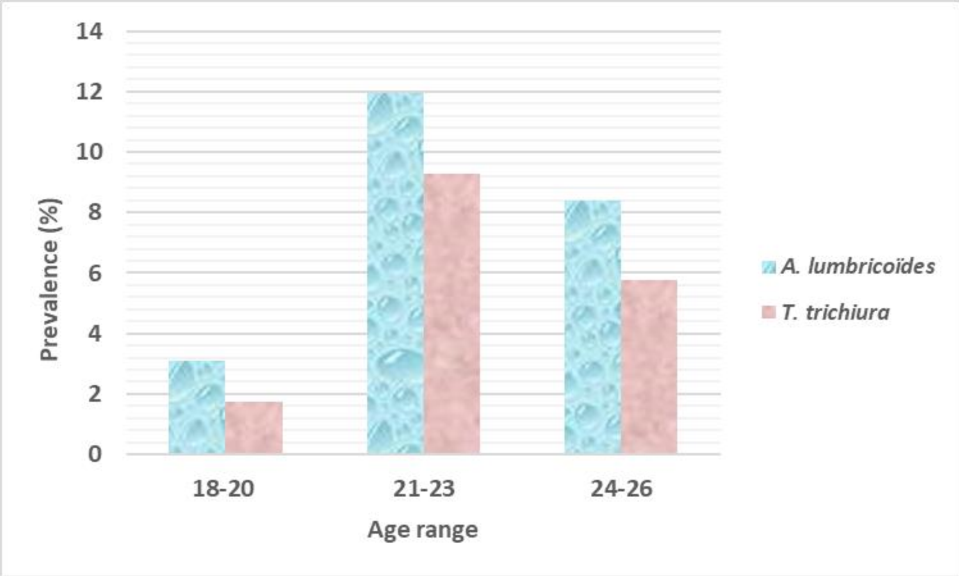

Fig. 3. Prevalence of A. lumbricoides and T. trichura infections by age group

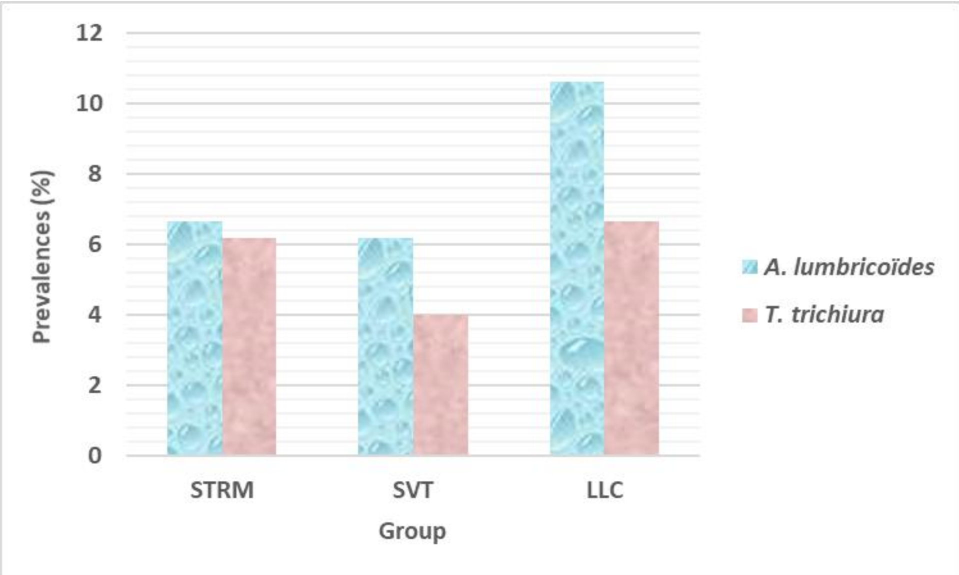

Fig. 4. Prevalence of A. lumbricoides and T. trichura infections as a function of pathway

Fig. 5 shows the variation in the prevalence of *A. lumbricoides* and *T.* t*richiura* infection with age. This variation is most pronounced in the 21-24 year age group.

3.4 FACTORS FAVOURING THE TRANSMISSION OF A. LUMBRICOIDES AND T. TRICHURA INFECTION

3.4.1 USE OF TOILETS

The university washrooms are the area where respondents' faeces are disposed of. These interviewees reported a lack of toilets at Félix HOUPHOUËT-BOIGNY University.

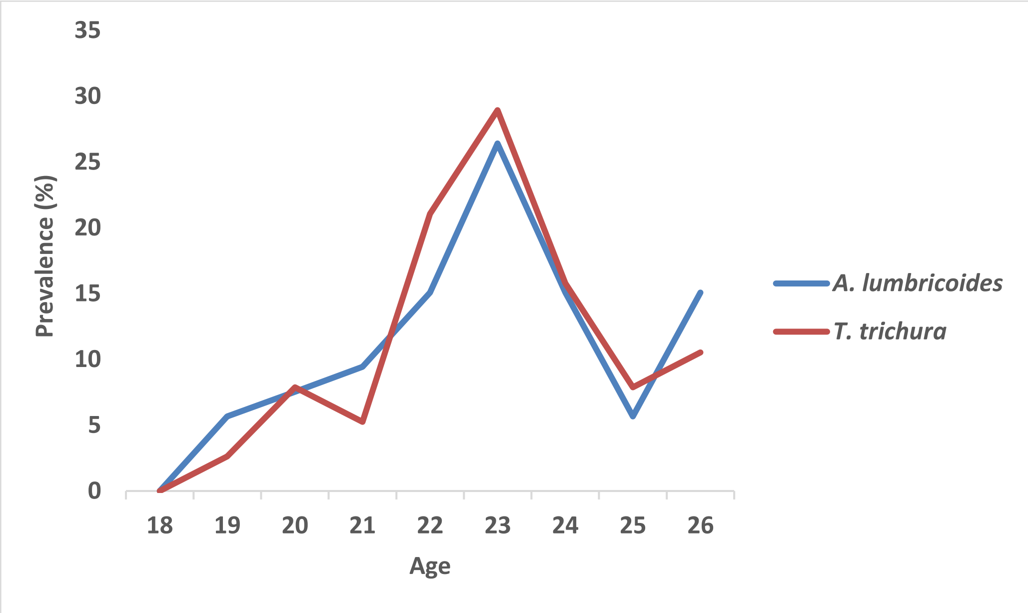

Fig. 5. Variation in prevalence of A. lumbricoides and T. trichura infection with age

A proportion of 93.80% of the individuals surveyed stated that they regularly use the university toilets. A lack of EHA (Water, Hygiene and Sanitation) sanitary facilities with a proportion of 98.67% (223 participants), added to this, the inexistence of hygienic material was notified.

The age category from 21 to 24 years old, which includes the majority of students attending university toilets, were the individuals in whom more people infected with Ascaris lumbricoides and *Trichirus trichiura* were detected

3.4.2 HYGIENE PRACTICES

The survey conducted among individuals who participated in the parasitological surveys made it possible to understand the distribution of socio-sanitary factors

The logistic regression model showed that *Ascaris lumbricoides* infection is associated with property in university toilets (OR=2.23, p≤0,05). It should be noted that the presence of excitatory posters was also reported. However, it should be noted that 143 participants (67.27%) reported using the bush for their needs. 51 (22.56%) stated that the bush is an open defecation area for them.

4 DISCUSSION

This study showed the following prevalence rates in this area: 23.45% and 16.81% for *Ascaris lumbricoides* and *Trichirus trichiura* infection respectively.

The results showed that at Félix HOUPHOUËT-BOIGNY University, *Ascaris lumbricoides* and *Trichirus trichiura* infections are of low endemicity [28]. This observation is mainly due to the mass treatment campaign with praziquantel carried out by the National Programme for the Control of Schistosomiasis, Geohelminthiasis and Lymphatic Filariasis in the health district of Abidjan, particularly at the Félix HOUPHOUËT-BOIGNY University of Cocody.

We note a predominance of *Ascaris lumbricoides* infection over *Trichirus trichiura* infection. Similar results have been reported by some authors in Côte d'Ivoire in rural areas in the west of the country [29].

The intensity of infestation is the number of eggs excreted in the faeces of infected persons. 28] Thus, the intensity of infection is mostly mild for infestation with *Ascaris lumbricoides* and *Trichirus trichiura*. The mild infection is explained by low parasitaemia.

According to our results, the prevalences of *Ascaris lumbricoides* and *Trichurus trichura* infestation are higher in the 21-24 age group than in the 18-20 age group. This finding could be explained by the fact that these students constitute the majority of the individuals questioned and have risky behaviours that expose them to the infestation. Among these behaviours, the use of toilets where the presence of enterobacteria was reported and the lack of hand washing were noted. Hence the possibility of infection and reinfection. There is also the possibility of contaminating the environment by urinating or defecating without normal hand washing.

The study showed a higher prevalence of *Ascaris lumbricoides* and *Trichirus trichiura* infection in boys than girls. However, when we cross sex and helminthiasis, the observed difference is not significant for both forms of infection. The results are in contradiction with those obtained in Agboville and Adzopé which found a significant difference between parasitized boys and girls ($p<0.01$) [30].

The existence of infected pupils despite mass treatment implies the existence of a reinfection environment. The questionnaire incriminated the use of toilets as a favourable environment for egg transmission. This has been proven in other previous studies in several localities in Côte d'Ivoire where the existence of a favourable environment for the development of germs was essential for the transmission of this pathology [31].

Lack of hygiene and limited access to sanitation could also be factors associated with the transmission of this disease in this locality. It should be noted that the answers to the questionnaires administered to the participating students helped to identify a crucial sanitation problem. It should be noted that Ascaris parasites live in the intestine and Ascaris eggs pass through the faeces of infected people. If an infected person defecates outside (for example, near bushes, in a garden or field). The eggs can then mature into a form of infectious parasite. Ascariasis is caused by the ingestion of eggs. This can happen when hands or fingers contaminated with dirt are put in the mouth or by eating vegetables or fruits that have not been thoroughly washed [33].

The prevention, control and eventual elimination of many neglected tropical diseases (NTDs) depend heavily on the availability of improved water, sanitation and hygiene (WASH) in endemic communities. Treatment alone will not break the cycle of transmission; improved WASH infrastructure and appropriate health-seeking behaviours are essential to achieve sustainable control, elimination or eradication of many NTDs [33], [34]. Global strategies for the control and elimination of many NTDs, such as helminthiases, specifically refer to the need to improve water and sanitation. However, in practice, the repeated large-scale administration of antibiotics or anthelmintics to at-risk populations [35], [36] is the main objective of many NTD control programmes. Hence the need to identify best practices and build a strong evidence base for sustainable and scalable collaborative programming for integrating WASH control activities into NTD control.

5 Conclusion

Ascaris lumbricoides infection and *Trichurus trichiura* infections are conditions that are rampant at the Félix HOUPHOUËT-BOIGNY University in Cocody (Côte d'Ivoire). This preliminary survey found prevalence rates of 23.45% for *Ascaris lumbricoides* infection and 16.81% for *Trichirus trichiura* infections. It provided an overview of the infection in this locality, highlighting the main environmental factors associated with transmission. These results will be used to raise the awareness of the authorities and the population and will enable a programme to be drawn up for the integrated control of helminthiases in general and *Ascaris lumbricoides* and *Trichirus trichiura* infection in particular at Félix HOUPHOUËT-BOIGNY University.

Conflicts Of Interest

The authors declare that they have no conflicts of interest regarding the publication of the article. Infested individuals were deparasited.

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