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Prevalence of Intestinal Parasitic Infections among Children Aged 1 to 5 Years Seen at Four (4) Health Facilities in Brazzaville, Republic of the Congo

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Abstract

Background: Intestinal parasitosis is a frequent public health problem in Africa. They remain endemic in the Republic of the Congo. Knowledge of the prevalence and factors associated with protozooses and geohelminthiasis is a means of reducing the intensity of these infections. A cross-sectional study of parasitic carriage in children aged under 5 was carried out between March and October 2022 in the integrated health centers: Sœur Martin, Q24 Karin Johnson, Fulbert Youlou and Maman Mboualé in Brazzaville. The samples collected were subjected to fresh parasitological examination using the Ritchie and Willis methods. **Results:** One hundred twenty-eight (128) stool samples were collected. In total, 18 samples were infected with at least one of the parasites (14.06%). The intestinal parasites identified, in order of prevalence, were: *Giardia intestinalis* (61.11%); *Entamoeba coli* (27.78%); and *Ascaris lumbricoides* (5.56%). Only one sample was co-infected with both *Giardia intestinalis* and *Entamoeba coli*. In light of these results, it should be noted that the estimated prevalence of intestinal parasitic infections is low among children aged 1 to 5 years. **Discussion and Conclusion:** The statistical results showed a significant association between whether or not a child received a proper course of deworming and parasite carriage. We therefore recommend the appropriate application of hygiene rules followed by a regular system of collective deworming in families within households to limit collective contamination through promiscuity, in order to ensure effective prevention against intestinal parasitosis.

Keywords

Prevalence, Intestinal Parasitosis, Children, Integrated Health Center, Brazzaville (Congo)

1. Introduction

Intestinal parasitoses are diseases caused by parasites developing in the digestive tract [1]. According to the WHO, they are widespread virtually worldwide, with high prevalence in many tropical and subtropical regions. Amoebiasis, ascariasis, hookworm and trichocephalosis are among the ten most common infections worldwide. Although not associated with a high mortality rate, complications are not uncommon, and many cases require hospitalization. For the most part, intestinal parasitosis gives an idea of the level of individual and collective hygiene; the demographic explosion and promiscuity can be considered a major factor in the multiplication of cases in these environments [2]. The WHO estimates the number of people affected worldwide at over 2 billion, with an estimated 155,000 deaths per year [3].

However, these include intestinal helminthiasis, diseases caused by flat and/or round parasitic worms known as helminths, and intestinal protozoiasis, caused by single-celled parasitic organisms of the human intestinal tract known as protozoa. The magnitude of these intestinal parasitoses and their adverse impact on childhood survival justifies the need to implement strategies aimed at reducing the morbidity associated with these conditions [4].

In many countries, they represent a real public health problem, especially in developing countries where promiscuity, lack of drinking water and sanitary facilities are felt [1]. Although considered benign, they can lead to serious complications such as malnutrition, anemia, stunted growth in children [5].

Several studies on these intestinal parasitoses have been carried out in different regions of the world, including Africa, where climatic, hygiene and socioeconomic conditions, as well as inadequate sanitation, are conducive to parasite proliferation [6].

Considered a developing country, the Congo is no exception, and remains very concerned by these intestinal parasites.

In the Republic of the Congo, studies carried out by Nsimsa *et al.* in Brazzaville in 1991 revealed an overall prevalence of intestinal parasitosis of 16.59% [7]. However, data reported in 2011 on intestinal helminthiasis in the various arrondissements of the Brazzaville department showed an average prevalence of 5.49% throughout the urban perimeter [8]. Congo's health pyramid means that CSIs (integrated health centers) are the first port of call for patients, especially children often suffering from known pathologies. As a result, decision trees (or algorithms) have been set up for the syndromic management of certain infections, notably parasitic infections in line with WHO recommendations [3]. These ISCs, which have only rudimentary laboratories, rarely perform parasitological analyses of stools. Therefore, in order to obtain recent data on an estimation of the prevalence of parasitic infections among children aged 1 to 5 years in the city of Brazzaville, four community health centers were selected for patient recruitment.

2. Materials and Methods

2.1. Study Areas

Our study was conducted from March 22 to October 11, 2022 in four (4) Integrated Health Centers or IHCs corresponding to four (4) different sites distributed in the northern and southern zones of Brazzaville (**Figure 1**), namely for the northern zone, CSI Sœur Martin (site 1 in arrondissement n˚3 Poto-poto) and CSI Maman Mboualé (site 4 in arrondissement n˚6 Talangaï), and for the southern zone, CSI Karin Johnson Q24 (site 2 in arrondissement n˚2 Bacongo) and CSI Fulbert Youlou (site 3 in arrondissement n˚8 Madibou).

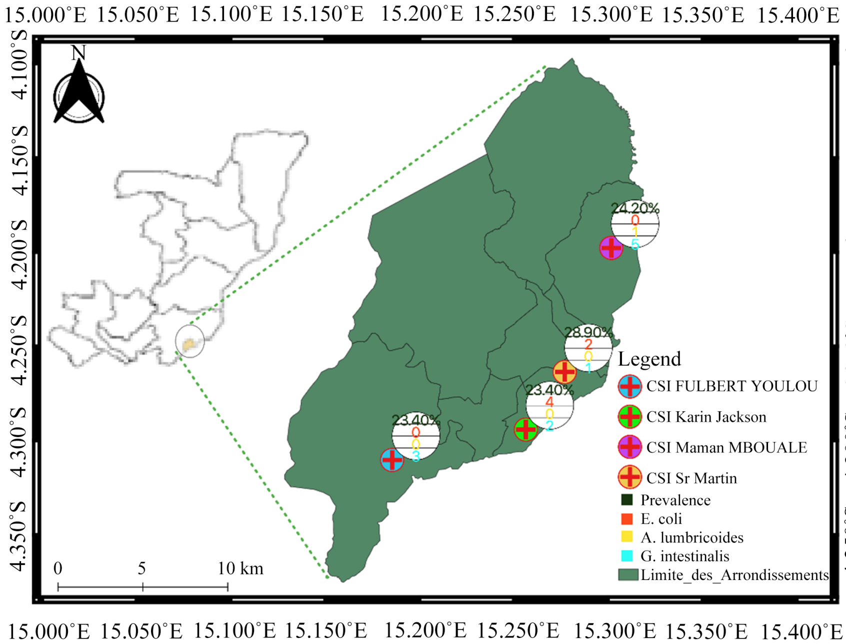


Figure 1. Map of sample collection sites.

Each of these CSIs has a laboratory, but parasitological analyses of stools are rarely carried out. Received patients are often treated systematically according to WHO recommendations [3].

2.2. Patient Recruitment and Sample Collection

This study included children aged 1 to 5 years residing in Brazzaville during the study period who were seen in outpatient clinics and who may or may not have presented with clinical signs typical of intestinal parasitic infections, such as diarrhea, cough, and/or fever, abdominal pain, and loss of appetite. After explaining the study to the parents and obtaining their consent, stool collection containers were distributed to them for the purpose of collecting the first morning stool sample. Additional information was obtained through a standardized questionnaire.

The samples collected in this manner were transported and analyzed at the National Public Health Laboratory in a cooler that was refrigerated daily.

2.3. Stool Examination

On receipt of the samples, a macroscopic examination was carried out to note the color and consistency of the stools. Three (3) microscopic techniques were then used: direct examination in the fresh state, followed by two concentration techniques: the modified Ritchie technique and the Willis flotation technique [9].

2.4. Ethical Considerations

The study protocol had received a favourable opinion from the Institutional Ethics Committee of the Congolese Foundation for Medical Research under the number Avis n˚037/CIE/FCRM/2021, and research authorizations to carry out the work in the various CSIs corresponding to our study sites had been received from each Health District supervising them. Assent forms were filled in individually by the child's guardians in the consultation room, and they were given an information sheet detailing the nature, objectives and progress of the study, as well as the benefits, constraints, confidentiality and rights of the study participant.

2.5. Statistical Analysis

Survey data were entered into Microsoft Excel. They were processed by R statistical software (version 3.4) in order to evaluate the level of infestation between the different study sites. For statistical comparisons, we used Pearson's Chi-square test or test of independence according to the conditions of applicability to assess the interdependence between qualitative variables. The test was considered significant, *i.e.* if there was a significant association between the variables, if the p-value was less than 0.05.

3. Results

3.1. Characteristics of the Study Population

A total of 128 collected samples formed the basis of the study, comprising 37, 30, 30, and 31 eligible children, respectively, whose parents gave their consent and provided stool samples for analysis at sites 1, 2, 3, and 4. It is acknowledged that the enumeration of integrated health centers in each study zone is not exhaustive. However, the northern zone represents the place where the majority of samples were collected (53.12%), with the greatest number collected at site 1 (28.90%).

We examined children under 5 years of age, with an average age of 2.1 ± 1.4 years and a M/F sex ratio of 1.03. The majority of these children were dewormed (88.28%), washed their hands after defecation (64.06%) and before meals (82.81%), most of whom used disinfectant (68.75%). They live in concessions with at least 10 people, and in houses with between 1 and 5 occupants. The majority of these houses have traditional latrines (74.22%).

The breakdown of the various socio-demographic characteristics and hygiene measures is given in Table 1.

Table 1. Socio-demographic characteristics and hygiene measures of the study population, by study site.

Socio-demographic characteristics / Sites	Site 1 n (%)	Site 2 n (%)	Site 3 n (%)	Site 4 n (%)	Total N (%)
❖ **District**					
Bacongo	-	23 (17.97)	-	-	23 (17.97)
Djiri	1 (0.78)	-	-	-	1 (0.78)
Kintélé	2 (1.56)	-	-	-	2 (1.56)
Madibou	1 (0.78)	2 (1.56)	30 (23.44)	-	33 (25.78)
Mfilou	1 (0.78)	-	-	-	1 (0.78)
Moungali	11 (8.6)	1 (0.78)	-	-	12 (9.38)
Ouenzé	5 (3.91)	-	-	-	5 (3.91)
Poto-Poto	12 (9.38)	-	-	1 (0.78)	13 (10.16)
Talangai	2 (1.56)	-	-	30 (23.44)	32 (25)
Makélékélé	2 (1.56)	4 (3.13)	-	-	6 (4.69)
❖ **Age (years)**					
1	14 (10.9)	11 (8.6)	17 (13.3)	24 (18.8)	66 (51.6)
2	8 (6.3)	6 (4.7)	4 (3.1)	4 (3.1)	22 (17.2)
3	4 (3.1)	4 (3.1)	-	3 (2.3)	11 (8.6)
4	8 (6.3)	1 (0.8)	4 (3.1)	3 (2.3)	16 (12.5)
5	3 (2.3)	8 (6.3)	2 (1.6)	-	13 (10.2)
❖ **Type of toilet**					
Traditional	21 (16.4)	21 (16.4)	29 (22.7)	24 (18.8)	95 (74.2)
Modern	16 (12.5)	9 (7)	1 (0.8)	7 (5.5)	33 (25.8)
❖ **Deworming**					
Yes	32 (25)	24 (18.8)	28 (21.9)	29 (22.7)	113 (88.3)
No	5 (3.9)	6 (4.7)	2 (1.6)	2 (1.6)	15 (11.7)
❖ **Number of people in the house**					
[1 - 5]	30 (23.4)	24 (18.8)	25 (19.5)	27 (21.1)	106 (82.8)
[6 - 10]	7 (5.5)	4 (3.1)	5 (3.9)	2 (1.6)	18 (14.1)
>10	-	2 (1.6)	-	2 (1.6)	4 (3.1)

Continued

❖ **Number of individuals in plot**					
0	4 (3.1)	4 (3.1)	9 (7)	10 (7.8)	27 (21.1)
[1 - 5]	9 (7)	2 (1.6)	2 (1.6)	-	13 (10.2)
[6 - 10]	5 (3.9)	4 (3.1)	13 (10.2)	5 (3.9)	27 (21.1)
>10	19 (14.8)	20 (15.6)	8 (6.3)	14 (10.9)	61 (47.7)
❖ **Hygiene measures after defecation**					
Does not wash hands	13 (10.2)	1 (0.8)	5 (3.9)	8 (6.3)	27 (21.1)
Rarely	1 (0.8)	10 (7.8)	2 (1.6)	6 (4.7)	19 (14.8)
Washes hands	23 (18)	19 (14.8)	23 (18)	17 (13.3)	82 (64.1)
❖ **Hygiene measures before meals**					
Does not wash hands	3 (2.3)	-	2 (1.6)	5 (3.9)	10 (7.8)
Rarely	5 (3.9)	3 (2.3)	2 (1.6)	2 (1.6)	12 (9.4)
Washes hands	29 (22.7)	27 (21.1)	26 (20.3)	24 (18.8)	106 (82.8)
❖ **Hand washing procedures**					
Single water	7 (5.5)	4 (3.1)	5 (3.9)	13 (10.2)	29 (22.7)
Disinfectant/Detergent	25 (19.5)	26 (20.3)	16 (12.5)	21 (16.4)	88 (68.8)
No	3 (2.3)	-	1 (0.8)	5 (3.9)	9 (7)
NS	2 (1.6)	-	-	-	2 (1.6)
❖ **Source of water supply**					
Untreated water (borehole water, spring water, well water)	1 (0.8)	1 (0.8)	9 (7)	-	11 (8.6)
Treated water (tap water mineral water, mineral…)	36 (28.1)	29 (22.7)	21 (16.4)	31 (24.2)	117 (91.4)
Total per CSI	**37** (28.90)	**30** (23.44)	**30** (23.44)	**31** (24.22)	**128** (100)

3.2. Parasite Infections

Of the four (4) sites included in our study, the highest rates of positive cases were reported at sites 2 and 4, at 20% and 19.35%, respectively. The average prevalence at the integrated health centers was 14.06%.

Regarding age, the highest rate was found among 5-year-old children, at 30.77%. The p-value (0.221), being greater than 0.05, indicates that there is no significant association between age and the occurrence of intestinal parasitic infections.

A total of 65 boys and 63 girls were examined. The majority of positive cases were among male children (10 cases) compared to female children (8 cases) with intestinal parasites. Pearson's chi-square test revealed no significant association between parasite carriage and the "sex" variable, as the p-value was well above 0.05 ($p > 0.05$).

The majority of children who tested positive for at least one intestinal parasite often play outside the home, accounting for 20% of the total, whereas a minority were found among children who spend more time indoors during their recreational activities, accounting for 3.57%. The p-value revealed no significant association between parasite carriage and the "play location" variable ($p > 0.05$; chi-square = 3.45).

Pearson's chi-square test showed no significant association between household population density and the occurrence of intestinal parasitic infections. A high number of positive cases was reported in households with 1 to 5 people living in the home (13 cases) and in plots with more than 10 people (7 cases).

Similarly, regarding the variable "type of toilet used," a high number of positive cases (11) in total were reported in households that use traditional toilets. The chi-square test yielded a p-value greater than 0.05 ($p = 0.242 > 0.05$), indicating that there is no significant association between parasite carriage and the type of toilet used by households.

A high rate of positive cases (33.3%) was observed among children who did not undergo deworming or did so only rarely. The p-value being less than 0.05 with an odds ratio (OR) of 0.263 indicates a significant, albeit weak, association between whether or not a child receives deworming treatment and the occurrence of intestinal parasitic infections. This implies that the more adequately a child is dewormed, the less likely they are to be infected with an intestinal parasite.

Although the rate of positive cases was higher among children seen in the clinic who presented with at least one of the typical clinical signs of an intestinal parasitic infection namely, (14.1%) it is worth noting that there were 4 positive cases among asymptomatic children, representing a rate of 13.8%. However, the chi-square test yielded a p-value well above 0.05. This indicates that there is no significant association between the presence or absence of clinical signs and parasite carriage. This implies that a child may carry the parasite without necessarily exhibiting any specific symptoms.

The distribution of the different study variables according to variation in infection prevalence is given in Table 2.

Table 2. Study variables according to variation in prevalence of infection in the study population.

Study variables	Positive N (%)	Negative N (%)	Total N (%)	p-value	OR (95% CI)
❖ **Site (CSI)**					
Sœur Martin	3 (8.11)	34 (91.89)	37		
Q24 Karin Johnson	6 (20)	24 (80)	30		
Fulbert Youlou	3 (10)	27 (90)	30	-	-
Maman Mbouaié	6 (19.35)	25 (80.65)	31		
Total	18 (14.06)	110 (85.94)	128		

Continued

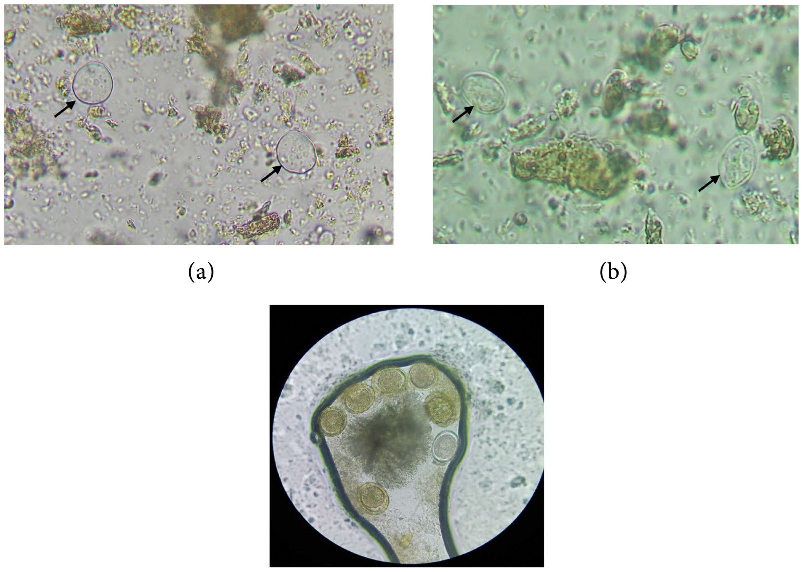
❖ **Age (years)**					
1	7 (10.61)	59 (89.39)	66		
2	2 (9.09)	20 (90.91)	22		
3	3 (27.27)	8 (72.73)	11	0.221	-
4	2 (12.5)	14 (87.5)	16		
5	4 (30.77)	9 (69.23)	13		
Total	18 (14.06)	110 (85.94)	128		
❖ **Sex**					
Male	10 (15.38)	55 (84.62)	65		
Female	8 (12.70)	55 (87.30)	63	0.800	1.247 (0.408 - 4.936)
Total	18 (14.06)	110 (85.94)	128		
❖ **Playing field**					
Courtyard	13 (16.25)	67 (83.75)	80		
Courtyard/outside the lot	4 (20)	16 (80)	20	0.178	-
Home	1 (3.57)	27 (96.43)	28		
Total	18 (14.06)	110 (85.94)	128		
❖ **House population size**					
[1 - 5]	13 (12.26)	93 (87.74)	106		
[6 - 10]	3 (16.67)	15 (83.33)	18	0.097	-
>10	2 (50)	2 (50)	4		
Total	18 (14.06)	110 (85.94)	128		
❖ **Population size in the plot**					
0	6 (22.22)	21 (77.78)	27		
[1 - 5]	2 (15.38)	11 (84.62)	13		
[6 - 10]	3 (2.3)	24 (18.8)	53	0.564	-
>10	7 (11.47)	54 (88.53)	61		
Total	18 (14.06)	110 (85.94)	128		
❖ **Type of toilet**					
Traditional	11 (11.58)	84 (88.42)	95		
Modern	7 (21.21)	26 (78.79)	33	0.242	0.489 (0.154 - 1.649)
Total	18 (14.06)	110 (85.94)	128		
❖ **Deworming**					
No	5 (33.3)	10 (66.7)	15	0.038	0.263 (0.067 - 1.139)
Yes	13 (11.5)	100 (88.5)	113		

Continued

❖ **Clinical signs**					
Absent	4 (13.8)	25 (86.2)	29	0.962	1.029 (0.287 - 4.679)
Present	14 (14.1)	85 (85.9)	99		

3.3. Prevalence of Parasite Species in the Study Population

At the conclusion of this study, three (3) parasitic species were identified, namely: *Giardia intestinalis* (Figure 2(b)) and *Ascaris lumbricoides* (Figure 2(c)), which are pathogenic, and *Entamoeba coli* (Figure 2(a)), which is commensal, with respective prevalences of 61.11%, 5.56%, and 27.78%.



(a) (b) (c)

Figure 2. Various species of intestinal parasites identified during the study. (a): 2 Entamoeba coli cysts viewed at 40× magnification, distilled water mount, (b): 2 Giardia intestinalis cysts viewed at 40× magnification, distilled water mount, (c): 7 Ascaris lumbricoides eggs viewed under a 40× objective, prepared using the Willis technique.

The most prevalent parasitic species is *Giardia intestinalis* (61.11%).

3.4. Prevalence of Parasite Species in the Study Population According to Mono- or Polyparasity

Of the entire study population, only one child was identified as being polyparasitic with two parasite species (*Entamoeba coli* + *Giardia intestinalis*), *i.e.* a prevalence of 5.56% compared with 94.45% for monoparasitic children.

3.5. Prevalence of Parasite Species in the Study Population, by Study Site

Figure 3 shows the distribution and prevalence of the various parasite species identified in children seen at the various IHCs.

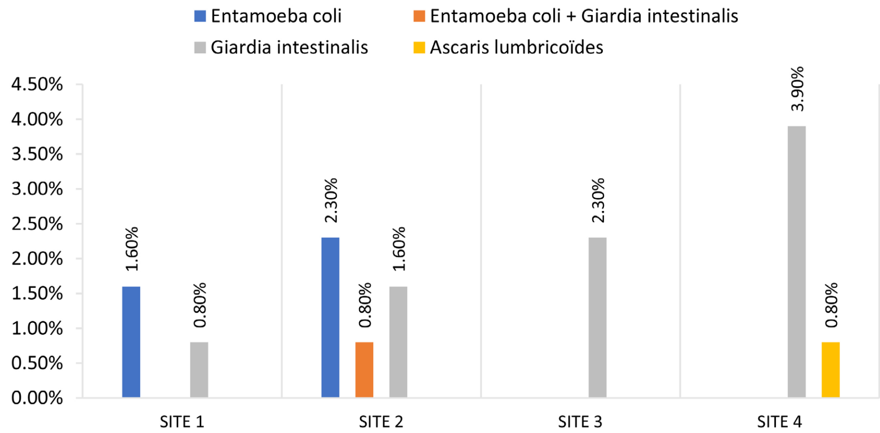


Figure 3. Distribution of parasite species prevalence by study site.

A total of 18 children (14.06%) tested positive for at least one species of intestinal parasite. The study revealed that protozoan parasites (*Giardia intestinalis* and *Entamoeba coli*) were present at all study sites, with *Giardia intestinalis* identified at all four (4) sites, with a high prevalence at site 4 (3.90%), followed by site 3 (2.3%). *Entamoeba coli* was only observed at sites 1 and 2, with a high prevalence at site 2 (2.3%).

Co-infestation (*Giardia intestinalis* + *Entamoeba coli*) was only observed at site 2, with a prevalence of 0.8%. The helminth group was only present at site 4, represented by a single geohelminth species, *Ascaris lumbricoïdes*, with a prevalence of 0.8%.

4. Discussion

A total of 128 stool samples were analyzed in the laboratory. Each sample underwent macroscopic and microscopic examination. This study revealed an average prevalence of 14.06%, with 8.11% for CSI1, 20% for CSI2, 10% for CSI3, and 19.35% for CSI4. These results are lower than those obtained at the National Public Health Laboratory in 1991 (16.59%) in Brazzaville [7]. In fact, this prevalence could be explained by inadequate hygiene practices within households, as the study revealed a high prevalence among children who tested positive and who played outside the home—that is, in the yard or off the property (20%)—and most of whom do not receive, or rarely receive, deworming treatment (33.3%).

Our results are also lower than those obtained in Yaoundé, Cameroon [6] on "Intestinal Parasites in Children Aged Zero to Five Years". In fact, of the 800 children they examined over a one-year period at two different study sites, 428 tested positive, representing a prevalence of 53.5%. Similarly, findings from Niamey, Niger [10], on "intestinal parasitic infections in children under 5 years of age," showed a prevalence of 33%.

We also noted a higher number of positive cases (11) among children whose families use traditional latrines as their sanitation system compared to those whose families use modern toilets (7). The p-value ($p = 0.242 > 0.05$) indicates that there is no significant association between the occurrence of intestinal parasitic infections and the type of toilet used by households. It is important to note that the survey of the type of toilet used by each of the target households in our study was not exhaustive, and that during the survey, no home visits were made to the households of the children surveyed. We relied on the information provided by guardians during the survey. However, our results corroborate those obtained in Cameroon in the city of Yaoundé [6]. Their study found that: "Children whose families use a modern sanitation system are significantly less likely to be infested than others ($\chi^2 = 3.3$; p = 0.0000)," although their p-value indicated a significant association between parasite carriage and the type of toilet used by households.

The variation in parasite prevalence rates observed in these studies can be attributed to regional differences, as countries in sub-Saharan Africa are the most affected due to unfavorable socioeconomic and hygienic conditions, as well as to sample size and the methodology used to collect the data.

In our study, the variation in prevalence by sex showed that 15.38% of our participants were male, compared with 12.70% who were female. Parasite carriage by sex was not statistically significant ($p = 0.800 > 0.05$). Our results corroborate the study conducted in Benin on "determining the proportion of intestinal protozoan infections among children aged 0 to 15 years admitted to the Order of Malta Regional Hospital in Djougou," which found a prevalence of 53.85% among males compared to 46.15% among females [11].

The lack of a significant association between parasite carriage and patient gender may be explained by the fact that girls and boys are subject to the same hygiene conditions and face the same risk of infestation regardless of their gender. Parasite carriage was high among 5-year-olds (30.77%). No significant association was observed between age and parasite carriage (p-value = 0.221 > 0.05). These results corroborate those obtained in Cameroon, where children aged 2 to 3 years had a prevalence of 18%, those aged 3 to 4 years accounted for 52.33%, and those aged 5 years had a prevalence of 76.12% [6]. The peak incidence of parasitic infection therefore occurs between the ages of 3 and 5, when children start attending preschool and sometimes elementary school, and when close contact and group play particularly in soil—are thought to facilitate transmission. In their study, the p-value ($p = 0.21 > 0.05$) showed no association between age and parasite carriage, which corroborates our findings. However, our results contradict those obtained in Benin in 2013 on the "Prevalence of Intestinal Parasites Among Pediatric Patients at the Saint Jean de Dieu Regional Hospital in Tanguieta," in which a high prevalence of parasitic infection was observed among children under 5 years of age, with a significant association between age and parasitic infection [12].

These findings suggest that children are prone to parasitic infections during their preschool years (between the ages of 3 and 5). This could be explained by the fact that at this age, children are in almost constant contact with the ground due to their recreational activities and also frequent environments (school, daycare, etc.) where close contact would facilitate the collective transmission of parasite eggs and/or cysts from one individual to another or from contaminated objects during group play.

The parasites isolated in our study were predominantly protozoa, accounting for 94% of the total, compared to 6% for helminths. Analysis of the samples ranked *Giardia intestinalis* first with a prevalence of 61.1%, followed by *Entamoeba coli* (27.78%) and Ascaris lumbricoides (5.56%). *Giardia intestinalis* is therefore the most dominant species in the studied population. These results are consistent with those obtained in Algeria, where the prevalence of protozoa was 96.65% and that of helminths 3.35% [13]. They also align with those obtained in Benin, with 87.5% protozoa and 12.5% helminths [12]. Similarly, those obtained in Cameroon, where the prevalence was three times higher than that of helminths, with a predominance of the species *Giardia intestinalis*, which alone accounted for 52% of the identified positive cases [6].

In fact, an analysis of the literature shows that intestinal protozoa are predominant in most developing countries. These parasitic species are transmitted in cystic form primarily through poorly washed raw foods (fruits, vegetables, salads, etc.) and drinking water, which is most often drawn from waterways polluted by human waste and consumed without prior treatment [14].

This high prevalence of protozoa compared to helminths can be explained by the fact that, during the study, we observed that all children were treated for parasites exclusively with antihelminthic drugs such as albendazole, ABZ, Vermox, etc., which are primarily effective against helminths rather than protozoa. This is because, according to the literature review, protozoa require a specific treatment (metronidazole, Flagyl, etc.) different from that used for helminths, but this treatment is not often included in the standard regimen during individual or mass deworming campaigns.

In our study, of the 128 children examined, 17 had a single parasite (94.44%) and only one had multiple parasites (5.56%). These results are consistent with those obtained in Benin in 2021, where 92.31% of subjects had a single parasite and 7.69% had multiple parasites [11]. They are also similar to those obtained in Algeria, where 76.5% of subjects had a single parasite and 23.5% had multiple parasites [15].

We conducted our work at four (4) different sites spread across two zones (North and South). The study revealed a prevalence of 8.11% for CSI_1 (Sister Martin, Poto-poto), 20% for CSI_2 (Karin Johnson, Bacongo), 10% for CSI_3 (Fulbert Youlou, Madibou), and 19.35% for CSI_4 (Maman Mboualé, Talangaï). Parasitic species belonging to the protozoa group (*Giardia intestinalis* and *Entamoeba coli*) were present at all study sites, particularly *Giardia intestinalis*, which was identified at all four (4) sites with a high prevalence of 3.90% at the fourth site, followed by site 3 (2.3%). The *Entamoeba coli* species, on the other hand, was observed only at sites 1 and 2, with a high prevalence of 2.3% at the second site. Co-infection (*Giardia intestinalis* + *Entamoeba coli*) was observed only at Site 2, with a prevalence of 0.8%. The helminth group was present only at Site 4 and was represented by a single species of geohelminth, *Ascaris lumbricoides*, with a prevalence of 0.8%.

It should be noted that, as a commensal species, *Entamoeba coli* is considered an indicator of fecal contamination in subjects who test positive. In contrast, *Ascaris lumbricoides* and *Giardia intestinalis* are pathogenic; their presence raises suspicion of a parasitic infection.

These results could be explained by caregivers' failure to properly implement personal and food hygiene measures, given that we are dealing with diseases linked to fecal contamination and that children in this age group (1 to 5 years old), who spend most of their time in prolonged contact with the ground, are potentially at risk. A strong emphasis on raising parents' awareness of this issue would be a valuable asset in supporting chemoprevention against the occurrence of intestinal parasitic infections.

However, controlling the parasitic burden can only be achieved through environmental sanitation and hygiene, coupled with public health education. The variability in findings across different studies suggests that the risk factors for the transmission of intestinal parasitic infections are numerous and complex [16].

Since microscopy is a technique with varying degrees of sensitivity, it is important to note that a single stool sample examined under a microscope may or may not detect low level infections and, as a result, may underestimate the prevalence.

5. Conclusion

In conclusion, it is important to note that the estimated prevalence of intestinal parasitic infections among children aged 1 to 5 years is low but not negligible. This protozoan infection is primarily caused by giardiasis. Children become infected at a young age. The CSI Q24 Karin Johnson and Maman Mboualé sites each showed a higher prevalence compared to those at the CSI Fulbert Youlou and Sœur Martin sites.

6. Study Limitations

During the period of this study, we encountered several constraints that made fieldwork rather complex, notably:

- Linguistics concerning the national (Lingala) and vernacular (Lari) languages, which was a hindrance to good communication during the interview with the tutors of the study participants.
- Forgetfulness, negligence (broken or lost stool pot) on the part of the tutors, as well as their moving with the study participant outside Brazzaville immediately after the interview, making it difficult to collect samples in the record time allotted for each site.
- The study participant's defecation habits. Indeed, stool sampling should take place early in the morning. However, we found that some children were quasi-constipated, while others only had bowel movements in the afternoon or even-

ing. This also hindered our ability to collect samples in record time.

- Finally, in September, we encountered an equipment breakdown at the last site, extending the study's planned completion time to four (4) months.

Conflicts of Interest

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

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