

Study of Neglected Tropical Diseases (NTDs): Gastrointestinal parasites in school children of Lolodorf neighborhood, south region, Cameroon.

Abstract

Background: Intestinal parasitic infections are still endemic in many parts of Cameroon and for effective control measures, epidemiological data are indispensable. This will enable adequate recommendations for the National control program for these infections.

Aim: This study aim to obtain basic data on the epidemiological situation of intestinal infections in school children of Ngovayang health area of Lolodorf neighborhood in the south region of Cameroon

Methodology: A total of 423 school children were recruited for the study. Stool samples were collected and examined microscopically for the search of helminthes eggs and protozoan cysts using Kato Katz and concentration formol-ether techniques respectively.

Results: Out of 423 children examined, 321 (75.9%) were infected with *Ascaris lumbricoides* (30.3%), *Trichuris trichiura* (64.5%), Hookworms (12.5%), *E. histolytica*/*E. dispar* (9.9%) and *E. coli* (34.0%). among whom, 117 (36.4%) had single infections, while 204 (63.6%) had multiple infections. Multiple infections were significantly high ($P < 0.05$) compared to single infections. *E. histolytica* infection was significantly more prevalent in females than in males ($P < 0.05$), same as in children aged 3-5 years for Hookworms ($P < 0.05$), 3-5 years and 11-15 years for *E. coli* ($P < 0.05$). *T. trichura* infections occurred more frequently as single infection ($P < 0.05$). Interactions between *T. trichiura*+ *E. coli* led to a significant increase of *E. coli* prevalence ($P < 0.05$). Significant high eggload was observed for *T. trichiura* ($P = 0.00001$) and in children between 3-5 years infected by *T. trichiura* ($P = 0.0001$) and hookworms ($P = 0.0001$). Children with low infection intensity were significantly more compared to those with average and high infection intensity ($P < 0.05$) for *A. lumbricoides*, *T. trichiura*, Hookworm. *T. trichiura* density increases significantly when it interacts with *A. lumbricoides* + Hookworms, *A. lumbricoides* + *E. coli*, Hookworms + *E. coli*, *E. histolytica*/*E. dispar* + *E. coli*, *A. lumbricoides* + Hookworms + *E. coli* and *A. lumbricoides* + *E. histolytica*/*E. dispar* + *E. coli* ($P < 0.05$).

Conclusion: This study has demonstrated that the Ngovayang health area is endemic for intestinal parasites. The protocol of mass drug administration recommended by MINSANTE is not adequate to reduce the endemicity level of these parasites, hence a necessity for a readjustment.

Keywords: Neglected Tropical Diseases, intestinal parasites, co-infection, prevalence, eggload, south Cameroon

1. Introduction

Nowadays, there still exist some groups of infection that sufficient attention has not been attributed to by donors and planners worldwide. These infections include schistosomiasis, soil transmitted helminths, trypanosomiasis, amebiasis etc, which are caused principally by parasites. These diseases are classified under Neglected Tropical Diseases (NTDs) firstly because they are tropical diseases and secondly because insufficient budget is attributed to them by donors and few cases are observed with less devastating effect as compared to other diseases like HIV AIDS and malaria [1]. Intestinal parasitic infections remain a serious public health problem in most less developed countries, especially due to the fact that most of them have oral-fecal mode of contamination (*Ascaris lumbricoides*, *Trichuris trichiura*, *Amoeba* species etc) [2-4]. School age children are the most exposed

group [5], with the risk factors increasing with poverty and tropical climate [6]. In this same group of population, intestinal helminthiasis occupies the first rank among all transmissible and non transmissible diseases following their devastating effects [7]. Also, 3.5 billions persons are infected with 450 millions being in the chronic state [6]. **Ascariasis**, hookworms and amebiasis alone could be responsible for 155.000 deaths each year [8].

In Cameroon, for about 15 years today, estimates showed that 6.5 million (42.6%) school age children were infected by *A. lumbricoides*, 6.5 millions (53.4%) by *Trichuris trichiura* and 2.6 million (14.7%) by *Necator americanus* [9]. In 2005, more than 10 million persons were infected by intestinal helminthiasis [10] and in 2012, these pathologies were still placed under **Neglected Tropical Diseases (NTDs)**, being prevalent in almost all the health districts and endemic in 180 health districts [11].

Despite the National Mass Drug Administration program adopted in 2004[12], the prevalence of intestinal infections are still high in some localities of the south west, west, central and east regions [13-15]. However, the epidemiological situations in some localities are not well known, among which is found the south region. In this region, 17% of children aged 6-11 years do not go to school [16], and could increase the risks of transmission in addition to parents, since they are not always involved in the mass drug administration program. This work was aimed to obtain basic data on the epidemiological situation of intestinal infections in school children of Ngovayang health area of Lolodorf neighborhood in the south region by: (i) identifying the different intestinal parasites (helminthes and protozoan) with their respective prevalence, (ii) determining infections intensity, (iii) evaluating the different parasites associations and the impact of co-infections on parasites intensity

2. MATERIALS AND METHODS

2.1. Study area

The study was conducted in the Ngovayang health area of Cameroon which is comprised of 8 villages (Ngovayang 1, Ngovayang 2, Ngovanyang 3, Bikala, Bingambo, Mbikiliki, Mougue, and Mvile) and six primary schools. It is a rural locality which is situated at about 15 Km from Lolodorf in the Ocean division of the south region. This area with a tropical humid climate was chosen for the study due to the absence of epidemiological data on intestinal infections. Two rivers (Mougue and Mbikiliki) cross the different villages, where many other little streams take their source. The entire area is characterized by the absence of electricity, with the presence of water sources (wells and non functional forages) which the entire populations do not have access on. The community members practice agriculture work, fishing, hunting and trading. A health center exists in Ngovayang 1 (Ngovayang mission) and the entire area has three agents of community health.

Mbikiliki (3°10.147'N, 10°32.572'E) and Bikala (3°11.850'N, 10°34.934'E) primary schools are characterized by the absence of good water sources, uncompleted pit toilet and sites that are reserved for garbage disposal. Mbikiliki is situated at about 4 Km from Bikala and the later is situated at about 6 Km from Ngovayang Mission.

Ngovayang Mission (3°13.067'N, 10°36.221'E), situated beside the unique health center of the area is characterized by the presence of forages, adequate toilets and a site for

garbage disposal. It is situated at about 2.5 Km from Mougue and at 6 Km from Ngovayang 2.

Ngovayang 2 (3°14.783'N, 10°38.550'E) is characterized by the absence of water sources, presence of non functional forage and a site that is reserved for garbage disposal. It is situated at 8 Km from Mougue (3°13.332'N, 10°36.982'E), which is characterized by the absence of water sources, the existence of a local pit toilet and a site that is reserved for garbage disposal. It is situated at about 3 Km from Bingambo.

Bingambo (3°13.709'N, 10°38.254'E) is characterized by the absence of water source, presence of well constructed toilets with poor maintenance and a site for garbage disposal. It is situated at about 11 Km from Lolodorf.

Defecation in ponds, streams or bushes around the school premises and the habit of walking barefooted is a common practice of school children in the area.

2.2. Study subjects

The study was conducted during the month of March 2015. Out of the 483 school children contacted, 423 (208 boys: 49.17% and 215 girls: 50.83%) participated in the survey. The sampled population was between the ages of 3-15 years and was divided into 3 classes of age interval (3-5years, 6-10 years and 11-15 years).

2.3. Ethical consideration

Ethical approval was obtained from Hospital Ethical Review Board of Lolodorf. The community leaders and the school administrators were duly informed on the objectives and benefits of the study. The children parents were also informed before sample collection and the benefits of the study. All children whose parents or guardians gave informed consent for their participation were included in the study. Participant's personal information was treated privately and was not divulged to a third party. All participants were treated freely with mebendazole 500mg.

2.4. Parasitological study

Samples collection which was conducted in six different villages during two days was done by three groups of person (one group per village) comprised of two persons per group. Following registration, one stool samples was collected from each participant in 50 ml screw-cap vial between 730 am and 10h am and was immediately divided into two portions. During the first day of samples collection, one person transported one portion of all the samples collected (unfixed) in a cooler containing ice blocks to the Parasitology laboratory (Nkomo which is situated at about 150km from the study area) of the Medical Research Centre (IMPM, Yaounde) for subsequent analysis the same day. The other portion of samples was fixed by 10% formol the same day by the remaining persons in the field to conserve the parasitic forms of the parasites. Samples collected during the second day were conserved and transported following the same procedure.

In the laboratory, the quantitative Kato-katz technique was used for the identification of helminths eggs following their morphology (*A. lumbricoides*, *T. trichiura*, and hookworm) and estimation of infection intensity, while the qualitative concentration formol ether technique was used to identified helminthes eggs and protozoan cysts[17,18]. To minimize the measurement bias on the parasitological data, all Kato slides were prepared the same day following stool samples collection to avoid the degeneration of hookworm eggs. Eggs were counted under a light microscope at 10X magnification and their number expressed in eggs

per gram of stool (epg), while the cysts of protozoan were observed at a magnification of 40X. Intensity of helminthes infection was evaluated as low (1-4999 epg, 1-999 epg, and 1-1999 epg); moderate (5000-49999 epg, 1000-9999 epg and 2000-3999epg) and high (≥ 50000 epg, ≥ 10000 epg and ≥ 4000 epg) infection intensity respectively for *A. lumbricoides*, *T. trichiura* and Hookworms [19].

2.5.Data Analysis

Parasitological data were analyzed using Statistic logistic PC DOS Version 2.0. The Chi-square test was used to compare the prevalence of parasites in relation to sex, age groups and villages, while one - way ANOVA or Kruskal-Wallis tests were used to compare the parasite intensity in relation to sex, age groups, villages and different parasites combinations. The Kruskal-Wallis test was used when the conditions of parametric ANOVA were not fulfilled. The level of statistical significance was at 95% ($P < 0.05$).

3. RESULTS

3.1. Parasite prevalence and infection intensities

Out of the 423 (87.6%) children included in the analysis, 321 (75.9%) were infected with at least one of the parasites *Ascaris lumbricoides* (30.3%), *Trichuris trichiura* (64.5%), Hookworms (12.5%), *E. histolytica*/ *E. dispar* (9.9%) and *E. coli* (34.0%). The global infection rates for helminthes and amoeba were 69.03% and 35.5% respectively. Transmission trend in the different schools varied significantly from 52.2% (Mougue) to 89.7% (Ngovayang Mission) ($P = 0.0001$). This difference was mostly observed between Ngovayang Mission compared to the rest of the schools with the exception being for Bingambo (Table 1 and 2). Infestation rate for *E. histolytica*/ *E. dispar* was more significantly ($P = 0.01$) prevalent in females (13.5%) than in males (6.3%). Hookworm infection was significantly high in children between the ages 3-5 years (25.0%) ($P = 0.02$), while children between 3-5 years (41.7%) and 11-15 years (41.7%) were significantly more infected by *E. coli* ($P = 0.04$). The variation trend of the different parasites prevalence was almost the same in both sexes, with no significantly difference observed for sex ($P = 0.3$) and age ($P = 0.07$) (Table 2).

Table 1. Distribution of study population (infection rates are expressed in percentage in brackets)

Variables	Boys(N)	Girls(N)	Total
Study group	208(49.2)	215(50.8)	423(100.00)
Infected children	162(77.9)	159(74.0)	321(75.9)
Uninfected children	46(22.1)	56(26.1)	102(24.1)
Single infections	66(31.7)	51(23.7)	117(36.4)
Multiple infections	96(46.2)	108(50.2)	204(63.6)

Table 2. Infection rates of different parasites with regards to sex, age and villages (%)

Variables	Parasite species				
	<i>A.lumbricoides</i>	<i>T. trichiura</i>	Hookworms	<i>E. histolytica</i> / <i>E. dispar</i>	<i>E. coli</i>
Sex					
Boys	63(30.0)	139(66.8)	27(13.0)	13(6.3)	65(31.2)
Girls	65(30.2)	135(62.8)	26(12.1)	29(13.5)	79(36.7)
Age					
3-5years	2(16.7)	9(75.0)	3(25.0)	2(16.7)	5(41.7)
6-10 years	77(28.5)	168(62.2)	27(10.0)	29(10.7)	81(30.0)

11-15 years	49(34.8)	97(68.8)	23(16.3)	11(7.8)	58(41.7)
Village					
Mbikiliki	21(30.0)	44(62.9)	10(14.3)	6(8.6)	29(41.4)
Bikala	14(21.5)	40(61.5)	2(3.1)	0(0.0)	12(18.5)
Ngovayang 2	26(38.8)	42(62.7)	4(6.0)	9(13.4)	23(34.3)
Ngovayang 1	44(37.9)	90(77.6)	25(21.6)	22(19.0)	48(41.4)
Bingambo	17(28.8)	36(61.0)	12(20.3)	5(8.5)	23(39.0)
Mougue	6(13.0)	22(47.3)	0(0.0)	0(0.0)	9(19.6)
TOTAL	128(30.3)	274(64.8)	53(12.5)	42(9.9)	144 (34.0)

The overall mean egg load for *A. lumbricoides*, *T. trichiura*, and Ankylostomes were 12854.4± 30406.0 epg of stool, 2345.7±6380.2 epg of stool and 378.0±750.7 epg of stool respectively. These values were significantly high in Ngovayang 2 for *A. lumbricoides* (18688.0± 41547.0 epg of stool; P= 0.002) and in Ngovayang 1 for *Trichuris trichiura* (4547.9± 9934.5 epg of stool; P= 0.0002) and Hookworms (594.9 ± 933.9 epg of stool; P= 0.01) (Table 3). High eggload was observed for all parasites species in girls compared to boys with significant observed for *T. trichiura* (P= 0.00001). The egg load was significantly high in children between 3-5 years infected by *T. trichiura* (P=0.0001) and hookworms (P=0.0001).

Table 3. Eggload of different parasites species by sex, age and village

Variables	Parasite species		
	<i>A.lumbricoides</i>	<i>T. trichiura</i>	Hookworms
Sex			
Boys	9291.7± 17424.1	1473.4± 3502.0	190.0± 271.0
Girls	16479.6± 39325.9	3182.2 ± 8177.4	566.0± 1013.7
Age			
3-5years	7008.0± 237.6	12120.0± 22078.4	3480.0± 0.0
6-10 years	11168.7± 31228.2	2371.9± 5396.2	264.0± 422.2
11-15 years	15470.3 ± 30011	1239.3± 2650.0	216.0± 300.0
Village			
Mbikiliki	15055.2± 30668.9	1196.6± 2817.6	24.0 ± 0.0
Bikala	5480.7 ± 5747.8	852.7± 2478.6	144.0± 0.0
Ngovayang 1	14205.7± 33129.4	4547.9± 9934.5	594.9 ± 933.9
Ngovayang 2	18688.0± 41547.0	1809.0± 2223.7	40.0± 27.7
Bingambo	4961.1± 6532.2	1206.2± 3025.6	96.0± 104.6
Mougue	3292.8 ± 5477.8	157.5± 208.5	/
TOTAL	12854.4± 30406.0	2345.7±6380.2	378.0±750.7

Infection intensity was generally low to high with high intensity observed for *A. lumbricoides* (7.8%) and *T. trichiura* (5.9%). The number of children with low infection intensity was significantly high compared to those with average and high infection intensity ($P=0.0001$) for *A. lumbricoides*, *T. trichiura*, Hookworms (Figure 1).

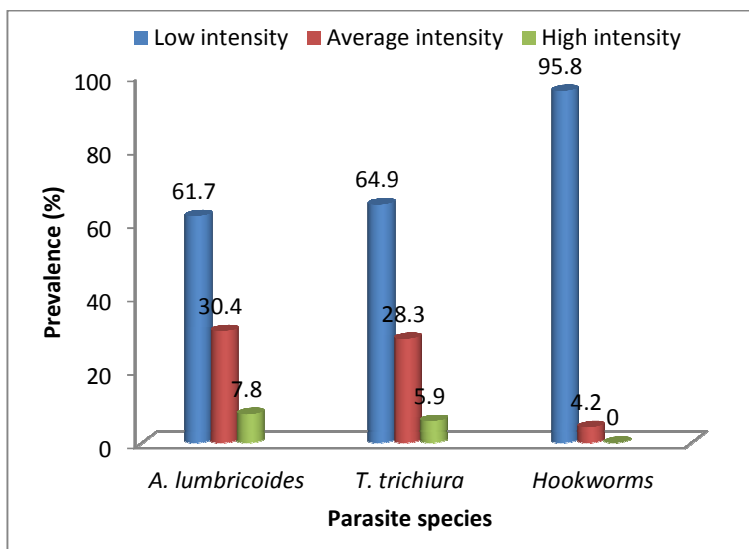


Figure 1. Prevalence of infection intensity for the different parasite species
A. lumbricoides (Low: 1-4999 epg , average: 5000-49999 e/g, high ≥ 50000 epg); *T. trichiura* (Low: 1-999 e/g, average: 1000-9999 epg, high: ≥ 10000 e/g) ; Hookworms (Low: 1-1999 e/g., average: 2000-3999epg., high ≥ 4000 epg) [19].

3.2. Prevalence of co-infections

Out of the 321 infected children, 117 (36.4%) had single infection, while 204 (63.6%) harbored more than one parasite species. Multiple infections were significantly high ($P=0.0001$) compared to single infections. Overall, *T. trichura* infections occurred more frequently as single species infection (72.7%; $P = 0.0001$) compared to other parasite species. The occurrence of multiple species infection was mostly observed for combinations involving *E. coli* (65.0%), with the highest occurrence rate observed for *T. trichiura* + *E.coli* (22,6%). Interactions between *T. trichiura* + *E.coli* led to a significant increase of *E. coli* prevalence ($P = 0.001$) compared to when the later occurred exclusively alone. Also, the association between *A. lumbricoides* + *T. trichiura* equally occurred in 20.1% of cases.

3.3. Helminthes-amoeba co-infection related to helminthes density

206
 207 The mean parasite density of *A. lumbricoides* (10561.7 epg of stool) increases when it
 208 coexists in the same host with *T. trichiura* (14857.1 epg of stool), *T. trichiura* + *E. coli*
 209 (16054.3 epg of stool) or *T. trichiura* + *E. histolytica*/ *E. dispar* + *E. coli* (13686,6 epg of
 210 stool). Its density decreased when it was found in association with other parasite species. No
 211 significant difference was observed for any of the cases. The parasite density of *T. trichiura*
 212 (1206.6 epg of stool) increases significantly when it coexists with *E. histolytica*/ *E. dispar*
 213 (11808 epg of stool), *A. lumbricoides* + Hookworms (7128 epg of stool), *A. lumbricoides* +
 214 *E. coli* (3285,4 epg of stool), Hookworms + *E. coli* (29624 epg of stool) , *E. histolytica*/ *E.*
 215 *dispar* + *E. coli* (1373,3 epg of stool), *A. lumbricoides* + Hookworm + *E. coli* (2174.4 epg
 216 of stool), *A. lumbricoides* + *E. histolytica*/ *E. dispar* + *E. coli* (5648.7 epg of stool).
 217 Hookworms occurred only in the presence of other parasites and in few participants (Table
 218 4).

219 Table 4. Intensity of parasitic helminthes in different parasite associations

Type of association	Number of cases (%)	Egg load	Standard deviation	p-value
Al only	14(12.2)	10561.7	16404,6	-
Al+Tt	42(36.5)	14857.1	32915.1	0.7
Al+Ank	1(0.9)	96.0	-	-
Al+Ec	2(1.7)	1164.0	17598.0	0.6
Al+Tt+Hw	7(6.1)	5739.4	18573.0	0.7
Al+Tt+Eh	2(1.7)	10344.0	29555.4	1.0
Al+Tt+Ec	28(24.6)	16054.3	16099.9	0.6
Al+Eh+Ec	2(1.7)	2028.0	14856.6	0.7
Al+Tt+ Eh+Ec	11(9.6)	13686.6	19770.3	0.8
Al+Tt+Hw+Ec	5(4.4)	7046.4	21926.2	0.4
Tt only	80(33.5)	1206.6	5127.0	-
Tt+Al	42(17.6)	1782.9	5120.8	0.2
Tt+ Hw	5(2.1)	3926.4	5911.4	0.2
Tt+ Eh	1(0.4)	11808.0	-	-
Tt+ Ec	42(17.6)	816.57	5003.0	
Tt+Al+Hw	7(2.9)	7128.0	5821.4	0.0001
Tt+Al++Eh	2(0.83)	840.0	6206.4	0.7
Tt+Al+Ec	28(11.7)	3285.43	5101.9	0.02
Tt +Hw+Ec	3(1.3)	29624.0	10166	0.04
Tt +Eh+Ec	9(3.8)	1373.3	6206.9	0.02
Tt+Al++ Eh+Ec	11(4.6)	5648.7	5739.5	0.02
Tt+Al+Hw+Ec	5(2.1)	2174.4	6821.8	0.00001
Tt+ Hw+ Eh+Ec	2(0.8)	2640.0	6535.9	-

220 Al= *A. lumbricoides*; Tt= *T. trichiura* ; Hw= Hookworms ; Eh= *E. histolytica* / *E. dispar*; Ec= *E. coli*

221 4. Discussion

222 This study is one of the first comprehensive studies to be conducted in this region of
 223 Cameroon. The findings from the current study confirm that Ngovayang health area is highly
 224 endemic (75.9%) for intestinal infections caused by *A. lumbricoides*, *T. trichura*,
 225 Hookworms, *E.histolytica*/ *E. dispar*, and *E. coli*. According to WHO, [20], infection
 226 prevalence situated between 20.0% - 50.0% and above 50.0% characterized areas with low
 227 risks and high risks of infection respectively. This high prevalence constitute a major threats
 228 for human health considering the morbidities and mortalities linked to these infections and

more especially in less developing countries [4] . Almost similar results (60.0%) were obtained in Tchad [21]. In Cameroon, despite the level of endemicity of these affections, most of the works carried out since the year 2010 have not revealed similar results: 42.4% in Barombi Koto and Marumba II [13], 23.4% in Bawa and Nloh [14], 45.6% in East region [15], 35.5% in Yoro [22], 33.8% in Muyenge [23]. The inaccessibility of previous epidemiological data for our study area serves as a limitation to situate a regression or progression of the epidemiological situation of parasitic infections in our study area. Infection prevalence remains high (69.03%) when only helminthes are taken in to consideration and is comparable to the infection rates obtained since many decades in other localities of Cameroon [24], confirming high transmission trend of these infections in the area. In line to the results of Richardson *et al.* and Ntonifor *et al.* [14, 23] , no significant difference in transmission was observed between sex, indicating that both males and females are exposed to equal risks of infections. Although the prevalence pathway seems to be in a ‘U’ shape as reported in previous studies [25], the exposure risk is similar in the different age groups.

The parasites prevalence was significantly high in some villages; despite the presence of good water source, adequate toilet, and presence of health center, as observed in Ngovayang 1. This might be linked to an exogenous source of transmission. According to PNUD [16], 17% of children between 6-11 years do not go to schools, and could serve as a potential source in the maintenance of parasites transmission at home, in addition to other members of the community (parents) who are not often included in the drug administration program. Also, absenteeism is a regular phenomenon in our study area (lowest participation rate recorded in Ngovayang 1 and Mbikiliki), and consequently these children do not always benefit from drug administered to children, thus serving as a supplementary source in the maintenance of parasites transmission. The significant difference of transmission trend between the different villages (belonging to the same geographical area), egg load for *T. trichiura* and hookworms, as well high prevalence of low infection intensity could reflect a difference in time acquisition of the parasite. Also the high infection intensity observed in females is contrary to results of previous studies [26] but similar to others [27]. This could be linked to host susceptibility, early acquisition of parasites in females and the number of adult female worms harboured. The infection intensity of *A. lumbricoides* was high in children between 11-15 years, what could reflect infection accumulation in children of this age group [13].

Generally, the hygiene habit practice by majority of our study population is poor (dirty hands, no access to water, walking barefoot, no adequate toilets etc) and this could explain the high prevalence and high egg load observed in children between 3-5 years for *T. trichiura*, Hookworms and *E. coli*. The overall prevalence of Hookworms (12.5%) obtained is extremely high compared to 1.4% and 2.6% obtained in other localities of Cameroon [13, 22], indicating that parasitic distribution is not homogeneous and varies with geographical areas. The risk factor of Hookworms has been shown to be linked to agricultural profession, with prevalence increasing with age [28]. In this study, children between 3-5 years were significantly more infected, what reflect their behaviour of walking barefooted which in turn facilitates their contamination by the infective larva through transcutaneous track. Also, *T. trichura* seemed to be the most prevalent parasite (64.5%) in all the villages. This observation

falls in line with previous results [14, 22, 29]. Low drug efficacy has been observed for this parasite in other endemic areas of Cameroon [13] and elsewhere [30], with anthelmintic resistance [31]. Also, its intensity is associated to age, reducing with increase in age. According to Galvani, [32], resistance is acquired with repeated exposure to the same antigen strain of a parasite.

The prevalence (35.5%) of parasitic protozoan (*E. coli* and *E. histolytica*/*E. dispar*) obtained during this study is higher than that obtained by Mazigo et al. [33] (20.5%), reflecting high circulation of the infesting forms (cysts) in our study area. *E. coli* was more prevalent, with its prevalence (34.0%) being higher than 17.9% and 25.8% obtained in previous studies [21, 34]. This observation could support the hypothesis that the cysts of *E. coli* could be more resistance in the environment than those of *E. histolytica*/*E. dispar*. Among the three age categories represented in this study the children within 3-5 years were least infected by *E. histolytica*/*E. dispar*. This can be attributed to their innate resistance due to the induced production of secretory immunoglobulin A that can diminish the adhesion between *E. histolytica* trophozoites epithelial cells, hence reducing new infection. *E. histolytica*. Also, the lack of antitrophozoite IgG and the acquired resistance due to intestinal IgA against the carbohydrate recognition site of *E. histolytica* galactose N-Acetyl D-galactosamine lecitin is responsible for the partial immunity enjoyed by the under fives [35-36].

Contrary to the results obtained in Yoro [34], children with multiple infections (63.6%) were significantly more than those with single infections (36.4%). This indicates that most parasitic infections do not occur singly but as co-infections [37-39], since a variety of environmental factors (same transmission routes) and host factors may influence the epidemiological and geographical patterns of infections and diseases.

Most studies have shown that parasitic co-infections could lead either to antagonistic or a synergetic relationship [40-41], consequently causing much morbidity in infected children. The association between helminthes parasites and amoeba species led to a significant increase of parasitic helminthes intensity, confirming a positive counteraction between the different parasites species involve in the association. The interaction between *T. trichiura* and *E. coli* might permit to bring out a hypothesis that, increase of *T. trichiura* infestation could lead to that of *E. coli*, either because they all have the transmission route (oral-fecal) or due to the absence of cross reactivity between anti- *T. trichiura* antibodies and anti- *E. coli* antibodies. Our observation is in line with the results obtained in association involving *Plasmodium falciparum*, *Schistosoma mansoni* and amoeba species, where a positive association was observed [34]. The present results also indicate that *T. trichiura* show synergism with *A. lumbricoides*, which is in accordance with results of previous studies [22, 42-43].

The results obtained in this study could be limited considering the techniques used which were more general than specific, thus having a shortcome on the identification of other intestinal parasites (eg *Strongyloides stercoralis*). Also, the distance from the study site to laboratory that samples analysis was performed could also contribute to underestimation of some parasitic forms (eg Hookworm eggs).

5. Conclusion

The results obtained in this work have demonstrated that, despite the National control program for intestinal parasites which is being executed in the country, the Ngovayang health area in the south region is still highly endemic for intestinal parasites including *A. lumbricoides*, *T. trichiura*, Hookworms, *E. histolytica* and *E. coli*, with a high level of co-infection. Also, the protocol of mass drug administration (once a year) as recommended by MINSANTE is not adequate to reduce the endemicity level of these parasites. The findings also suggest that concomitant infections between helminthes parasites and amoeba species led to an increase of helminthes parasites intensity. We also recommend that drug administration should be given to the entire community and should be accompanied by sanitation education for the population to take better preventive measures against these infections. The school teachers could also enlighten the parents during Parents Teachers' Association meeting (PTA) on the preventive measures for these diseases which could be taken in their various homes. Taking into consideration the consequences of these infections on morbidity and mortality of children, it will be vital to evaluate the morbidities factors associated to theses affections (anemia and malnutrition), evaluate treatment impact on the different morbidities, and evaluate the impact of these infections on public health by determining the contribution of parents in the maintenance of disease transmission.

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