



Prevalence and Intensity of Infection of Gastro-Intestinal Parasites in Babadjou, West Region of Cameroon

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Abstract: Helminth infections, such as *Ascaris lumbricoides*, *Trichuris trichiura* and Hookworms are major public health concerns. The aim of this study was to evaluate the prevalence and intensity of infection of gastro-intestinal helminthiasis in Babadjou. Qualitative and quantitative analyses were carried out on eight hundred and twenty five (825) stool samples collected from residents using the simple centrifugal flotation and McMaster count technique respectively. Out of the 825 samples examined, 70(8.5%) were infected with at least one helminth parasite with prevalence and intensities of infection of 4.4% and 2594.44 ± 3897.17 for *A. lumbricoides*, 4.2% and 72.86 ± 110.04 for *T. trichiura*, 1.9% and 83.33 ± 72.37 for Hookworms and 0.2% and 50 ± 00 for *Capillaria hepatica* respectively. Males (13.8%) were more infected than females (8.6%). The prevalence of *A. lumbricoides* and *T. trichiura* vary significantly with age groups with those of 1-10 years taking the lead (17.9%). The prevalence between the three educational levels differed significantly ($P < 0.05$) for *A. lumbricoides*, *T. trichiura* and Hookworm where those from the primary level were most infected (28.6%). The locality of Bamedji showed very high prevalences of *A. lumbricoides* (35.7%) and *T. trichiura* (17.9%) with significant differences as well. From the different occupations involved in the current study, students harboured all the four nematodes encountered. Cases of double and triple infections were recorded with *A. lumbricoides*+ *T. trichiura* (2.4%) being the highest and *A. lumbricoides*+ *T. trichiura*+ Hookworms (0.2%) the only triple infection registered. According to fecal concentration of eggs, 77.01% of infections were light infections, 3.44% moderate and 19.54% heavy infections. Only *A. lumbricoides* had heavy infections while all Hookworm infections were light. The results found on this study show that, it is important to control and prevent gastrointestinal helminths in and around Babadjou.

Keywords: Gastro-intestinal Helminths, Prevalence, Intensity, Babadjou, West Region, Cameroon

1. Introduction

Parasitic infections constitute a major health problem in tropical and subtropical zones where climatic conditions like temperature and humidity, lack of hygiene, poverty, socio-cultural habits and demographic parameters favour their development¹. The World Health Organization (WHO) estimates over 2 billion people in the world living with these parasitic infections where school age children and women at the age of procreation are the most infected².

These parasitic diseases kill more than 155,000 thousand

people per year with 97% of these deaths occurring in the developing countries³. Intestinal helminthiasis among these parasitic infections are the most common infections occurring throughout the developing world⁴ with 89.9 million school age children infected in Sub Saharan Africa⁵. In 2004, a report from the Cameroonian Public health Secretary of state revealed 16.1 million inhabitants in Cameroon with more than 10 million infected with helminthiasis⁶. The commonest and well known of these helminthiasis are Ascariasis caused by *Ascaris lumbricoides* affecting 1.5 billion people, Hookworms (*Ancylostoma duodenale* and *Necator americanus*) affecting 1 billion and trichuriasis due to *Trichuris trichiura* affecting 800

million people throughout the world ⁷.

Given that there is limited information in Babadjou regarding the occurrence of STHs, our main objective was to determine the prevalence and intensity of infection of helminthiasis among residents in Babadjou.

2. Materials and Methods

2.1. Area of Study

This study was carried out in Babadjou situated along the Bafoussam-Bamenda (National n°6) transect in the Bamboutos Division with a surface area of 250 km² and a population of 50.000 inhabitants. Its geographical position or coordinates are 5° 40' North, 10° 12' East. Temperatures are relatively low with intense rainfall. The dry season runs from December-April and the rainy season from May- November. Babadjou is bordered in the North by the Bamevuh and Bammock villages of the South West Region, in the East by the Pinying village of the North West region, in the West by the Balatchi village and in the South by the Bamessingue village both of the Western Region ⁸.

2.2. Ethical Clearance

To carry out this research, an ethical clearance was obtained from the National Ethics Committee of Cameroon, in order to ensure consent and confidentiality of the participants.

2.3. Study Population

The subjects were 825 from 14 different quarters of Babadjou randomly selected between October and December 2014. This study population was comprised of both children and adults aged from 2 to 98 years with a mean age of 22.8 ± 19.9 years. Three educational levels were represented (Nursery, Primary and Secondary levels of education). The study population was made up of 486 (59%) females and 339 (41%) males with a majority being students.

2.4. Parasitological Examination

Coprologic analysis was done to have a quantitative and qualitative appreciation of the prevalence of infection of the parasites. For the qualitative analysis, faeces were analysed by the double-centrifugal flotation technique using saturated sodium chloride solution (concentration: 6.84M). For

quantitative analysis or determination of the number of eggs per gram of faeces, the Mc Master technique described by Thienpont *et al.*, ⁹ was used.

2.5. Statistical Analysis

Data was stored in a Microsoft Excel spread sheet and then exported to SPSS (Statistical Package for Social Science, v 20) software for analysis. Summary statistics were generated using the same software. For the purpose of modeling these data, explanatory variables were first explored for associations between parasites using χ^2 test. The prevalence of helminth parasites were compared between demographic parameters using the chi square test. They were all tested at 5% significance level.

3. Results

3.1. Prevalence of Infection Among Residents

Out of the eight hundred and twenty five (825) stool samples examined, 70(8.5%) were infected with at least one parasitic helminth (table 1). Four different helminths were recorded, all of which were nematodes. These nematodes included: *Ascaris lumbricoides*, *Trichuris trichiura*, Hookworm and *Capillaria hepatica* with specific prevalences of 4.4% (36 infected), 4.2% (35 infected), 1.9% (16 infected) and 0.2% (2 infected) respectively.

Table 1. The overall percentage of infected and uninfected individuals.

| Parasitic status | No. of individuals | Frequency (%) |
|-------------------------------------|--------------------|---------------|
| Infected with at least one parasite | 70 | 8.5 |
| Not infected | 755 | 91.5 |
| Total | 825 | 100.0 |

Generally, both sexes were infected with all the above stated nematodes. Out of the 486 females examined, 42 (8.6%) harboured parasites while 47 (13.8%) of the 339 males were tested positive for these nematodes as shown on table 2 below. It can be noted that the overall prevalence was higher in males than in females with no significant difference ($P>0.05$). *Ascaris lumbricoides* (5.0%), *Trichuris trichiura* (5.6%) and Hookworm (2.9%) infections were slightly higher in males while in females, it was 3.9%, 3.3%, and 1.2% respectively. *Capillaria hepatica* had no difference in prevalence between both sexes.

Table 2. Prevalence of parasitic helminths with participant gender.

| Parasitic helminths | Gender | | Total N (%) | χ^2 | Df | p-value |
|-----------------------------|---------------|-------------|-------------|----------|----|---------|
| | Females N (%) | Males N (%) | | | | |
| <i>Ascaris lumbricoides</i> | 19 (3.9)* | 17 (5.0) | 36 (4.4) | 0.575 | 1 | 0.448 |
| <i>Trichuris trichiura</i> | 16 (3.3) | 19 (5.6) | 35 (4.2) | 2.608 | 1 | 0.106 |
| <i>Capillaria hepatica</i> | 1(0.2) | 1 (0.3) | 2 (0.2) | 0.065 | 1 | 0.799 |
| Hookworm | 6 (1.2) | 10 (2.9) | 16 (1.9) | 3.074 | 1 | 0.08 |
| Total | 42 (8.6) | 47(13.8) | 87(10.5) | | | |

*: Number of positive cases and prevalence (%) in bracket

It can be noticed on table 3 below that Hookworm infections were present in all the age groups except the last

age group. The prevalence of parasitic helminthiasis was highest in children from 1 to 10 years with an overall

prevalence of 17.9%. In this group, *A. lumbricoides*, *T. trichiura*, Hookworm and *C. hepatica* infections had specific prevalences of 7.6%, 7.2%, 2.9% and 0.4% respectively. This was followed by those of the second group who were aged from 11 to 20 years with *A. lumbricoides* (4.9%) and *T. trichiura* (4.5%) having the highest rates of occurrence. We

can also note that prevalence gradually decreased with increasing age. The least infections occurred in the 51 - 60 age group with only 1 (2.4%) Hookworm infection while it was completely absent in those of 60 years and above. The prevalence of *A. lumbricoides* and *T. trichiura* had significant differences between the age groups ($P < 0.05$).

Table 3. The Prevalence of helminth infections amongst age groups.

| Age group (years) | Parasitic helminths | | | | |
|-------------------|-----------------------------------|----------------------------------|----------------------------------|----------------|-------------|
| | <i>Ascaris lumbricoides</i> N (%) | <i>Trichuris trichiura</i> N (%) | <i>Capillaria hepatica</i> N (%) | Hookworm N (%) | Total N (%) |
| 2-10 | 21(7.6)* | 20(7.2) | 1 (0.4) | 8 (2.9) | 50 (17.9) |
| 11-20 | 12 (4.9) | 11(4.5) | | 3 (1.2) | 26(10.5) |
| 21-30 | 1 (1.2) | 2 (2.4) | | 2 (2.4) | 5(6.0) |
| 31-40 | 2 (3.1) | 1 (1.6) | | 1 (1.6) | 4(6.25) |
| 41-50 | | 1 (1.9) | 1 (1.9) | 1 (1.9) | 3(5.6) |
| 51-60 | | | | 1 (2.4) | 1(2.4) |
| >60 | | | | | |
| Total | 36 (4.4) | 35 (4.2) | 2 (0.2) | 16 (1.9) | 89 (10.78) |
| χ^2 | 16.18 | 13.01 | | 3.343 | |
| p-value | 0.013 | 0.043 | | 0.765 | |

*: Number of positive cases and prevalence (%) in bracket

The prevalence between nursery, primary and secondary school children differ significantly ($P < 0.05$). Those from the primary level were the most infected (28.6%) against a prevalence of 17.3% from the secondary level of education.

Only 2 participants came from the nursery level of which none of them was infected. We also observed a prevalence of 2.9% from those who did not provide any information on their educational status (Table 4).

Table 4. The prevalence of parasitic helminths according to level of education.

| Helminths | Level of education | | | | χ^2 | Df | p-value |
|-----------------------------|--------------------|---------------|---------------|-----------------|----------|----|---------|
| | Unknown N (%) | Nursery N (%) | Primary N (%) | Secondary N (%) | | | |
| <i>Ascaris lumbricoides</i> | 4 (0.8)* | 0 (0) | 27 (12.7) | 5 (5.3) | 51,702 | 3 | 0.000 |
| <i>Trichuris trichiura</i> | 6 (1.2) | 0 (0) | 25 (11.8) | 4 (4.2) | 41,796 | 3 | 0.000 |
| Hookworm | 4 (0.8) | 0 (0) | 8 (3.8) | 4 (4.2) | 10,019 | 3 | 0.04 |
| <i>Capillaria hepatica</i> | 1 (0.2) | 0 (0) | 1 (0.5) | 0 (0) | | | |
| Total | 15 (2.9) | 0 (0) | 61 (28.6) | 13 (17.3) | | | |

*: Number of positive cases and prevalence (%) in bracket

Out of the 14 quarters involved in our study, at least one parasitic helminth was identified in each of them except Nkameleh which harboured no parasites. Bamedji showed very high prevalences of *A. lumbricoides* (35.7%) and *T. trichiura* (17.9%) with significant differences ($P < 0.05$) between the localities as shown on table 5 below.

Table 5. The prevalence of parasitic helminths among localities.

| Localities | Parasitic helminths | | | | Total |
|-------------|-----------------------------------|----------------------------------|----------------|----------------------------------|------------|
| | <i>Ascaris lumbricoides</i> N (%) | <i>Trichuris trichiura</i> N (%) | Hookworm N (%) | <i>Capillaria hepatica</i> N (%) | |
| Balepo | 2 (3.0)* | 1(1.5) | 0 (0) | | 3 (6.06) |
| Bamedji | 10(35.7) | 5(17.9) | 0(0) | | 15 (53.57) |
| Bamedjingha | 2(1.2) | 7(4.3) | 5(3.0) | | 14 (8.53) |
| Bamejuhi | 1(0.7) | 3(2.0) | 4(2.6) | 1 (0.7) | 9 (5.96) |
| King place | 5(10.6) | 4(5.5) | 1(2.1) | | 10 (21.27) |
| Metongfeu | 0(0) | 0(0) | 1(3.1) | | 1 (3.10) |
| Ngagong | 2(3.4) | 5(8.5) | 1(1.7) | | 8 (13.55) |
| Ngindah | 1(6.2) | 1(6.2) | 0(0) | | 2 (12.5) |
| Ngon-yeuh | 1(3.3) | 3(10.0) | 0(0) | | 4 (13.33) |
| Nkameleh | 0(0) | 0(0) | 0(0) | | 0 |
| Takang | 1(2.8) | 0(0) | 3(8.3) | 1 (2.8) | 5 (13.8) |
| Tchimego | 0(0) | 1(3.6) | 0(0) | | 1 (3.57) |
| Toumaka | 5(9.4) | 2(3.8) | 1(1.9) | | 8 (15.09) |
| Zavion | 6(5.7) | 3(2.9) | 0(0) | | 9 (8.57) |
| Total | 36(4.4) | 35(4.2) | 16(1.9) | 2 (0.2) | 89 (10.78) |
| χ^2 | 86.984 | 27.203 | 15.062 | | |
| p-value | 0.000 | 0.018 | 0.374 | | |

*: Number of positive cases and prevalence (%) in bracket

Looking at table 6, one can easily notice the complete absence of infection in most of the occupations yet, students harboured all the 4 nematodes identified during the course of this study. The prevalence of *A. lumbricoides* was relatively high in gardeners (11.1%) followed by students (8.5%) and house wives (2.5). The pattern observed for *T. trichiura* was

higher in bike riders (7.7%), followed by students (6.7%) and farmers (4.8%). The trend observed for Hookworm was higher in teachers (25%) and *C. hepatica* infections recorded high prevalence in farmers. However, all these differences were not statistically significant ($P > 0.05$).

Table 6. The prevalence of parasitic helminths according to occupation.

| Profession | Helminths | | | | Total |
|------------|--------------------------------------|-------------------------------------|--------------------------|-------------------------------------|------------|
| | <i>Ascaris lumbricoides</i> N (%) | <i>Trichuris trichiura</i> N (%) | <i>Hookworm</i> N (%) | <i>Capillaria hepatica</i> N (%) | |
| Farming | 1 (1.6)* | 3 (4.8) | | 1 (1.6) | 5 (7.9) |
| Student | 29 (8.5) | 23 (6.7) | 10 (2.9) | 1 (0.3) | 63 (18.42) |
| Teaching | | | 1 (25) | | 1 (25.0) |
| Gardening | 1 (11.1) | | | | 1 (11.11) |
| House wife | 2 (2.5) | 1 (1.2) | 2 (2.5) | | 5 (6.5) |
| Bike rider | | 1 (7.7) | | | 1 (7.6) |
| Unknown | 3 (1.1) | 7 (2.5) | 3 (1.1) | | 13 (4.5) |
| Total | 36 (4.4) | 35 (4.2) | 16 (1.9) | 2 (0.2) | 89 (10.78) |
| χ^2 | 26.209 | 11.447 | 16.466 | | |
| Df | 15 | 15 | 15 | | |
| p-value | 0.051 | 0.781 | 0.421 | | |

*: Number of positive cases and prevalence (%) in bracket

In the course of our work, cases of parasitic associations were identified. Figure 1 below gives us a general overview of the different types of associations. Seven hundred and fifty five (91.5%) individuals of the study population was tested negative of parasitic helminths. The highest infections were single infections with 53(6.4%) individuals followed by 15(1.8%) participants with double infections. Only 2(0.2%) members of the study population harboured triple infections.

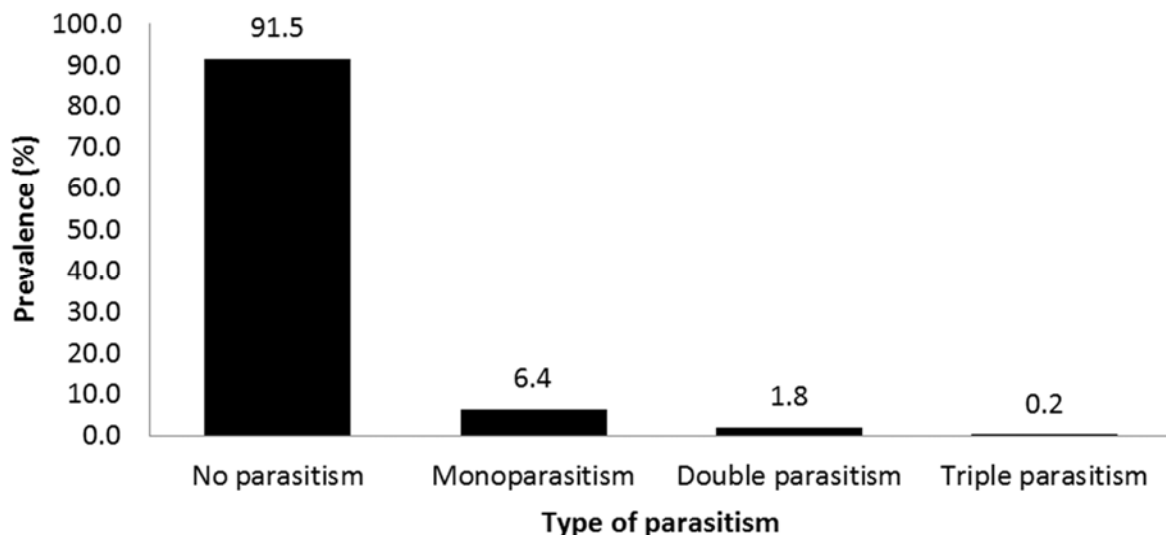


Figure 1. General presentation of parasitic associations.

The patterns of single, double and triple infections are shown in figure 2 below. *A. lumbricoides* and *T. trichiura* recorded the highest infection rates of 2.4% each amongst the single infections. Three types of double infections were observed with the association *A. lumbricoides* + *T. trichiura* being the most prevalent (1.6%). The two other associations were those of *A. lumbricoides* + Hookworm and *C. hepatica* + Hookworm with a prevalence of 0.1% each. Only one triple infection was recorded. It was that of *A. lumbricoides* + *T. trichiura* + Hookworm with a prevalence of 0.2%.

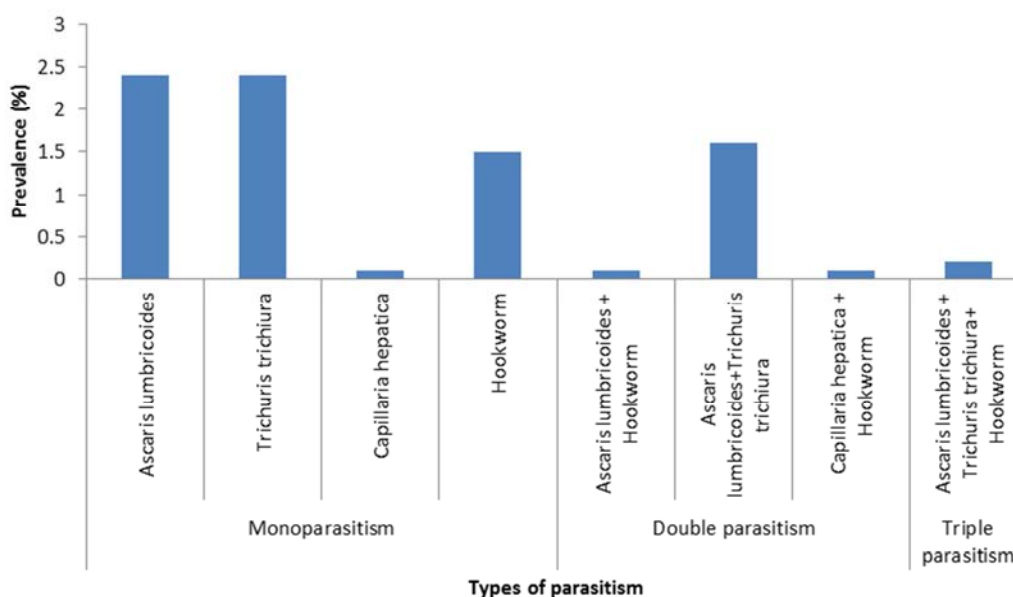


Figure 2. Prevalence of Single and mixed intestinal infections.

3.2. Intensity of Infection (mean EPG) Among Residents

The specific intensity of infection which is expressed in terms of mean concentration of eggs per gram (EPG) of faeces is shown on table 7. Out of the 825 stool samples examined, *A. lumbricoides* (2594.44 ± 3897.174) recorded the highest intensity of infection and *C. hepatica* the lowest (50 ± 00).

Table 7. Intensity of infection of the different helminth Parasites.

| Parasites | No. Infected | Egg per gram (Mean \pm SD) |
|-----------------------------|--------------|------------------------------|
| <i>Ascaris lumbricoides</i> | 36* | 2594.44 ± 3897.174 |
| <i>Trichuris trichiura</i> | 35 | 72.86 ± 110.042 |
| Hookworm | 16 | 83.33 ± 72.375 |
| <i>Capillaria hepatica</i> | 2 | 50 ± 00 |

*No. infected: number of infected individuals

Based on the modified classification of geohelminths according to the faecal concentration of eggs by Deuyo (1997), table 8 was established. The pre-dominant intensity of infection was the light infection, where all Hookworm (100%) infections were light infections. In general, 77.01% of infections were light infections, 3.44% moderate and 19.54% heavy infections. *A. lumbricoides* recorded 47.2% of heavy and light infections each and 5.6% moderate. Light and moderate infections were also observed in *T. trichiura* with faecal concentrations of 97.1% and 2.9% respectively.

Table 8. Distribution according to faecal concentration of eggs.

| Parasites | Intensity of infection | | | Total N |
|-----------------------------|------------------------|-------------------|----------------|------------|
| | Light N (%) | Moderate N (%) | Heavy N (%) | |
| <i>Ascaris lumbricoides</i> | 17 (47.2)* | 2 (5.6) | 17 (47.2) | 36 |
| <i>Trichuris trichiura</i> | 34 (97.1) | 1 (2.9) | | 35 |
| Hookworm | 16 (100) | | | 16 |
| Total | 67 (77.01) | 3 (3.44) | 17 (19.54) | 87 |

*: Number of positive cases and prevalence (%) in bracket

4. Discussion

The main interest of this study was the prevalence and intensity of infection of helminthiasis in Babadjou in which the overall prevalence was found to be 8.5%. This result corroborates that of Nougning¹ in the localities of Bambui and Bambili North West Region of Cameroon who also recorded a prevalence of 8.5% among residents and the 8.2% obtained during a comparative study carried out in Wuyi and Laogang in the Republic of china¹⁰. It was relatively lower than the prevalence (13.8%) reported by Ephrem *et al.*¹² in Ethiopia and that of Wabo Poné *et al.*,¹¹ in Dschang, Western Region of Cameroon with a prevalence of 41.5%. However, this overall prevalence is relatively high as compared to the 0.9% recorded by Zadock¹³ in the Same district. These differences may be explained by variations in socio-economic status, regular de-worming campaigns, improvement in hygienic conditions, climatic and geographic conditions of the study area, as well as local endemicity of the study area for these particular parasites.

Four parasitic helminths were identified including *A. lumbricoides*, *T. trichiura*, Hookworms and *C. hepatica* with specific prevalences of 4.4%, 4.2%, 1.9% and 0.2% respectively. These results are similar to the values obtained by Nougning¹ who recorded 4.37% in *A. lumbricoides*, 2.75% in *T. trichiura* and 1.57% in Hookworm infections but relatively low as compared to those registered in Dschang by Wabo Poné *et al.*,¹¹ (*A. lumbricoides*: 18%, *T. trichiura*: 36%, Hookworm: 11%). These low specific rates may be due to public awareness, improvement of environmental sanitation and the national de-worming campaign for the fight against gastro-intestinal parasites. From the overall prevalence of intestinal helminths, *A. lumbricoides* comprised the most prevalent helminth parasite (4.4%). This observation is consistent with the findings of Maffo Tatsinkou *et al.*,¹⁴ in Dschang, Cameroon and Mohammed *et*

*al.*¹⁵ in Ethiopia who observed prevalences of 10.9% and 4.32% respectively. The high existence of this parasite among residents may be due to the resistant nature of the eggs to various environmental conditions. Also, these eggs are very adhesive and can easily stick to fruits, vegetables, flies and dust particles. The least prevalence was observed in *C. hepatica* (0.2%). This is obvious because it is rarely found in humans and there are no endemic areas of infection with *C. hepatica* and human infection primarily results from zoonotic transmission or might have been the case of spurious infection¹⁶ with most of these infections found in children. This result corroborates that of Maffo¹⁷ who also observed a prevalence of 0.2%. This can be explained by the fact that unembryonated eggs might have been ingested by individuals in which case they were harmlessly pass out in the faeces (spurious infection). Also, identification of *C. hepatica* eggs in the stool does not result from infection of the human host, but from ingestion of livers from infected animals by that host and the eggs will as well be harmlessly passed out in faeces¹⁸.

Among the various sexes, the males (13.8%) harbour most of the helminth parasites than the females (8.6%). These results are similar to those obtained in Cameroon by Maffo¹⁷ who recorded 21.53% and 17.84% in men and women respectively. This was also observed in Nigeria by Abelau *et al.*,¹⁹ who recorded a higher prevalence in men (23.6%) than in women (20.2%) and by Akinseye *et al.*,²⁰. The higher prevalence in males recorded in this study may be due to the playing activities of male children. This could also be attributed to consistent exposure of the men to using of bare hands in carrying out farming and other laborious works without proper washing of the hands before eating. However, this difference though not statistically significant ($P > 0.05$) was not in agreement with those observed in Nigeria by Bui and Kofur²¹ where females harboured more parasites than the males. The presence of these nematodes in both sexes is a clear indication that infection with helminth parasites is not sex dependent meanwhile Wabo Poné *et al.*,¹¹ observed a significant difference in the prevalence of helminth parasites between both sexes in Cameroon.

Furthermore, the findings of the current study also depicted that intestinal helminthic infections are more prevalent in younger children. The four helminth parasites occurred most in children of 2-10 years with *A. lumbricoides* and *T. trichiura* taking the lead. This result agrees with those carried out in Ethiopia by Gessesew *et al.*,²² and Mohammed *et al.*,¹⁵ and in Nigeria by Nmor *et al.*,²³. The second group with high infection rates was that of 11- 20 years. This remark was also in line with the report of Mohammed *et al.*,¹⁵. The significant difference between prevalence in age groups might be attributed to the fact that younger children cannot properly keep their personal hygiene and their habit of crawling on contaminated soil exposes them to infection²³. Also, the prevalence of helminthiasis decreased with increasing age with the last age group (> 60) harbouring no parasites at all. This is in accordance with the findings of Seleshi *et al.*,²⁴ who said it is probably due to the

mature way adults handle personal hygiene; Susan²⁵ observed that immunity against intestinal helminths increases with age due to higher level of acquired immunity in the older ones. In contrast, these results did not agree with the report of Abelau *et al.*,¹ in Nigeria who found helminth parasites to be most common among the adult ages from 20-50 years and Payne *et al.*,²⁶ in prison inmates in Dschang, Cameroon due to indiscriminate eating when permitted to go out and work without surveillance. Hookworm infections tend to occur in almost all age groups. This is similar to the reports of Hesham *et al.*,²⁷ who suggests that the differences in mode of infection and infectious stages in hookworm as compared to *A. lumbricoides* and *T. trichiura* may explain why Hookworm infection tends to occur in older age groups given that most populations of rural communities are embedded in agriculture in which they work barefooted on daily basis.

The prevalence of intestinal helminthiasis varied significantly between the different localities with Bamedji harbouring most of the parasites. This could be attributed to some ecological factors such as temperature, relative humidity and rainfall³¹ which affect the epidemiology of these parasites as well as their social habits, the standard of personal and environmental hygiene.

The current study reported students and farmers with high prevalence of intestinal helminthiasis. This is in agreement with the records of Akinseye *et al.*,²⁰ who suggest that the high prevalence of STH among these adolescents could be associated with poverty in the area, poor hygiene and sanitation. Higher percentage of the population lives in mud housing. These people are predominantly farmers using bare hands during farming, depending solely on stream water and uncovered wells for their drinking water, which may be polluted from the source with faecal materials as children defecate in their surrounding environment.

Another important factor is the level of education of individuals. The present study revealed very high prevalence (28.6%) in those from the primary level of education. One can conclude that they are ignorant of the dangers that await them when they do not take personal and environmental hygiene into consideration. This calls for the need of an integrated approach that includes education on personal hygiene, improved sanitary and environmental conditions and provisions of portable drinking water which are inevitable measures in achieving a sustainable elimination of these infections²⁰.

Multiple helminth infection is a common phenomenon in areas where different types of parasites are encountered. Cases of simple, double and triple infections were observed with respective prevalence of 6.4%, 1.8% and 0.2% in the total study population. The highest infections were single infections where 2.4%, 2.4%, 1.5% and 0.1% of the total population harboured only *A. lumbricoides*, *T. trichiura*, Hookworm and *C. hepatica* respectively. Three types of double parasitisms were identified with *A. lumbricoides* + *T. trichiura* being the most prevalent (1.6%). This is similar to the report of Nougning¹ which revealed only this association

with a prevalence rate of 1.58% and Ngangnan²⁸ who recorded a 0.5% rate for this association in the Littoral Region of Cameroon but different from that of Agbolade *et al.*,⁴ who recorded the most prevalent co-infection as that of scariasis + hookworm and Tesfahun and Achenef²⁹ who revealed highest double infection in *Schistosoma mansoni* + *A. lumbricoides*. This might be due to the fact that both parasites have the same mode of transmission (faeco-oral). The two other associations were those of *A. lumbricoides* + Hookworm which is in line with the results of Akinseye *et al.*,²⁰ and *C. hepatica* + Hookworm with a prevalence of 0.1% each. Only one triple infection was identified: *A. lumbricoides* + *T. trichiura* + Hookworm. This is in agreement with the report of Agbolade *et al.*,⁴ and Hesham *et al.*,²⁷ where 25% was infected with a combination of trichuriasis, ascariasis and Hookworm infection but different from the combination of *S. mansoni* + *A. lumbricoides* + Hookworms observed by Tesfahun and Achenef²⁹. This is probably due to local endemicity of the study area for these three helminth parasites, free interaction between the host and the contaminated environment and most of all absence of competitive exclusion between the different parasites¹⁴.

The egg count method as a measure of intensity of intestinal helminth infections, although susceptible to errors of sampling due to periodicity of egg production by female worms and uneven distribution of eggs in faeces, is still widely used³⁰. The intensity of helminth infections in this study has been assessed by egg counts where *Ascaris lumbricoides* (2594.44 ± 3897.174) showed the highest parasitic-mean intensity and *C. hepatica* (50 ± 00) the lowest. This was in line with the observations of Maffo tatsinkou *et al.*,¹⁴. This could be attributed to the fact that *Ascaris* has a higher egg output (200,000 egg per day) compared to *Trichuris* and hookworm and that *C. hepatica* is an exceptionally rare infection in humans and where both worms and eggs could not be easily detected in stools of infected hosts. However, the cornerstone of diagnosis still remains the liver biopsy^{31, 32}. The mean parasitic intensity for each nematode obtained in the present study was lower as compared to that obtained by Wabo Poné *et al.*,¹¹. These authors registered 3722 ± 5677, 563 ± 982 and 875 ± 1462 for *A. lumbricoides*, *T. trichiura* and Hookworm respectively.

The categorization of the intensity of infection due to *A. lumbricoides*, *T. trichiura*, the Hookworms and *C. hepatica* showed that majority of the sampled population harboured no parasites. However, 77.01% of infections were light infections. This high rate of light infection is in agreement with the findings of Bethony *et al.*,³³, Zadock¹³; Megwi³⁴ and Maffo tatsinkou *et al.*,¹⁴ who reported a 100% light infection. This might be attributed to the method used for egg count per gram of faeces as the McMaster technique used in the present study is less sensitive as compared to the Kato Katz technique. This can also be explained by the range of values used for classification; that means in the present study, the classification used by Deuyo³⁵ was adopted. Only *A. lumbricoides* had heavy infections. It could be related to the fact that eggs of *A. lumbricoides* can remain viable in the soil for long periods

because they are resistant to extremes temperatures than the eggs of other parasites³⁶. This is consistent with the findings of Megwi³⁴ in the Western Region of Cameroon and WHO³⁷ who reported that intestinal parasites are neither evenly nor randomly distributed among hosts, but tend to aggregate in a few heavily infected individuals. All Hookworm infections (100%) were light infections. This is probably due to the fact that, most of these infections occurred instead in children as it is known that heavier infections occur during adulthood^{38, 39}.

5. Conclusion

This work showed a relatively low prevalence of gastro-intestinal helminths in our study area, a proof of the effectiveness of the national de-worming campaigns but could reach endemic proportions in cases of non- treatment and non respect of sanitary rules. So, it is better to say that prevention is better than cure and health education is one of the key factors to the realization of the Cameroon's vision as an emerging nation by the year 2035.

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