Original Research Article

Enteric parasitosis of HIV-positive patients in Cameroon: case of the Regional Hospital of Bafoussam (Western Region)

ABSTRACT

Objectives: The Human Immunodeficiency Virus (HIV) causes a progressive alteration of the immune system leading to increased susceptibility to infectious agents. A few studies have been done on gastrointestinal parasites in HIV-infected persons in Cameroon. However, these studies need to be updated. The objective of this study was to identify and determine the prevalence of gastrointestinal parasites in relation to associated factors in HIV+ patients at the Bafoussam Regional Hospital.

Methods: The study was conducted from May to December 2021 on 240 patients aged from 3 to 73 years. Stool and blood samples were tested for parasites and HIV viral loads respectively.

Results: The analyses revealed that 58 (24.2%) patients were carriers of at least one parasite species. A total of 7 parasite species were identified, the most predominant being *Entamoeba histolytica* (12.62%) followed by *Cryptosporidium* spp (4.54%). A high majority, 91.3% had undetectable viral loads with the presence of intestinal parasitosis. However, the most infested patients were those with viral loads above 50 copies/ml. With respect to the duration of antiretroviral treatment, the rate of infestation was higher in patients with less than 12 months on treatment (OR=2.8; p=0.04). The prevalence of infestation was significantly higher in those under 20 years of age (OR = 5.13; p = 0.03). The distribution of gastrointestinal parasite species according to viral loads varied significantly for *Blastocystis hominis* and *Dicrocoelum dendriticum* with $p<0.05$.

Conclusion: The presence of these parasites reveals that people living with HIV should be regularly screened and treated to improve their health status.

Keywords: Gastrointestinal parasitosis, HIV positive, Viral load, Bafoussam, Cameroon.

1. INTRODUCTION

Gastrointestinal parasites are endemic in tropical countries. These countries are furthermore confronted with the human immunodeficiency virus (HIV), this is the case in sub-Saharan Africa [1]. HIV/AIDS causes a disruption of the immune system by destroying CD4 T cells, predisposing patients to opportunistic infections [2]. These infections can be viral, bacterial or parasitic and are associated with increased morbidity and mortality [3,4]. The gastrointestinal parasites incriminated in this disease are: *Cryptosporidia*, *Microspora*, *Cytoisospora belli* and more rarely *Cyclospora cayetanensis* [5]. Other pathogens are known to be associated with HIV+ patients, such as *Blastocystis hominis* [6,7].

In addition to the effects of HIV enteropathy, the presence of gastrointestinal parasites regularly induces diarrhoea which, in the long term, can lead to dehydration, weight loss syndrome, disruption of nutrient absorption [8,9], anorexia, and

general deterioration of the patient's health [3]. These parasites also decrease the efficiency of the immune system by preventing the secretion of type A immunoglobulin (IgA), thus the organism is predisposed to develop bacterial and/or viral infections [10]. This immunoglobulin is the primary antibody isotype at mucosal surfaces [11]. Similarly, it has been reported that poor sanitation and malnutrition can promote the spread of these infections [12].

With the improvement in the care of People Living with HIV (PLHIV) in recent years worldwide, the introduction of Highly Active Antiretroviral Therapy (HAART) as the primary treatment for HIV has led to a reduction in the frequency of infections; including those caused by enteroparasites [13]. A study in Antioquia, Colombia, in a population of PLWHA on ART showed a prevalence of 29.2% [14] and Ethiopia with 24.7% [15]. In some regions in Cameroon a high prevalence of gastrointestinal parasites has been registered; 52.08% in Yaoundé [16], 27.9% in Douala [17] and 59.5% in Dschang (West) [18]. In view of new measures for the management of people living with HIV in Cameroon by the Ministry of Public Health, it would be important to update the epidemiological data on intestinal parasitic infections in this category of patients affiliated to the Bafoussam Regional Hospital. The objective of this study was to identify and determine the prevalence of gastrointestinal parasites in relation to associated factors in HIV+ patients at the Bafoussam Regional Hospital.

2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

2.1. Study site

This study was conducted at the Bafoussam Regional Hospital, center for people living with HIV in the Mifi Division, Western Region of Cameroon (Figure 1). These HIV+ patients came from several areas in the region and from other parts of the country.

The study area is characterized by an equatorial monsoon climate with four seasons: the long dry season (November to mid-March), the short rainy season (mid-March to May), the short dry season (June to July) and the long rainy season (August to October) [19]. It is located 5°-7° North Latitude and 8°-20° East Longitude in the region. Rainfall averages 2,000 mm per year, spread over the period from March to November [20]. Its average altitude is 1,450 meters. Bafoussam has approximately 98,339 inhabitants [21].

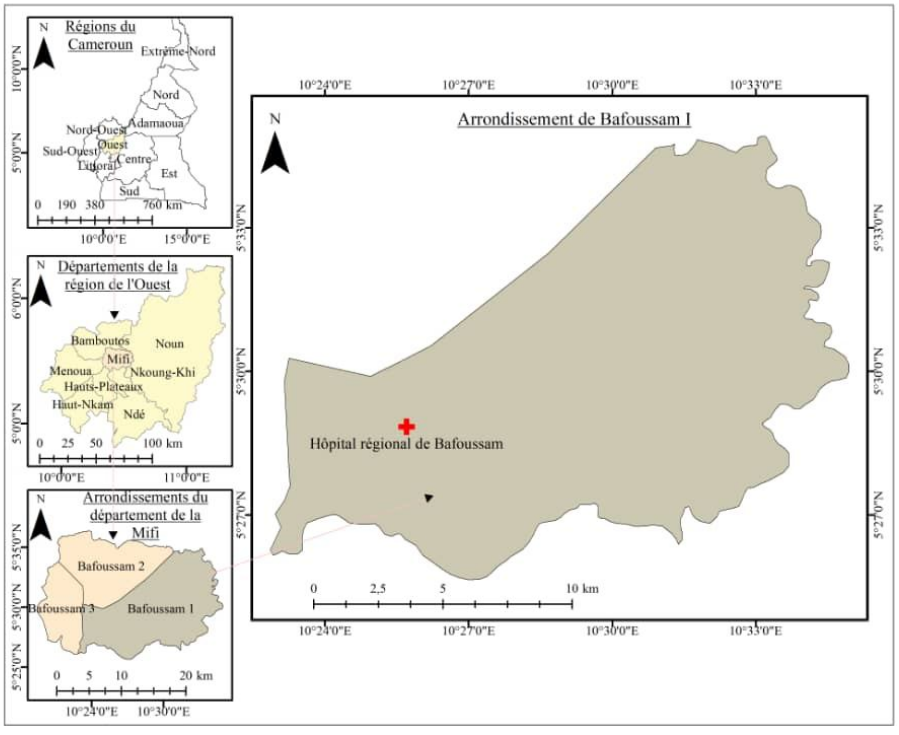

Figure 1: Geographical location of the Bafoussam Regional Hospital.

2.2. Study population

The study population consisted of HIV-positive subjects who visited the HIV care center of the Bafoussam regional hospital for routine viral load monitoring.

2.3. Data collection

A questionnaire was used to collect socio-demographic information. It included: age, sex, and place of residence, level of education, marital status, occupation and hygienic behaviors. Data on the viral load was collected from the file of each HIV + patient at the HIV Approved Treatment Center (ATC).

2.4. Laboratory analysis

The parasitological data were obtained by microscopic observation after informed consent. A transparent spot and a sealed plastic jar was given to each participant for stool collection. Each stool sample was analyzed using three methods; direct microscopy, then stool was concentrated using a modified Formol-Ether technique where gasoline replaced ether [22,23] and finally, the fecal smears were stained using the Kinyoun method, a modified acid-base staining technique, to detect oocysts [24] using methylene blue in place of Malachite green.

2.5. Laboratory techniques

2.5.1. Direct microscopy method

After placing a drop of physiological water or lugol on an object slide, a small amount of fecal material was removed from each spot with an applicator and diluted in this drop of water. Subsequently, the preparation was covered with a coverslip gently on the slide to avoid air bubbles and the preparation was examined under the microscope.

2.5.2. Formalin and Ether Concentration Method

Using a swab stick, approximately 1 g (pea size) of stool was emulsified in 7 ml of 10% formol water in a centrifuge tube. Pour the entire contents of the tube through wire gauze into an evaporation basin. The collected suspension was transferred to a conical (centrifuge) tube, 3 ml of gasoline was added (replacing the ether), mixed for 30 seconds and centrifuged at 3000 rpm for 1 minute. With an applicator stick, the cap was peeled off and the supernatant discarded (gasoline, fecal debris and formalin water) by inverting the tube with a quick motion and subsequently shaking the deposit. Finally, a drop of the pellet was moved with a Pasteur pipette to a slide, covered with a coverslip, and examined under a microscope for the detection of eggs and cysts.

2.5.3. Modified Ziehl–Neelsen Method

From the concentration pellet, a smear was prepared on a slide and left to dry. The smear was later fixed with methanol for 1 minute, then stained with Kinyoun's fuchsin carbol for 5 minutes, rinsed immediately with tap water. The smear was then decolorized with sulfuric acid for 2 minutes followed by washing with tap water. Finally methylene blue was used as a counterstain for 1 minutes, then washed with tap water, dried and examined under the microscope.

2.6. Statistical analysis

The data collected after these fields and laboratory activities were recorded in Microsoft Excel 2013 and then analyzed by SPSS version 22 (Statistical Package for Social Sciences) and Medcalc version 14.8.1. Descriptive statistics was used to bring out the different frequency distribution tables and graphics. Chi-square (χ^2) test was used to compare the prevalence of intestinal parasites with respect to viral load levels, protocol types, duration of antiretroviral therapy, monthly income, behavioral and hygienic characteristics while Odds Ratio were calculated to estimate the risk attributable to different factors with confidence intervals. $P<0.05$ were considered statistically significant.

3. RESULTS

3.1. Socio-demographic characteristics of the study population

A total of 240 patients aged 3 to 73 years agreed to participate in the study. The mean age ± SD was 44.19 ± 14.01. The female gender was more represented (71.3%) than the male gender (28.7%) (Table 1); that is, an F/M sex ratio of 2.48. The 41-50 age group was more represented (31.3%) followed by the 51-60 age group (23.3%). According to marital status, married patients were more represented (51.7%) followed by single patients (21.3%). Patients with secondary

education level were more represented (45.4%). In terms of occupation, the majority were housewives (43.8%) followed by employers in the informal sector (33.3%).

Table 1: Socio-demographic characteristics.

Parameters		Frequency (N=240)	Percent
Gender	Female	171	71.3
	Male	69	28.7
Age range (years)	≤20	17	7.1
	21-30	17	7.1
	31-40	50	20.8
	41-50	75	31.3
	51-60	56	23.3
	> 60	25	10.4
Marital status	Single	51	21.3
	Married	124	51.7
	Divorced	18	7.5
	Widow	47	19.6
Level of education	Illiterate	21	8.8
	Primary	97	40.4
	Secondary	109	45.4
	Universitary	13	5.4
Profession	Student	13	5.4
	Agriculture	17	7.1
	Employee S I	80	33.3
	Civil servant	25	10.4
	Housewife	105	43.8

3.2. Viral load of patients

Out of the 240 patients, 6 (2.5%) had viral loads above 1000 copies per ml of blood, 15 (6.3%) were between 50 and 1000 copies and 219 (91.3%) appeared below 50 copies.

3.3. Prevalence of gastrointestinal parasites

The overall prevalence in the study population was 58 cases (24.2%). Protozoa were more frequent than helminths with a prevalence of 22.9% and 1.3% respectively. Among these protozoa, two species are known to be opportunistic, namely: *Cryptosporidium* spp and *Isospora belli*. Of the 7 identified species, *Entamoeba histolytica* (12.62%) was the species with the highest frequency followed by *Cryptosporidium* spp (4.54%) and the least frequent were *Dicrocoelum dendriticum* (0.65%) and *Heterophyes heterophyes* (0.65%) (Table 2).

Table 2: Frequencies of identified intestinal parasites.

Parasites species	Frequency	Percent
Entamoeba histolytica	30	12.62
Cryptosporidium spp	11	4.54
Blastocystis hominis	7	3.19
Entamoeba coli	3	1.43
Isospora belli	3	1.09
Dicrocoelum dendriticum	2	0.65
Heterophyes heterophyes	2	0.65
Total	58	24.2

3.4. Multiparasitism

Majority of patients were infested with only one parasite (49 of 58, or 84.48% of HIV-infected participants); dual parasitism was observed in 6 patients (13.79%) and triparasitism in only 1 patient (1.72%).

3.5. Distribution of gastrointestinal parasite species according to viral load

Of the seven parasites identified, prevalence was positively correlated with viral load in species (*Cryptosporidium* spp, *Dicrocoelum dendriticum*, *Entamoeba coli*, *Blastocystis hominis* and *Entamoeba histolytica*). This correlation were statistically significant in *Blastocystis hominis* and *Dicrocoelum dendriticum* ($p<0.05$). In contrast, the parasites *Heterophyes heterophyes* and *Isospora belli* were present only in patients with an undetectable viral load (Figure 2).

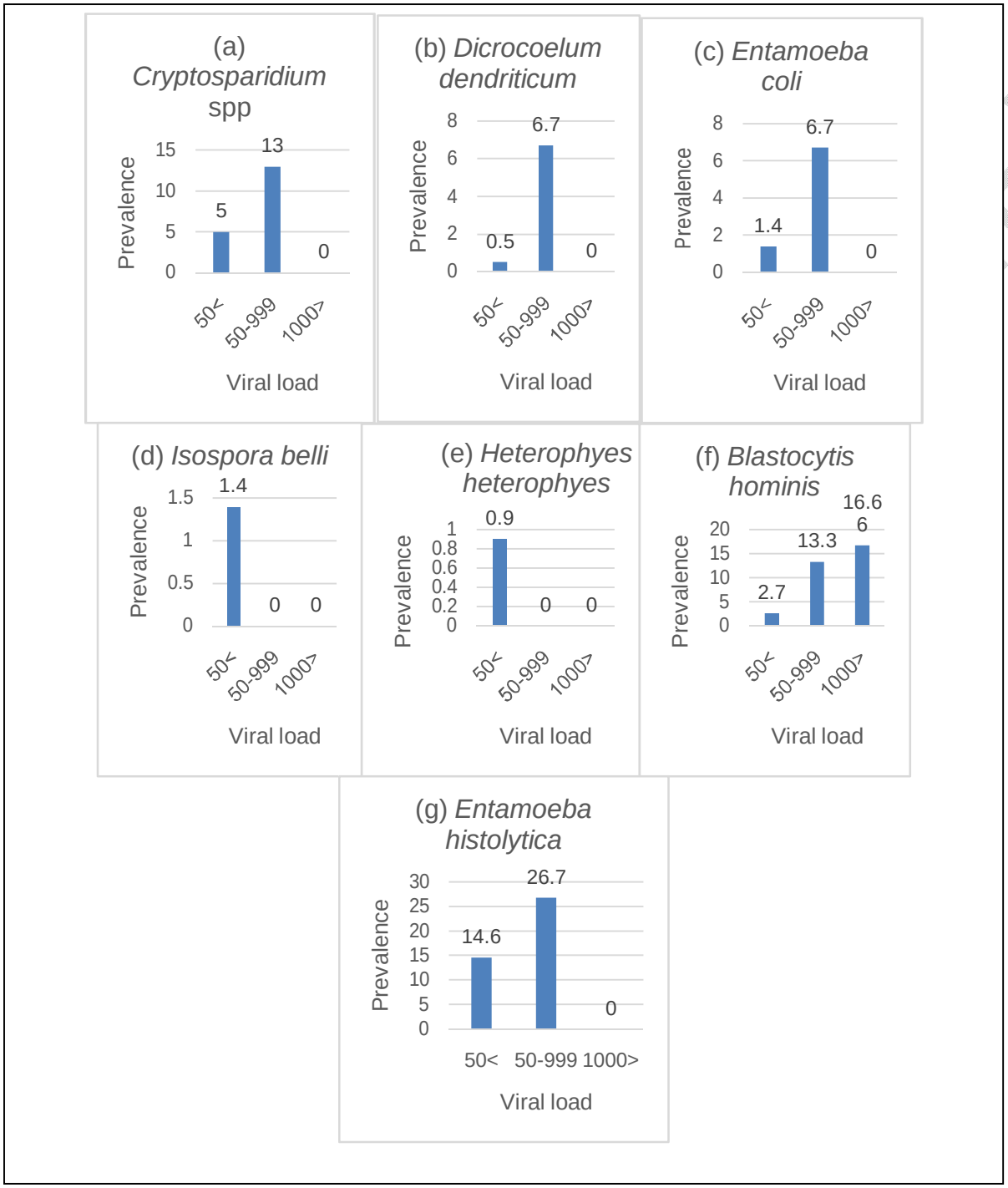

Figure 2: Prevalence of gastrointestinal parasites according to viral load

3.6. Risk factors for intestinal parasite infection by protocol type, duration of antiretroviral therapy, and monthly income

Infestation was higher among participants on first-line antiretroviral therapy (24.8%), but those on third-line therapy were not infested (Table 3). Depending on the duration of antiretroviral treatment, the infestation rate was significantly higher in those under 12 months (44.4%) on treatment than those over 36 months (22.3%) (p=0.04; OR=2.8). Participants with a monthly income of less than 35,000 FCA were infested (27.4%) and the least infested were participants with an income between 35 and 70,000 FCA (17%).

Table 3: Risk factors for intestinal parasite infection by protocol type, duration of antiretroviral therapy, and monthly income.

Parameters	Modalities	Total N	Infestant N (%)	OR (95IC)	p-value
Protocol type	1er line	214	53 (24.8)	0.33 (0.006-16.9)	0.58
	2e line	23	5 (21.7)	0.29 (0.005-16.79)	0.55
	3e line	3	0 (0)	1	
Duration of antiretroviral therapy	12 month<	18	8 (44.4)	2.8 (1.04-7.48)	**0.04***
	12-36 month	20	5 (25)	1.16 (0.40-3.37)	0.78
	>36 month	202	45 (22.3)	1	
Monthly income	<35000	157	43 (27.4)	1.84 (0.83-4.1)	0.13
	35-70000	53	9 (17)	1	
	>70-140000	20	4 (20)	1.22 (0.33-4.52)	0.76
	>140000	10	2 (20)	1.22 (0.22-6.74)	0.81

3.7. Risk factors of intestinal parasitic infection according to socio-demographics characteristics

The bivariate analysis showed no statistically significant association between prevalence and sex, gender, marital status, education level and occupation as shown in Table 3. The only variable significantly associated with the prevalence of intestinal parasites was the age group under 20 years (Table 4).

Table 4: Risk factors of intestinal parasitic infection according to socio-demographics characteristics.

Parameters	Modalities	Total N	Infestant N (%)	OR (95% IC)	p-value
Gender	Female	171	44 (25.7)	1.36 (0.68-2.68)	0.37
	Male	69	14 (20.4)	1[a]	
Age range (years)	≤20	17	7 (41.2)	5.13 (1.09-24.07)	**0.03**
	21-30	17	5 (29.4)	3.05 (0.62-15.05)	0.16
	31-40	50	14 (28.0)	2.85 (0.73-11.05)	0.12
	41-50	75	19 (25.3)	2.48 (0.66-9.25)	0.17
	51-60	56	10 (17.9)	1.59 (0.39-6.37)	0.5
	> 60	25	3 (12.0)	1[a]	
Marital status	Single	51	16 (31.4)	1.64 (0.79-3.40)	0.18
	Married	124	27 (21.8)	1[a]	
	Divorced	18	4 (22.2)	1.02 (0.31-3.37)	0.96
	Widow	47	11 (23.4)	1.09 (0.49-2.43)	0.82
Level of education	Illiterate	21	5 (23.8)	1.12 (0.37-3.34)	0.83
	Primary	97	25 (27.8)	1.24 (0.66-2.32)	0.48
	Secondary	109	25(22.9)	1.04 (0.57-1.98)	0.83
	Universitary	13	3 (23.1)	1[a]	
Profession	Student	13	5 (38.5)	2.91 (0.54-15.56)	0.21
	Agriculture	17	3 (17.6)	1[a]	
	Employee S I	80	16 (20.0)	1.16 (0.29-4.55)	0.82
	Civil servant	25	5 (20)	1.16 (0.23-5.69)	0.84
	Housewife	105	29 (27.6)	1.78 (0.47-6.65)	0.39

3.8. Risk factors for intestinal parasite infection according to behavioral and hygienic characteristics

There was no evidence of an association between intestinal parasitism and the type of gastrointestinal parasite management, knowledge of gastrointestinal parasites, drinking water quality, the washing of fruit before consumption, street feeding, and freshwater bathing presented in table 5. According to the place of management of gastrointestinal parasites (GIP), participants doing self-medication were more infested and the least infested were those doing traditional pharmacopoeia with prevalence 29.4% and 20% respectively. Patients who had knowledge of parasites were more infested (24.7%) than those with no knowledge (23.8%). The prevalence was higher among patients who consumed water from the Cameroon water society (CDE).

Table 5: Risk factors for intestinal parasite infection according to behavioral and hygienic characteristics

Parameters	Modalities	Total N	Infestant N (%)	OR (95% IC)	p-value
Place of care for GIP	Hospital	115	24 (21.0)	1.05 (0.38-2.87)	0.91
	Self-medication	95	28 (29.4)	1.67 (0.61-4.53)	0.31
	Pharmacopoeia	30	6 (20.0)	1[a]	
Knowledge of GIP	Yes	89	22 (24.7)	1.04 (0.56-1.93)	0.87
	No	151	36 (23.8)	1[a]	
Drinking water quality	CDE	170	41 (24.0)	1.58 (0.18-13.99)	0.67
	Drilling	35	8 (22.9)	1.48 (0.15-14.59)	0.73
	Well	6	1 (16.7)	1[a]	
	Spring	19	6 (31,6)	2.30 (0,21-24,31)	0.48
	Mineral water	10	2 (20.0)	1.25 (0.08-17.65)	0.86
Washing of fruits before consumption	All the time	185	47 (25.4)	1.36 (0.65-2.85)	0.41
	Often	55	11 (20.0)	1[a]	
Hand washing before meals	All the time	165	39 (23.6)	1[a]	
	Often	75	19 (25.3)	1.09 (0.58-2.06)	0.77
Nutrition in the street	All the time	29	4 (13.79)	1[a]	
	Often	134	33 (24.6)	2.04 (0.66-6.29)	0.21
	Never	77	21 (27.3)	2.34 (0.72-7.54)	0.15
Fresh water swimming	Often	15	2 (13.3)	1[a]	
	Never	225	56 (24.9)	0.46 (0.10-2.12)	0.32

3.9. Distribution of gastrointestinal parasites in HIV+ patients in the Western Region according to Divisions

The study population came from several Divisions namely: Mifi 143 (59.6%), Noun 33 (13.8%), Bamboutos 18 (7.5%), Haut-Plateaux 9 (3.8%), Koung-Khi 9 (3.8%), Menoua 9 (3.8%) and patients not from the Western region "Others" 19 (7.9%). Seven species of gastrointestinal parasites were identified in the region: *Cryptosporidium* spp, *Dicrocoelum dendriticum*, *Entamoeba coli*, *Isospora belli*, *Heterophyes heterophyes*, *Blastocystis hominis* and *Entamoeba histolytica* (Table 6). All of these parasite species were found to infest patients with higher prevalence and *Entamoeba histolytica* significantly infested patients in Mifi division ($p<0.05$). In the Haut-Plateaux division, no species were identified.

Table 6: Parasite infestation rates in patients according to departments.

	Name of Departments N (%)							
Parasite Species	Bamboutos	Haut-Plateaux	Koung-Khi	Menoua	Mifi	Noun	Other	p-value
E. histolytica	+ 2 (5.6)	-	+ 4 (11.1)	+ 3 (8.3)	+ 21 (58.3)	+ 6 (16.7)	-	X^2=13.74; **p=0.03**
Cryptosporidium spp	-	-	-	-	+ 10 (76.9)	+ 2 (15.4)	+ 1 (7.7)	X^2=2.82; p=0.83
B. hominis	+ 2 (22.2)	-	-	+ 1 (11.1)	+ 6 (66.7)	-	-	X^2=6.24; p=0.39
E. coli	+ 1 (25.0)	-	-	-	+ 3 (75.0)	-	-	X^2=1.68; p=0.94
I. belli	-	-	-	-	+ 2 (66.7)	+ 1 (33.3)	-	X^2=0.636; p=0.728
D. dendriticum	-	-	-	-	+ 2 (100)	-	-	X^2=1.36; p=0.96
H. heterophyes	-	-	-	-	+ 2 (100)	-	-	X^2=1.36; p=0.91

***Legend**: N (%) = Number of infested individuals (prevalence of infestation in percent); X^2 = Chi-square; + = present parasite; - = absent parasite.*

4. DISCUSSION

The main objective of this study was to identify and determine the prevalence of gastrointestinal parasites in relation to associated factors in HIV+ patients that were followed and eligible for viral load at the Bafoussam Regional Hospital in Cameroon.

The overall prevalence of gastrointestinal parasites in the present study was 24.2%. This prevalence is close to that obtained by [17] in Cameroon 27.9%, [25] in Ghana (25.2%), [26] in Brazil (28.88%), [15] in Ethiopia (24.7%) and [14] in Colombia (29.2%). Nevertheless, it was lower than 52.08% obtained by Taheu *et al*. in Yaoundé, Cameroon [16]. The low infestation rate is due to the introduction of highly active antiretroviral therapy as the primary treatment for HIV which has led to a reduction in the frequency of infections, including those caused by enteroparasites and has improved the clinical and laboratory outcomes of patients [13]. In addition, it can be attributed to effective counseling and ongoing education on hygienic practices for HIV-positive individuals by health care professionals [27].

People living with HIV were more infested with protozoa (22.7%). Only 1.3% were carriers of helminths. This observation is consistent with the work of Yacouba *et al*. in Burkina Faso [28] and Taheu *et al*. in Cameroon [16]. This low prevalence of helminths in the present work can be due to regular deworming of patients and good follow-up with antiretrovirals. Sarfati *et al*. (op. Cit.) explained that the prevalence of gastrointestinal parasites in HIV-infected patients has significantly decreased in countries where antiretroviral treatment is widely available [29].

Participants were more infested with Entamoeba histolytica. This result is similar to those obtained in Cameroon [30] and Ethiopia [31]. This parasitosis leads to serious pathologies such as amoebic colitis and amoebic liver abscess and can result in death [32]. Several studies have shown an increased prevalence of *E. histolytica* infection in HIV-positive patients in Mexico, China, South Africa, and Ethiopia [33,34].

Multiparasitism was rare. This result shows that the introduction of highly active antiretroviral therapy as the primary treatment for HIV led to a reduction in the frequency of infections, including those caused by enteroparasites and improved clinical and laboratory outcomes for patients [13] and by the highly diverse background of patients.

The distribution of gastrointestinal parasites is positively correlated with viral load for *Blastocystis hominis* and *Dicrocoelum dendriticum* with $p<0.05$. Then, a high prevalence of *B. hominis* in patients with viral load higher than 50 copies/ml was observed. Our results are in agreement with that of Zhang *et al*. In China where he revealed the high prevalence of *B. hominis* in HIV/AIDS patients with viral load above 50 copies/ml [7]. Furthermore, in Equatorial Guinea Roka *et al*. showed high viral load was a risk factor for this protozoan [35]. Similarly, Adarvishi *et al*. [36] reported that *B. hominis* is one of the most common intestinal protozoa in HIV-infected patients due to their depressed immune system. On the other hand, the presence of the species *D. dendriticum* can be explained by human contact with pets such as sheep and cattle. In West Cameroon, the breeding of these animals is a profession for many people such as in the Bamboutos, Noun, Menoua, Nde departments and many others. In infected humans, complications may be related to immunosuppression. Indeed, cases of patients infected with human immunodeficiency virus (HIV) and *D. dendriticum* have been reported [37]. The prevalence of *cryptosporidium* spp according to viral load shows that patients with viral loads between 50 and 1000 copies per ml of blood and less than 50 copies were infested. This observation could be due to the fact that some associated infections may have an influence on the immunity of the latter. Furthermore, their presence can be attributed to the consumption of unwashed or raw fruits and the consumption of groundwater or tap water [38]. Nevertheless, this result did not show a statistical difference between cryptosporidiosis and viral load level. In Bafoussam II, a recent study showed the existence of *Cryptosporidium* spp in outpatients with a low rate [39]. However, no factors were associated with this parasite.

Depending on the duration of antiretroviral treatment, the rate of infestation was significantly higher in those under 12 months on treatment. The likelihood of parasitic infection was 2.8 times higher than that of other participants. This could be due to the fact that antiretroviral therapy results in a robust immunological response and because of maximal viral suppression [40].

Regarding the demographic characteristics of the participants, there was a significant difference in intestinal parasitic infections according to age. The age group under 20 years was the most infected. This result can be explained by the fact that they are more susceptible to intestinal infectious diseases than adults due to their poor hygiene habits; they are often in contact with contaminated soils and their immune system is immature [41,42].

Patients from the Mifi department were more infested and harbored all species of parasites. This observation could be due to a lack of sanitation, as the city of Bafoussam, which is the center of this Division, is a large commercial center with promiscuity and insalubrity. According to Santos and Merlini, the co-infection of different parasitic species depends on environmental contamination and indicates the degree of insalubrity [43]. This could explain these cases of polyparasitism observed in the present work.

5. CONCLUSION

The present study conducted at the Bafoussam Regional Hospital consisted to identify and determine the prevalence gastrointestinal parasites in relation with factors in HIV+ patients, followed and eligible for viral load. A total of 7 parasite species were identified. These parasites appeared with an overall prevalence of 24.2%. Protozoa represented 22.9% of all parasites and the majority species was *Entamoeba histolytica*. This prevalence was significantly high in patients with viral loads above 50 copies per ml and those on antiretroviral treatment within 12 months. In the study population, 91.3% had undetectable viral loads. The age group of less than 20 years and hand washing all the time after defecation were the risk factors for parasitic infestations. In addition, *Blastocystis hominis* species and *Dicrocoelum dendriticum* influenced the viral load. Thus, improved health education, good hygiene and good lifestyle habits are important to prevent and control these infestations. Therefore, HIV+ patients should be screened regularly for these parasites and treated if infected to improve their health status. The use of antiretroviral drugs has reduced the occurrence of gastrointestinal parasites.

CONSENT

With the help of an information sheet and after a brief explanation, patients were invited to take part in the study by signing an informed consent form. In the case of children and adolescents (under 20 years of age), their parents or guardians legal signed on their behalf.

ETHICAL APPROVAL

Ethical clearance was obtained from the Institutional Research Ethics Committee for Human Health of the University of Douala (CEI-UDo) reference number: 2605 CEI-UDo/04/2021. Authorization for the collection of stool and blood was obtained from the management of the Bafoussam Regional Hospital. Written informed consent, as authorized by the ethics committee, was requested and obtained from all participants before they could take part in the study. For reasons of confidentiality, patients had identified numbers. Results from participants with gastrointestinal parasites were referred to the head of the confirmed Treatment Center.

REFERENCES

1. Assefa S, Erko B, Medhin G, Assefa Z, Shimelis T. Intestinal parasitic infections in relation to HIV/AIDS status, diarrhea and CD4 T-cell count. BMC Infect Dis. 2009;9: 1–6. DOI: 10.1186/1471-2334-9-155.

2. Nwosu FC, Avershina E, Wilson R, Rudi K. Gut microbiota in HIV infection: implication for disease progression and management. Gastroenterol Res Pract. 2014;2014.DOI: 10.1155/2014/803185

3. Konaté A, Minta D, Diarra M, Dolo A, Dembele M, Diarra B, et al. Parasitoses digestives au cours de la diarrhée du sida. Bull Soc Pathol Exot. 2005;98: 33–35. PMID: 15915971

4. Wumba R, Enache-Angoulvant A, Develoux M, Mulumba A, Mulumba P, Hennequin C, et al. Prévalence des infections opportunistes digestives parasitaires à Kinshasa (République Démogratique du Congo), Résultats d'une enquête préliminaire chez 50 patients au stade SIDA. Med Trop. 2007;67: 145–148.

5. Majer S, Neumayr A. Parasites de l'appareil gastro-intestinal. Forum médical suisse. EMH Media; 2015. pp. 242–250.

6. Tan KS. New insights on classification, identification, and clinical relevance of Blastocystis spp. Clin Microbiol Rev. 2008;21: 639–665. DOI: 10.1128/CMR.00022-08

7. Zhang S-X, Kang F-Y, Chen J-X, Tian L-G, Geng L-L. Risk factors for Blastocystis infection in HIV/AIDS patients with highly active antiretroviral therapy in Southwest China. Infect Dis Poverty. 2019;8: 83–90. DOI: 10.1186/s40249-019-0596-7

8. Akinbo FO, Okaka CE, Omoregie R. Prevalence of intestinal parasitic infections among HIV patients in Benin City, Nigeria. Libyan J Med. 2010;5. DOI: 10.3402/ljm.v5i0.5506

9. Babatunde S, Salami A, Fabiyi J, Agbede O, Desalu O. Prevalence of intestinal parasitic infestation in HIV seropositive and seronegative patients in Ilorin, Nigeria. Ann Afr Med. 2010;9. DOI: 10.4103/1596-3519.68356

10. Victor B, Kanobana K, Gabriël S, Polman K, Deckers N, Dorny P, et al. Proteomic analysis of Taenia solium metacestode excretion–secretion proteins. Proteomics. 2012;12: 1860–1869. DOI: 10.1002/pmic.201100496

11. Pabst O. New concepts in the generation and functions of IgA. Nat Rev Immunol. 2012;12: 821–832. DOI: 10.1038/nri3322

12. Dianou D, Poda J-N, Savadogo L, Sorgho H, Wango S, Sondo B. Parasitoses intestinales dans la zone du complexe hydroagricole du Sourou au Burkina Faso. VertigO- Rev Électronique En Sci Environ. 2004;5.

13. Suleiman BA, Yahaya M, Olaniyan F, Sule A, Sufiyan M. Determinants of health-related quality of life among human immunodeficiency virus positive (HIV-positive) patients at Ahmadu Bello University teaching hospital, Zaria, Nigeria-2015. BMC Public Health. 2020;20: 1–9. DOI: 10.1186/s12889-020-08659-9

14. Botero-Garcés J, Villegas-Arbeláez E, Giraldo S, Urán-Velásquez J, Arias-Agudelo L, Alzate-Ángel JC, et al. Prevalence of intestinal parasites in a cohort of HIV-infected patients from Antioquia, Colombia. Biomédica. 2021;41: 153–164. DOI: 10.7705/biomedica.5992

15. Dereb E, Negash M, Teklu T, Damtie D, Abere A, Kebede F, et al. Intestinal Parasitosis and its Association with CD4+ T Cell Count and Viral Load among People Living with HIV in Parasite Endemic Settings of Northwest Ethiopia. HIVAIDS Auckl NZ. 2021;13: 1055. DOI: 10.2147/HIV.S328269

16. Taheu CN, Meliedje CDT, Bong GGB, Likeng JLN, Ghomsi FM, Nkoth AF, et al. Intestinal Parasites Infestation among People Living with HIV under Antiretroviral Therapy in Peri-urban Area of Yaoundé, Cameroon. Eur J Med Health Sci. 2021;3: 59–64.

17. Lehman LG, Kangam L, Nguepi E, Mbenoun M-L, Bilong Bilong CF. Study of intestinal parasitic infections associated with HIV infection in Douala, Cameroon. Retrovirology. 2012;9: 1–1. DOI: 10.3855/jidc.2757

18. Nkenfou CN, Nana CT, Payne VK. Intestinal parasitic infections in HIV infected and non-infected patients in a low HIV prevalence region, West-Cameroon. PloS One. 2013;8: e57914. DOI: 10.1371/journal.pone.0057914

19. Olivry J-C. Fleuves et rivières du Cameroun. 1986.

20. Touko BH, Manjeli Y, Teguia A, Tchoumboué J. Evaluation et prédiction de l'effet du type génétique sur l'évolution du poids vif de la poule locale camerounaise (Gallus domesticus). Livest Res Rural Dev. 2009;21: 3.

21. BUCREP. Troisième recensement général de la population et de l'habitat Cameroun: Rapport de présentation des résultats définitifs. Bureaeu Central des Recensements et des Etudes de Population Yaoundé; 2010.

22. Allen AV, Ridley DS. Further observations on the formol-ether concentration technique for faecal parasites. J Clin Pathol. 1970;23: 545–546. DOI:10.1136/jcp.23.6.545

23. Organisation Mondiale de la Santé. Parasitologie médicale: techniques de base pour le laboratoire. Parasitologie médicale: techniques de base pour le laboratoire. 1993. pp. viii–118.

24. Tuli L, Singh DK, Gulati AK, Sundar S, Mohapatra TM. A multiattribute utility evaluation of different methods for the detection of enteric protozoa causing diarrhea in AIDS patients. BMC Microbiol. 2010;10: 1–7. DOI: 10.1186/1471-2180-10-11

25. Tay S, Aryee E, Badu K. Intestinal parasitemia and HIV/AIDS co-infections at varying CD4+ T-cell levels. HIVAIDS Res Treat. 2017;4: 40–48.

26. Barcelos NB, Silva L de F, Dias RFG, Menezes Filho HR de, Rodrigues RM. Opportunistic and non-opportunistic intestinal parasites in HIV/AIDS patients in relation to their clinical and epidemiological status in a specialized medical service in Goiás, Brazil. Rev Inst Med Trop São Paulo. 2018;60. DOI: 10.1590/S1678-9946201860013

27. Deku JG, Botchway KA, Kinanyok S, Gedzeah CK, Duneeh RV, Duedu KO. Intestinal Parasitic Infection and Associated Risk Factors among HIV-Infected Patients Seeking Healthcare in a Rural Hospital in Ghana. El-Ashram S, editor. J Pathog. 2022;2022: 1–7. DOI:10.1155/2022/5652637

28. Yacouba A, Sawadogo MP, Diallo I, Sangare I, Bamba S, Ouattara B, et al. Opportunistic and other intestinal parasites infections among HIV-positive patients in the era of combination antiretroviral therapy and preventive treatment in Ouagadougou, Burkina Faso. J HIV Clin Sci Res. 2017;4: 008–014.

29. Sarfati C, Bourgeois A, Menotti J, Liegeois F, Moyou Somo R, Delaporte E, et al. Prevalence of intestinal parasites including microsporidia in human immunodeficiency virus-infected adults in Cameroon: a cross-sectional study. Am J Trop Med Hyg. 2006;74: 162–164. PMID: 16407362

30. Nack J, Tankoua-Tchounda R, Fokou R, Lontsi-Demano M. Prépondérance des levures parmi les infestations gastro-intestinales à Douala (Cameroun) : prévalence et facteurs de risque. 2020;22: 5.

31. Feleke DG, Ali A, Bisetegn H, Andualem M. Intestinal parasitic infections and associated factors among people living with HIV attending Dessie Referral Hospital, Dessie town, North-east Ethiopia: a cross-sectional study. AIDS Res Ther. 2022;19: 19. DOI:10.1186/s12981-022-00443-6

32. Shirley D-AT, Farr L, Watanabe K, Moonah S. A review of the global burden, new diagnostics, and current therapeutics for amebiasis. Open forum infectious diseases. Oxford University Press US; 2018. p. ofy161. DOI: 10.1093/ofid/ofy161

33. Abdollahi A, Saffar H, Saffar H, Sheikhbahaei S, Rasoulinejad M. Is the evaluation of Entamoeba histolytica infection in HIV-positive patients of any clinical significance? 2015. PMID: 25597605

34. Moran P, Ramos F, Ramiro M, Curiel O, González E, Valadez A, et al. Entamoeba histolytica and/or Entamoeba dispar: infection frequency in HIV+/AIDS patients in Mexico City. Exp Parasitol. 2005;110: 331–334. DOI: 10.1016/j.exppara.2005.03.023

35. Roka M, Goñi P, Rubio E, Clavel A. Intestinal parasites in HIV-seropositive patients in the Continental Region of Equatorial Guinea: its relation with socio-demographic, health and immune systems factors. Trans R Soc Trop Med Hyg. 2013;107: 502–510. DOI: 10.1093/trstmh/trt049

36. Adarvishi S, Asadi M, GHASEMI DCM, Tavalla M, Hardani F. Prevalence of intestinal parasites in HIV-positive patients attending Ahvaz health centers in 2012: a cross-sectional study in south of Iran. 2016.

37. Cringoli G, Rinaldi L. Helminth-Trematode: Dicrocoelium dendriticum. In: Motarjemi Y, editor. Encyclopedia of Food Safety. Waltham: Academic Press; 2014. pp. 124–129. DOI: 10.1016/B978-0-12-378612-8.00151-7

38. Nakibirango J, Mugenyi V, Nsaba D, Nsimemukama A, Rugera SP, Okongo B. Prevalence of cryptosporidiosis and hygiene practices among HIV/AIDS patients in southwest Uganda. HIVAIDS Auckl NZ. 2019;11: 141. DOI: 10.2147/HIV.S206195

39. Tchinde YD, Abongwa LE, David F, Helen Ngum N. The Prevalence, Intensity and Risk Factors of Gastrointestinal Parasitic Infections in Outpatients in Bafoussam II, West Region, Cameroon. Int J Trop Dis Health. 2021; 25–36. DOI: 10.9734/ijtdh/2021/v42i1530519

40. Zeynudin A, Hemalatha K, Kannan S. Prevalence of opportunistic intestinal parasitic infection among HIV infected patients who are taking antiretroviral treatment at Jimma Health Center, Jimma, Ethiopia. : 4. PMID: 23467951

41. Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, Diemert D, et al. Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. The lancet. 2006;367: 1521–1532. DOI: 10.1016/S0140-6736(06)68653-4

42. LaBeaud AD, Nayakwadi Singer M, McKibben M, Mungai P, Muchiri EM, McKibben E, et al. Parasitism in children aged three years and under: relationship between infection and growth in rural coastal Kenya. PLoS Negl Trop Dis. 2015;9: e0003721. DOI: 10.1371/journal.pntd.0003721

43. Santos SA dos, Merlini LS. Prevalência de enteroparasitoses na população do município de Maria Helena, Paraná. Ciênc Saúde Coletiva. 2010;15: 899–905. DOI:10.1590/S1413-81232010000300033