

*Original Research Article*

GASTROINTESTINAL TRACT OPPORTUNISTIC PARASITIC  
INFECTIONS AMONG HIV/AIDS PATIENTS UNDER ART? IN THE  
DSCHANG HEALTH DISTRICT

**ABSTRACT**

**Background:** The analyses of the recurrence of opportunistic gastrointestinal parasitic infections is crucial for the effective management of HIV infection in sub-Saharan African countries where intestinal parasites are very common. More and recent information on the interested field is needed in order to better understand the magnitude of the problem. The present analytical case control study was designed in other to determine the prevalence of gastrointestinal opportunistic parasites and detect the associated risk factors among HIV positive patients in 4 sanitary centres in Dschang Health District (west Cameroon).

**Methodology:** Stool specimens were collected from 305 individuals, 97/305(31.8%) HIV positive patients and 208/305(68.2%) HIV negative participants. These specimens were examined for the research of gastrointestinal opportunistic parasites using the sedimentation concentration techniques followed by modified Zeihl Neelsen staining technique for the detection of different oocyst of the parasites. Statistical analysis performed included the Chi-square test and logistic regression.  $P > 0.05$  was considered significant.

**Results:** Out of the 97 HIV positive patients, 16/97(16.49%) were infected with opportunistic intestinal parasites. Out of the 208 negative participants, 40/208(19.4%) were infected. There was no significant association between the occurrence of opportunistic intestinal parasitic infections and HIV sero-status (OR=0.815; IC=0.410-1.620;  $p=0.559$ ). The parasite species of *Cryptosporidium parvum*, *Microsporidium*, *Cyclospora cayetanensis* and *Cycloisospora belli* were detected in 38(12.5%); 11(3.6%); 4 (1.3%), and 3(1%) participants respectively in the overall population. Drinking water obtained from springs (OR=8.46; CI=1.56-14.34;  $p=0.00$ ), boreholes (OR=3.129; CI=1.24-7.881;  $p=0.00$ ) and wells (OR=4.01; CI=3.77-4.26;  $p=0.00$ ) were associated to opportunistic parasitic infections. Opportunistic parasitic infections in HIV positive patients were not statistically associated with CD4 count, viral load, type and duration of antiretroviral therapy with respective p values of 0.15; 0.58; 0.08 and 0.54.

**Conclusion:** Regular screening and treatment of intestinal opportunistic parasitic infections coupled with Adherence to highly active antiretroviral therapy is very vital in improving the overall quality of care of HIV/AIDS patients.

**KEYWORDS:** HIV, Parasites, Opportunistic, seropositive, gastrointestinal tract.

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UNDER PEER REVIEW

## INTRODUCTION

Neglected tropical diseases, including intestinal parasitic infections are among the most common infections worldwide. They are a significant cause of morbidity and mortality in low and middle income countries of tropical and subtropical regions[1].

Acquired immune deficiency syndrome (AIDS) and its etiologic agent Human immune deficiency Virus (HIV) is one of the most important pandemic worldwide[2]. AIDS pandemic took a life every minute in 2021, with 650 000 AIDS-related deaths despite effective HAART and strategies used for preventing and managing opportunistic infections. Globally, there was an estimate of 38.4 million people living with HIV at the end of 2021[2].

AIDS is a condition in humans in which progressive failure of the immune system allows life-threatening infections and cancers to thrive. Lifelong Antiretroviral HIV infection free is associated to increased vulnerability of patients to other infections, known as HIV-related opportunistic infections (OIs). The opportunity offered by the patient's weakened immune system for opportunistic infections is due to the fact that HIV infects vital cells of the immune system, including helper CD4 T cells[1], macrophages[3].

*Cryptosporidium parvum*, *Cycloisospora belli*, *Cyclospora cayetanensis*, *Microsporidium*, species such as *Enterocytozoon bieneusi* have been incriminated as causes of prolonged diarrhea, especially in AIDS patients, although they are thought to cause self-limiting diarrhea in immunocompetent individuals[4].

Few similar studies, have been carried out in Cameroun in Yaounde, Douala, Fako division, Bamenda, and South West regions, giving a prevalence of 9.7%[3]; 7.4%[5]; 82.6%[6], 34.5%[4]; 53.7% [7] respectively. In the Dschang district, West Region of Cameroon by Nkenfou *et al*, 2011 found a prevalence of 19.0% [8].

The objective of this study was to determine the prevalence of intestinal opportunistic parasitic infections among HIV positive patients and to investigate the clinical, laboratory, and epidemiologic characteristics associated with the different parasitic infections.

## I. MATERIALS AND METHODS

### I.1. Study area

This analytical case control study was conducted in Cameroon. More specifically in the 4 principal health centres of the Dschang health district. This is a district located in the Menoua division in the west region of Cameroon. The town of Dschang is located between latitude 5°20' to latitude 5°28' in the north and between longitude 10°3' and 10°6' in the East and at an altitude of 1382-1500m in the high land of west Cameroon. Its climate type is the soudano-guineen with two seasons: a dry season (November to March) and a raining season (March to November). The Dschang health district is one of the major health districts in the West region. It extends over approximately 1060 km<sup>2</sup>. It is bounded to the east by the health district of Penka Michel, to the northeast by the health district of Batcham, to the west by the health district of Fontem, to the southeast by the health district of Bandja, and to the south by the health district of Santchou. It is made up of 22 health areas and 322 communities. Of the six districts of the Menoua department, it covers four (districts of Dschang, Fokoué, Nkong-ni and Fongo-tongo) and the Fondonera group.

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### I.2. Strategies for the recruitment of the studied population

An ethical clearance delivered by the RERCHH (Regional Ethics and Research Committee for Human Health) was obtained. After obtaining participants consents and assents, they filed prepared questionnaires.

- Target population; made up of HIV positive and negative individuals in Dschang health district of the west region of Cameroon

- source population; every person living with HIV/AIDS under ART of age 12 and above without gender distinction, pregnant or not coming for consultation or receiving ART at the DREAM (Drug Resource Enhancement against AIDS and Malnutrition) centre for our group of HIV positive patients and HIV negative individuals living in the Dschang health district for our group of negative participants

### I.3. Collection and transport of stool samples

A Stool container was given to HIV positive and negative to put in their stool. The container was labelled with the patient's attributed code. Patients were properly instructed on how to collect samples (they had to collect approximately 5 grams of stool and avoid mixing the stool with water or urine). Specimens were immediately transported using a box filled with ice from the collection sites in Dschang regional hospital annex, the *Saint Vincent de Paul* hospital, the

'Centre Catholic Notre Dame de la Sante Servante de Marie de Batseng'la' and DREAM centre to the laboratory of medical analyses of the Dschang Regional Hospital Annex for analyses. If the analyses were delayed the specimens was conserved with formalin at 10% at -2 to -8°C (the stool specimen was totally submerging in formalin).

#### I.4. Analyses of samples

For HIV negative participants a confirmation of his or her HIV sero-negative status was done by practising an immune-chromatographic assay for HIV using a Determine (HIV 1&2) strip.

##### I.4.1. Formalin-Ether Concentration

We mixed 5 grams of stools specimen with 7 ml of 10% formalin in a clean 15 ml conical centrifuge tube. The resulting mixture was filtered through a cotton gauze into a beaker and the filtrate poured back into the same tube and the debris were discarded. After adding 4 ml of ethyl acetate, we closed the tube, and shake vigorously in an inverted position for 30 seconds then we carefully removed the lead, centrifuged at 1500 rotations per minutes for 5 minutes. We used a cotton-tipped applicator to remove debris from sides of the centrifuge tube and added several drops of 10% formalin to suspend the concentrated specimen, after being sure that the specimen is well mixed. We prepared a smear using 2 to 3 drops of the specimen depending on density, we air dried completely at room. Temperature.

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##### I.4.2. Modified Zeihl-Neelsen Method

The modified Ziehl-Neelsen method uses a carbol fuchsin stain, acid alcohol decolourizer, and methylene blue counterstain. Acid-fast organisms stain red, while the background of debris stains blue. Faecal smears were made directly from the concentration deposit, we allowed it to air dry at room temperature and then we fixed in methanol for 3 minutes. After Staining with strong carbol fuchsin for 15-20 minutes, we rinsed thoroughly in tap water then decolourised in acid alcohol (1% HCl in methanol) for 15 seconds later we rinsed again thoroughly in tap water after which we counterstained with methylene blue for 30 seconds and finally rinsed thoroughly and air dry. After staining we examined our slides x100 objectives. For the detection of the different forms of ~~o~~ parasites. Microscopic examinations were done independently by experienced clinical laboratory technicians and by the principal investigator; the determination & verification was done by the principal investigator.

### **I.4.3. Quality control**

Validation (biological and technical) was done by the principal investigator and supervised by the laboratory head or any available experienced laboratory technician.

Confirmation of sufficient specimen volume and correct procedural technique was done by the principal investigator and experienced laboratory technician.

Data on antiretroviral treatment and most recent CD4+ cells count were obtained from the medical files of patients.

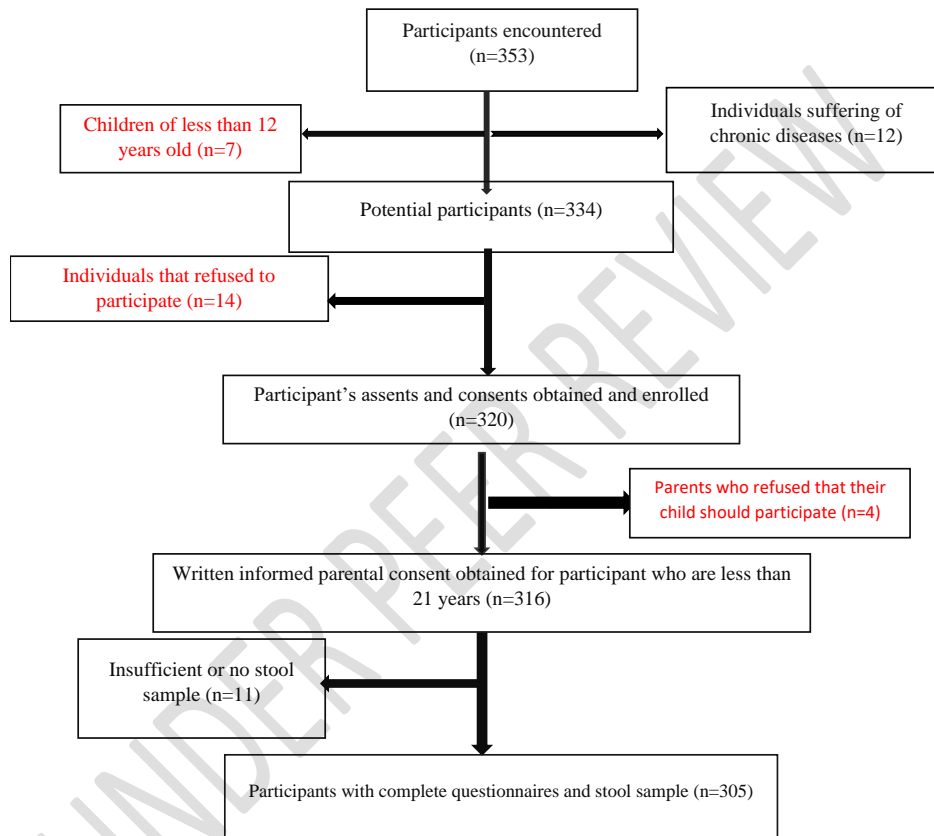
### **I.5. Data analysis**

Data were entered using Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSSSTM) version 25. The Chi square ( $\chi^2$ ) permitted us to compare the prevalence of intestinal infections with respect to serological status, sociodemographic characters and risk factors, it permitted us to detect any relationship between two nominal qualitative variables. A multinomial logistic regression was used to calculate odd ratios and determine potential risk factors among nominal variables. This study will, make it possible to determine the prevalence of intestinal opportunistic parasitic infections and HIV and the threshold of significance of error  $\alpha=5\%$  for a confidence interval 95% CI ( $p<0.05$ ,  $p>0.05$ ).

## II. RESULTS

### II.1. Presentation of studied population

Figure 1 shows that we encountered a total of 353 individuals on the field but 19 individuals were excluded and 14 refused to participate. Four parents refused that their child should participate and 11 stool samples were absent or not sufficient.



**Figure 1: Synoptic diagram of studied population**

### II.2. Profile of the studied population

The general characteristics of the study population are summarized in Table 1. We enrolled a total of 305 (100%) participants in the study, 31.8% (97/305) were HIV positive patients and 68.2% (208/305) were HIV negative participants. We notice a predominance of females, with 72.2% (70/97) among HIV positive patients and 66.8% (139/208) among HIV negative participants. The age range of 35-65 was the most represented with 84.5% (82/97) among HIV

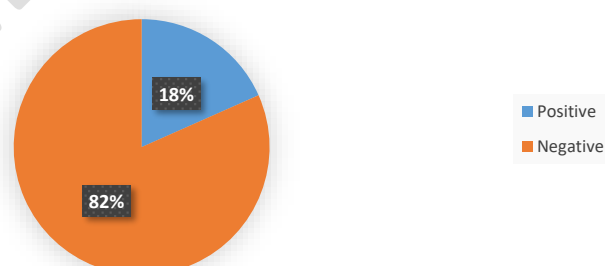
positive patients, while {25-35} was the most represented age range with 41.3%(86/208) among HIV negative participants. Those living in rural areas were the most represented among HIV positive participants with 66.0%(64/97) but were the least represented with 40.4% (84/208) among HIV negative participants. The formal sector which was made up of bankers, teachers, and nurses was the least represented with 7.2% (7/97) among HIV positive patients. While the informal sector which was made up of traders, household, farmers, and breeders was the most represented with 86.1% (179//208) among HIV negative participants.

**Table 1: Distribution of the population with respect to demographic characters**

Parameters		HIV-positive n (percentage%)	HIV-Negative n (percentage%)
Gender	Female	70(72.2%)	139(66.8%)
	Male	27(27.8%)	69(33.2%)
Age	{12-25}	2(2.1%)	24(11.5%)
	{25-35}	8(8.2%)	86(41.3%)
	{35-65}	82(84.5%)	81(38.9%)
	{>65}	5(5.2%)	17(8.2%)
Profession	Formal sector	7(7.2%)	29(13.9%)
	Informal sector	90(92.8%)	179(86.1%)
Residence	rural	64(66.0%)	84(40.4%)
	urban	33(34.0%)	124(59.6%)

### II.3. Prevalence of opportunistic parasitic infections

Of the 305 participants enrolled, 56/305(18%) were infected with at least one species of opportunistic intestinal parasite, as shown in figure 2.



**Figure 2: General prevalence of opportunistic parasitic infections among HIV positive and Negative participant**



## II.4. Prevalence of opportunistic parasitic infection according to HIV status

HIV negative participants were more infected with opportunistic parasitic infections with 19.2%(40/208) than HIV positive patients with 16.49%(16/97) as shown in table 2.

**Table 2: General prevalence of parasitic infection according to HIV status**

HIV positive			HIV negative	
Status	n(frequency)	Prevalence (%)	N(frequency)	Prevalence (%)
Number examined	97	100.0	208	100.0
Positive	16	16.49	40	19.2

## II.5. Single and mixt infections among HIV positive and negative participants

Table 3 show ~~us~~ that the most encountered opportunistic intestinal parasite was *Cryptosporidium parvum*, and it was more present in HIV negative participants with 13.5% (28/208) than in HIV positive patients with 10.3% (10/97). We also notice that *Cycloisospora belli* was absent in HIV negative participants. *Cyclospora cayetanensis* was the parasite that was the least present with, 1% (1/97) in HIV positive patients. Only one case of triple infection was present among the HIV negative participants. The parasites implicated in this triple infection was *Cyclospora cayetanensis*, *Cryptosporidium parvum* and *Microsporidium*. Three cases of double infections were present in HIV negative participants, but only 1 case was present in HIV positive participants. The parasites implicated in this double infection was *Cyclospora cayetanensis* and *Cryptosporidium parvum*

**Table 3: Prevalence of single and mixed infections among HIV positive and negative participants**

HIV positive			HIV negative	
Parasite specie	Frequency(n)	Percentage (%)	Frequency(n)	Percentage (%)
Single infections	<i>C. parvum</i> ,	10	28	13.5%
	<i>C. cayetanensis</i>	2	2	(1%)
	<i>C. belli</i> ,	3	0	0
	<i>Microsporidium</i>	1	10	4.8%

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Mixed infections	<i>C. cayetanensis</i> + <i>C. parvum</i> ,	1	1%	3	1.44%
	<i>C. cayetanensis</i> + <i>C. parvum</i> + <i>Microsporidium</i>	0	0	1	0.4%

## II.6. Risk factors and sociodemographic characters

Table 4 shows that gender, occupation and residence could be identified as risk factors but none of sociodemographic character below was identified as a risk factor significantly associated with opportunistic intestinal parasitic infection.

**Table 4: Multinomial logistic regression analysis of sociodemographic characters of studied population**

Parameters	Number examined	Number of positive	Odds ratio	Confidence Interval at 95%	p-value
<b>Gender</b>					
Male	96	18	-	-	-
Female	209	38	1.019	0.533-1.948	0.955
<b>Age</b>					
{12-25}	26	07	0.128	0.14-1.205	0.72
{25-35}	94	21	0.210	0.21-2.098	0.184
{35-65}	163	27	0.253	0.31-2.056	1.98
{>65}	22	01			
<b>Occupations</b>					
Informal sector	269	50	1.17	0.437-3.285	0.806
Formal sector	36	6	-	-	-
<b>Residence</b>					
Urban	148	32	-	-	-
Rural	157	24	1.11	0.58-2.14	0.7

## II.7. Associated risk factors of opportunistic intestinal parasitic infections(OIPIs)

The results in table 5 shows that, washing of food before eating, washing of hands before eating, putting hands in the mouth, eating together in family in the same plate, consumption of eggs and milk are risk factors associated with OIPIs? since their odd ratios are less than 1. These associations were only significant in the type of drinking water, where those that drink borehole water are 3.129 (CI=1.24-7.881 p=0.00) times more susceptible to get infected with opportunistic intestinal parasites than those that drink mineral water. Those that drink source water are 8.46(CI=1.56-14.34 p=0.00) times more susceptible of getting infected than those drinking mineral water. Those that drink well are 4.01(CI=3.77-4.26, p=0.00) times more

susceptible to get infected. There is a significant relationship between washing of hands before eating and opportunistic intestinal parasitic infections ( $p=0.011$ ). The rest of variables were not considered as associated risk factors, since there was no significant relation between them and opportunistic intestinal parasitic infections.

**Table 5: Multinomial logistic regression analysis of associated Risk factors of the studied population**

Parameter	Number examined	Number of positive	Odds ratio	Confidence interval at 95%	p-value
<b>Wash food before?</b>					
Yes	245	42	-	-	-
No	60	14	1.376	0.571-3.314	0.477
<b>Wash hands before eating</b>					
Yes	75	22	-	-	-
No	230	34	0.362	0.165-0.793	0.011
<b>Drinking water source</b>					
Mineral	05	0	-	-	-
Borehole	132	26	3.129	1.24-7.881	0.00
Well	07	02	4.01	3.77-4.26	0.00
Tap	23	04	4.47	1.80-3.97	0.00
spring	80	11	8.46	1.56-14.34	0.00
<b>Putting hands in the mouth</b>					
Yes	92	20	-	-	-
No	213	36	1.182	0.628-2.227	0.604
<b>Eating together in the same plate</b>					
Yes	58	11	-	-	-
No	247	45	1.080	0.509-2.294	0.927
<b>Having animals at home</b>					
Yes	190	38	-	-	-
No	115	18	0.742	0.401-1.374	0.343
<b>Using modern toilets</b>					
Yes	110	19	-	-	-
Non	195	37	0.466	0.493-1.706	0.748
<b>Washing hand after toilets</b>					
Yes	214	35	-	-	-
No	91	21	0.652	0.335-1.197	0.167
<b>HIV infection</b>					
Yes	97	40	0.815	0.410-1.620	0.559
No	208	16	-	-	-

### III.8. Prevalence of parasitic infection according to clinical characteristic of the study population

From table 6 we noticed that most of HIV positive patients (59/97(60.82%)) had normal CD4+ lymphocyte count (500-1000 cells/mm<sup>3</sup>) with 22.03% (13/59) infected with intestinal opportunistic parasites. Participants with viral load lower than Low Level Detectable (LDL) were the most represented (85/97(87.63%)), but those with viral load lower than 40 copies/mL were the most infected with intestinal opportunistic parasites 28.57% (2/7) with. Most of HIV

positive patients used **TLD as ART?** (80/97(82.47%)). But all those that used **DRD and ARAL as ART** were not infected with intestinal opportunistic parasites. Patients that followed ART therapy for more than 10 years were the most infected with intestinal opportunistic parasites with 18.18% (8/44) followed by those who followed the therapy for less than 5 years with 17.94% (7/39%). Generally, **we** notice that the occurrence of opportunistic intestinal infection was not significantly related to clinical parameters of patients (CD4<sup>+</sup> count, type of ART, Viral load and duration of ART). ~~This is because all the p. values obtained were greater than 0.05~~

**Table 6: Prevalence of parasitic infection according to clinical characteristic of the study population**

Parameters	N	NP	Prevalence %	P value (chi <sup>2</sup> )
<b>CD4(cells/mm<sup>3</sup>)</b>				
<b>&lt;500</b>	22	2	9.09	0.15
<b>500-1000</b>	59	13	22.03	
<b>&gt;1000</b>	16	1	6.25	
<b>Viral load(copies/mL)</b>				
<b>&lt;40</b>	7	2	28.57	0.58
<b>&lt;LDL</b>	85	13	15.29	
<b>&gt;40</b>	5	1	20	
<b>Type of ART</b>				
<b>ALD</b>	3	0	0	0.08
<b>ARAL</b>	1	1	100	
<b>ARTL</b>	9	1	11.11	
<b>DRD</b>	1	1	100	
<b>TELE</b>	3	0	0	
<b>TLD</b>	80	13	16.25	
<b>Time <b>ART</b>(years)</b>				
<b>&lt;5</b>	39	7	17.94	0.54
<b>5-10</b>	14	1	7.14	
<b>&gt;10</b>	44	8	18.18	

NE number examine, NP: number of positive

LDL: Low Level Detectable, TLD: Tenofovir, Lamivudine, Dolutegravir, ARTL: Atazanavir, Ritonavir, Tenofovir, Lamivudine, DRD: Dorunavir, Ritonavir, Dolutegravir. ARAL: Atazanavir, Ritonavir, Abacavir, Lomivalone, ALD: Abacavir, Lomivalone, Dolutegravir, TELE: Tenofovir, Emtricitabine, Lamivudine, Elvitegravir, ART: Anti-Retroviral Therapy

## DISCUSSION

Patients infected with the Human Immunodeficiency Virus (HIV) often have opportunistic infections, among which coccidiosis are the most common parasitic infections that aggravate their health status. Parasitological techniques (modified Ziehl Neelsen staining techniques) for the detection of these parasites are not done in our hospitals, hence no diagnostic of these parasites. The main objective of the study was to determine the prevalence of intestinal opportunistic parasites among HIV positive patients in the Dschang health district.

Opportunistic intestinal parasites were encountered with a prevalence of 16.49% (16/97) among HIV positive patients while 19.2% (40/208) were found among HIV negative participants, the difference was not significant ( $P = 0.559$ ). These results are different from that obtained by Nkenfou *et al*, 2013,[8] in the west region of Cameroon, where 19.04% (4/42) of HIV/AIDS patients were infected with opportunistic intestinal parasites and only 2% (7/354) of the HIV negative patients were infected with opportunistic intestinal parasites. Possible explanations for having higher prevalence of parasites among HIV negative participants when compared with HIV positive patients are that; during the past years there was improvement in the management of HIV/AIDS and increase in the availability of HAART which is now free of charge[9]. Also, HIV infected patients are more often likely to be in contact with the health care system and thus more exposed to anti-parasitic drugs. Moreover, there is evidence, in vivo as well as in vitro, that the control of cryptosporidiosis in patients on HAART are also helped by the anti-HIV protease inhibitors, which could be acting on the aspartyl protease of the parasites[10]. The prevalence of opportunistic parasitic infections in HIV positive patients was 16.49% similar to that obtained by Bissong *et al*, 2015[4] who had a prevalence of 15.5% but different from a study carried by Botero-Garcés *et al*, 2021 [11] in Antioquia, Colombia where there was only 1% of OIPs in HIV positive patients. This difference may be due to the fact that sub-Saharan Africa has seasonal climate variations. Climate change exacerbate the pressures exerted on water availability, accessibility, and demand, further emphasizing the potentially increasing threat of water borne infectious diseases[3]. Based on parasitological examination of the stool specimens, 4 species of opportunistic intestinal parasites were detected in HIV positive patients. The detected parasites included: *Cryptosporidium parvum*, *Cycloisospora belli*, *Cyclospora cayetanensis* and *Microsporidium*. The most frequently detected parasite was *Cryptosporidium parvum* in 10/97(10.3%) patients. These results are higher than those obtained by Kuete *et al*, 2014 [12] in Yaounde Cameroon with the prevalence of *Cryptosporidium parvum* of 6%(4/6470). This difference may be due to the difference in the site of the study, Yaounde

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being the political capital is more developed than Dschang. These results were lower than that of Nsagha *et al*, 2017 [6] and Chefor *et al*, 2020 [7] who had prevalence of *Cryptosporidium parvum* of 44% and 23.3% respectively. These studies were carried out in the southwest region of the country, where the climate favours the rapid distribution of these protozoans [5]. The least encountered opportunistic parasite was *Cycloisopora belli* 1% (3/305). This prevalence is similar to the 0.5% obtained by Kuete *et al*, 2014 [12].

The risks factors identified among the socio-demographic characteristic were: gender, occupation, and residence. Gender was identified as a risk factor associated with OIPIs (OD=1.019, CI= 0.533-1.948) but there was not a significant difference of the occurrence of opportunistic infections between both sexes (p=0.955). These results are similar to that obtained by Mbiandou *et al*, 2019 (p=0.2161) [13] in Cameroon and Botero-Garcés *et al*, 2021 (p=0.06, CI=-0.8-27.5) in Colombia [11]. This may be because males and females in our studied population practise similar activities (farming for example) that exposes them equally to these parasites. Participants working in informal sectors were more infected than those working in the formal sector but this difference was not significant (p=0.806) like in the study of Mbiandou *et al*, 2019 (p= 0.0891). These results may be due to the fact that those working in the informal sector (farmers, breeders, traders) are more likely to ingest cysts of protozoan from the soil, and unwashed fruits and vegetables. Their line of duty as transmission of these parasites is through the ingestion of contaminated soil, water or food. Participants living in rural were more infected than those living in urban areas but, the difference was not significant (p=0.7, CI=0.58, 2.14, OR=1.11) similar to what was obtained by Nsagha *et al*, 2017 [6] (p=0.45). This is most probably due to the fact that the transmission of IOPIs is through the ingestion of contaminated soil or water both of which were very feasible among the rural population. Also, it might be due to the fact that many rural dwellers are more in contact with their domestic animals especially goats, sheep, and dogs, thus increasing their chances of being infected with these parasites. Also, it might be due to the fact that rural dwellers are involved in farming activities where they are likely to ingest cysts of protozoan from the soil, and unwashed fruits and vegetables while working.. The type of drinking water source was significantly associated with OIPIs (p=0.00). This result is different from that obtained by Kuete *et al*, 2015 where consuming water from boreholes, dug wells or sachet did not influence significantly any of intestinal protozoa infections in Douala (p>0.05). This difference is due to the difference in the study site Douala more socio-economically developed than Dschang.

Clinical findings (CD4<sup>+</sup> count, viral load type of ART, duration of the ART therapy), of HIV positive patients were not significantly related with OIPIs ( $p=0.15$ ,  $p=0.58$ ,  $p=0.08$ ,  $p=0.54$  respectively). Similarly, in the study of Botero-Garcés *et al*, 2021 where the viral load and the CD4<sup>+</sup> count was not significantly associated with intestinal parasitic infections ( $p=0.851$  and  $p=0.121$  respectively). The introduction of the highly active antiretroviral therapy (HAART) as the main treatment for HIV has led to a reduction in infections frequency, including those caused by enteroparasites and has improved the clinical and laboratory outcomes of the patients[9]. These results are different from those of Nsagha *et al*, 2017 [6] in Cameroon and Adamu *et al*, 2013[14] in Ethiopia where IPI prevalence were significantly higher in patients with CD4<sup>+</sup> T cell count below 200 cells/ $\mu$ l ( $p=0.000$  and  $p=0.03$  respectively). The reason for this difference is that all our HIV positive patients were enrolled at the DREAM centre, which is a clinic specialized to follow up HIV infected patients also, patients recruited there reported (through questionnaires) having no symptoms of abdominal dysfunction. Their average CD4<sup>+</sup> T cells was 724.2 cells/ $\mu$ l with the majority 90/97 (92.8%) of participants having values of CD4<sup>+</sup> T count greater than 500 cells/ $\text{mm}^3$  of blood. Majority of our participants that is, 85/97 (87.6%) had undetectable viral load and were on ART since they were diagnosed with the disease, and had never stopped their treatment. Furthermore, in our study, all the HIV positive patients were under HAART treatment, so their viral load was controlled. A health talk was done every morning at the DREAM centre on HIV/AIDS by health personnel on the management of the disease and on ways to avoid infection with parasitic diseases.

Several limitations in our study should be highlighted. First, our HIV positive population was recruited by convenience in a time limited frame from patients attending a single health facility who were willing to inform consent. Thus, the data obtained from HIV infected patients cannot be assumed to be representative of the general population not actively receiving health care, secondly, detection of *Cryptosporidium* spp. may be under-estimated due to limitations of the sensitivity of our assay, which is around 92%. Thus, a negative result in this assay does not rule out the possibility of *Cryptosporidium* spp. infection. Such a result may be due to intermittent excretion of the parasite, or the amount of antigen in the sample may be below the level of detection of our assay. It is possible that some parasites were not detected in this study because all the specific techniques were not used for their search. Thirdly, CD4 cells counts were not measured at the time of the stool specimen collection; instead, we have taken the most recent CD4 cells counts that were documented in the files of patients. In fact, it might have happened that the CD4 cells counts of patients may in reality be higher (for patients who started treatment)

or lower (for HAART naïve patients) than the collected data by the time of stool sample collection.

## CONCLUSION

This was an analytical **case control** study whose principal objective was to determine the prevalence of opportunistic intestinal parasitic infections in HIV positive patients.

- The overall prevalence of OIPIs was 18%. The prevalence of OIPIs in HIV positive patients on ART was 16,4% and the prevalence of OIPIs in HIV negative participants (control group) was 19.2%. There was no significant relationship between HIV and the OIPIs
- The risk factors statistically related to OIPIs was drinking borehole water, Well water and source water.
- Clinical findings (CD4+ count, viral load type of ART, duration of the ART therapy), of HIV positive patients were not significantly related to OIPIs.

The prevalence of intestinal parasites found in this study has attracted the attention of health professionals to the need for parasitological examinations in the routine treatment of patients with HIV/ AIDS, including specific tests, given the clinical importance of these diseases in the evolution of AIDS. Also, adherence to HAART treatment has become crucial in the clinical and public health management of HIV infection.

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**Commented [a10]:** The conclusions are not related to the results of the study, so it is preferable to rewrite it with the most important conclusions that came out of the study



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