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Prevalence and Risk Factors Associated with Intestinal Parasitosis in HIV/AIDS Patients on HAART in the Ndop Health District, North West Region, Cameroon

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Abstract: *Background:* Intestinal parasites induce an immunological alteration that favors progression from HIV to AIDS. These enteric parasitic agents vary from patient to patient and from country to country depending on endemicity, seasonal variation of pathogens, and also the immune status of the patient. Therefore, studies are required to evaluate the spectrum of these parasites in specific locations to better plan their control. The purpose of this study was to determine the prevalence and risk factors associated with intestinal parasitosis in HIV/AIDS patients on Highly Active Antiretroviral Therapy (HAART). *Methods:* A cross sectional study was carried out from the month of March to July 2018 on HIV patients on HAART in the Ndop Health District, Cameroon. Three centers were selected for this study using a two-stage stratified sampling technique. Stool and blood were collected from 347 participants. Stool was examined for intestinal parasites using direct microscopy, fomol-ether concentration technique, and modified Ziehl-Neelsen staining technique. Blood collected was analyzed using a Pima Alere CD4+ T cell counter. A structured questionnaire was administered to collect socio-demographic and clinical data. Data were analyzed with SPSS version 20 and p value < 0.05 was considered statistically significant. *Results:* Three hundred and forty-seven (347) consented individuals were recruited into the study. The ages of study participants ranged between 22-78 years. The mean (±SD) age of the study participants was 42 (±10) years. Among the 347 participants, 67 (19.3% (CI = 15.3%-23.9%)) were infected with at least one intestinal parasite. Forty-two (12.1% (CI =8.9%-15.9%)) of study participants were infected with protozoan while 28 (8.1% (CI= 5.2%-11.0%)) were infected with helminths. Intestinal parasites identified included; Ascaris *lumbricoides, Hookworm, Taenia spp, Schistosoma mansoni, Entamoeba histolytica/dispar, Cryptosproridum spp, Blastocystis hominis, Cyclospra spp, Isospora belli, Gardia intestinalis, and Entamoeba coli.* Low CD4+ T lymphocyte cell counts were significantly associated ($P< 0.01$) with intestinal parasitic infection in HIV/AIDS patients on HAART. *Conclusion:* Intestinal parasites are a problem to HIV/AID patient on HAART. Screening for intestinal parasites in HIV/AIDS patients on HAART must be highlighted and awareness created among HIV/AIDS patients.

Keywords: HIV/AIDS, Intestinal Parasites (IPs), Risk Factors, CD4+ T Lymphocyte Cell Count, Diarrhea, Highly Active Antiretroviral Therapy (HAART), Cameroon

1. Background

Intestinal infections continue to be one of the major causes of public health problems in the world, particularly in the developing countries [1]. Globally an estimated 3.5 billion people are affected by intestinal parasites, while 450 million becomes ill due to intestinal parasitic infections [1]. Most of these infections are severe in individuals with compromised immune system such as HIV/AIDS patients. Intestinal parasites are a major concern in all races with sub-Saharan Africa being the region most affected by these parasites [2]. In 2010, an estimated 68% (22.9 million) of all HIV cases and 66% of all deaths (1.2 million) occurred in this region. Nearly 3 decades after HIV was discovered, it remains a number one killer disease in sub- Saharan Africa where 67% of the world's 33 million affected individuals leave [3]. In 2016, Cameroon had 32,000 new HIV infections and 29,000 AIDS related deaths [2].

There is an epidemiological overlap between intestinal parasites and HIV infections, which is more common in low- and middle-income countries [4, 5]. This interaction may either increase susceptibility or enhance cell-cell interaction and virus replication thereby indirectly increasing the transmission of HIV infection [6]. The prevalence of Intestinal parasites in HIV/AIDS patients has been shown to vary with geographical location, with a prevalence of 34%, 57.48% and 82.3% reported in HIV/AIDS on HAART respectively in towns of Bamenda, Yaounde, Buea and Limbe in Cameroon [4, 7, 8]. As CD4+ T cells levels drastically diminished in poorly managed HIV infections, parasites which produce self-limiting diseases in immunocompetent hosts tend to result in severe outcomes such as profuse diarrhea in immunocompromised subjects [3, 9]. Diarrhea in immunocompromised patients are usually profuse, generally accompanied by weight loss, anorexia, malabsorption syndrome and in some cases fever and abdominal pain [4, 10].

Intestinal parasites induce immunological alterations that favor the progression of HIV patients to a disease state, AIDS. After HIV has spread to the systemic circulation its replication is limited by the fact that usually few activated lymphocytes and differentiated macrophages are present in the blood stream [6, 11]. Resting T cells and undifferentiated monocytes are not susceptible to HIV infection. However, in parasitic infections the number of activated T cells expressing human leucocyte antigen and HIV co-receptors are elevated, thereby increasing the viral load and hence facilitates the conversion of HIV infections to AIDS [6, 11]. Viral load has been shown to decrease after elimination of the parasites by antiparasitic treatment [12].

The most common intestinal parasites that affect HIV/AIDS patients in Cameroon are; *Giardia intestinalis, Entamoeba histolytica*, *Cyclospora cayetanenensis*, and Cryptosporidium species, *Ascaris lumbricoides* (roundworm), *Trichiuris trichiuria* (whipworm), hookworms (*Ancylostoma duodenale, Necator americanicus*) and *Strongyliodes stercolaris* [4]. These parasites are mostly transmitted by the fecal-oral route in areas where sanitation is poor [13, 14].

Intestinal parasites (IPs) vary with geographical location, therefore studies are required to evaluate the spectrum of these parasites in specific locations so as to better control the burden IPs [5]. There was therefore a need to carry out a study on HIV/AIDS patients on HAART at the Ndop Health District to determine the prevalence and risk factors associated with intestinal parasitosis in HIV/AIDS patients on Highly Active Antiretroviral Therapy (HAART).

2. Methods

2.1. Study Design and Study Area

This was a cross-sectional study carried out from the month of March to July, 2020 at the Ndop Health District (NHD) situated 06°00'N, and 10°42'E in the Northwest Region (NW) of Cameroon [15, 16].

Ndop is a plain with low land vegetation and has a mean annual temperature of 24°C [15, 16]. This tropical climate favors the growth and consequent spread of intestinal parasites in this District [17, 18]. It has a high-water table with good river and stream network running down from nearby hills such as the Sabga hill which bound this area [16]. This creates a good environment for agriculture especially rice farming where most of the work is done manually and entails walking barefooted in the rice paddy, which predisposes them to intestinal parasitic infections. Walking bare footed in the rice paddy becomes a habit which is also practice in nearby dry farms. This area suffers a lot of water treatment problem as construction of good water catchments are difficult due to low land relief of the Ndop Health District, making these catchments prone to float and contamination by surface runoffs from farms, rivers and streams [16]. Although the low water table makes the construction of wells very easy and less expensive, it poses a lot of problems in treating these wells as they are open to contamination by surface runoffs. Those unable to construct these wells are force to fetch water from nearby streams and rivers since this area has a good stream and river network. All these predispose the inhabitants of this locality to intestinal parasitic infections.

2.2. Study Population and Sample Size Determination

This study was carried out among HIV/AIDS patients, twenty-one years and above on Highly Active Antiretroviral Therapy (HAART) at the Ndop Health District, North West Region of Cameroon. Using the Lorenz formula, the minimum sample size was calculated as shown below [19];

$$n = \frac{z^2 p(1-p)}{d^2}$$

Where;

n = minimum sample size Z= constant=1.96 d = bound of error =0.05

p = Pre-study estimate of the prevalence of intestinal parasites =34.5% [4]

Substituting, $n = \frac{(1.96)^2\ 0.345(1-0.345)}{(0.05)^2}$

n = 347 participants.

2.3. Sampling Technique

The simple random sampling technique by the ballotery method was used to select three treatment centers, which were; Ndop District Hospital (NDH), Babessi Medicalized Health center (BBMHC) and Balikumbat Medicalized Health center (BLMHC) from seven treatment centers (Bamunka UIHC, Ndop District Hospital, CMA Bambalang, Babessi Medicalised Health Center, Balikumbat Medicalised Health center, Saint Monica Baba 1, and Saint John the Baptist Ndop). Participants in each cluster were then sampled using the consecutive sampling technique until the sample size was achieved.

2.4. Recruitment of Participants and Administration of Questionnaire

HIV patients attending the HIV treatment centers in the NHD for routine checkups were sensitized on intestinal parasites and how it affects HIV/AIDS patients. The objectives of the study, benefits and possible discomforts to the participants were also discussed.

Questionnaires were pretested on 10 people attending the Ndop District Hospital HIV treatment center to see if they could read understand and fill the questionnaire under minimal assistance. Modifications were then made for the question to be more of a structural type questionnaire in a simpler language. These structured and pretested questionnaires were then administered by the investigator in order to collect socio-demographic characteristics and clinical information from consenting individuals. Questionnaires were filed and stored in a locker for subsequent coding and entry into excel spreadsheet in preparation for data analysis.

2.5. Collection and Processing of Specimens (Stool and Blood)

Blood

About 4mL of venous blood was collected into a labeled (participant code and initials) EDTA tube by venipuncture using a vacutainer set and analyzed using the Pima Alere counter for the amount of CD4+ T lymphocyte cell count per microliter of blood.

2.6. Stool

The participants were instructed to collect stool sample into a clean wide mouth labeled specimen container making sure soil or other contaminants don't get into the stool container, closed firmly and brought to the examination area as soon as possible (at most 15 minutes especially for watery stool so as to increase the chances of identifying trophozoite of parasites). Direct microscopy was done immediately and 10% formalin was added into the rest of the stool specimen. Making sure the stool specimen was completely covered by 10% formalin. The specimen container was firmly closed and stored in the specimen room in the Ndop District Hospital Laboratory for subsequent processing.

2.7. Examination of Stool Specimen

2.7.1. Direct Microscopy

Direct wet mount involves microscopic examination of fresh fecal specimens by wet preparations with physiological saline (saline wet mount) or iodine solution (iodine wet mount). The procedure provides rapid diagnosis for intestinal parasites when they are present in sufficient density in the fecal sample [20].

The stool specimen was mixed for homogeneity and a little quantity collected from the sample bottle mounted and in normal saline, covered with a cover slide and examined for parasites using the 10X objective lens of a microscope. Parasites seen were identified by adding iodine to the preparation and using the 40X objective lens to observe and identify.

2.7.2. Formol Ether Concentration Technique for Stool Concentration

The Fomol-ether concentration technique was used to concentrate parasites and ova in stool so as to increase the chances of identifying a parasite. The sediments were then examined for the presence of parasites or their ova in stool, after which a smear of the sediment was made, air dried and stained by a modified Ziehl Neelsen staining technique for the identification of *Isospora belli*, Cyclospora *spp* and *Cryptosporidium spp* [20].

2.7.3. Modified Ziehl Neelsen Staining Technique for Acid Fast Parasites

This is an acid-fast stain in which the primary stain (carbolfuchsin) is retained by coccidian parasites after decolorization. The dried stool smears were fixed with methanol and air dried after which they were placed on a staining rack and stained. Stained smears were observed using the 10X objective lens then the 100X oil immersion objective lens for the identification of parasites that retained carbol fuchsin [23].

2.8. Ethical Considerations

Ethical clearance was obtained from the Ethical Review Board of the Faculty of Health Sciences (FHS) of the University of Buea (reference number: 2018/0226/UB/SG/IRB/FHS) followed by administrative authorization from the Regional Delegate of Public Health for the NW Region of Cameroon. Information on the objectives of the study, the possible benefits and discomforts of the study were provided to participants, and participants were only accepted into the study after signing an informed consent form. The samples were identified and processed using codes, Names were not used throughout the study; this was to ensured confidentiality of participants. The various treatment centers were provided with the findings for necessary action. The samples collected were solely used to accomplish study objectives.

3. Data Management and Analysis

Prior to data analysis, raw data gotten from questionnaires and also laboratory examination of participants' specimens were entered into a Microsoft excel spreadsheet. This data was then stored in a computer hard disk drive with a password to secure it and backup in a disk drive and the investigators e-mail account to prevent data loss. This process was done at the end of each week throughout the period of data collection.

Data was analyzed using statistical package for social sciences version 20 (SPSS V20) computer program. Pearson chi-square test was used to verify possible association between IPs and other variables. Multivariate logistic regression analysis was used to measure the strength of association of possible risk factors. Statistically significant level was set at $P < 0.05$.

4. Results

4.1. Socio-demographic Characteristics

A total of 347 participants were recruited for the study. There were more females (79%) than males (21.0%) with the ages of study participants ranging between 22-78 years with the mean (±SD) age being 42 (±10) years. One hundred and thirty-four (134) (38.6%) of the respondents were in the age group of 32-41 years followed by 111 participants (32.0%) in the age group of 42-51 years (Table 1). Majority of the participants were farmers, that is 83.3% with teachers and hookers each making 2.3%. Christians (85%) dominated the study population followed by Muslims (10.1%) and Pagans (4.9%). Thirty-eight-point six percent (38.6%) of participants did not attend any formal education, 48.7% attended primary education and only 21.7% of study participants had post primary education (Table 1).

Participants drank mostly pipe borne water (58.8%). Majority (44.1%) of participants had the habit of always walking barefooted in the farms, other groups of participants (33.4%) only walked barefooted in the farms depending on the climate of the day with most complaining of difficulties working with farm shoes when it was muddy and Just about 22.5% of participants hardly walked barefooted in the farms (Table 1).

Table 1. *Socio-demographic characteristics.*

Characteristic		Intestinal parasites		Total N (%)	X^2-value	P-value
		Absent N (%)	Present N (%)			
Age groups	22-31	38 (82.6)	8 (17.4)	46 (100)	12.083	0.429
	32-41	105 (78.4)	29 (21.6)	134 (100)		
	42-51	93 (83.8)	18 (16.2)	111 (100)		
	52-61	32 (84.2)	6 (15.8)	38 (100)		
	>61	12 (66.7)	6 (33.3)	18 (100)		
Sex	Female	225 (82.1)	49 (17.9)	274 (100)	0.940	0.193*
	Male	55 (75.3)	18 (24.7)	73 (100)		
Marital status	Married	141 (82.9)	29 (17.1)	170 (100)	11.404	0.188*
	Widow or Widower	69 (73.4)	25 (26.6)	94 (100)		
	Single	68 (84.0)	13 (16.0)	81 (100)		
	Divorced	2 (100.0)	0 (0.0)	2 (100)		
Occupation	Farmer	229 (79.2)	60 (20.8)	289 (100)	14.036	0.447
	Teacher	6 (75.0)	2 (25.0)	8 (100)		
	Hooker	8 (100)	0 (0.0)	8 (100)		
	Others	37 (88.1)	5 (11.9)	42 (100)		
Religion	Christian	238 (80.7)	57 (19.3)	295 (100)	5.995	0.050*
	Muslim	25 (71.4)	10 (28.6)	35 (100)		
	Pagan	17 (100.0)	0 (0.0)	17 (100)		
Level of Education	None	107 (79.9)	27 (20.1)	134 (100)	1.135	0.769
	Primary	137 (81.1)	32 (18.9)	169 (100)		
	Secondary	32 (84.2)	6 (15.8)	38 (100)		
	Tertiary	4 (66.7)	2 (33.3)	6 (100)		
Water source	Streams/rivers/wells	115 (80.4)	28 (19.6)	143 (100)	0.012	0.914
	Pipe borne water	165 (80.9)	39 (19.1)	204 (100)		
Walking barefooted in the farms	No	65 (83.3)	13 (16.7)	78 (100)	4.836	0.089*
	Sometimes	86 (74.1)	30 (25.9)	116 (100)		
	Always	129 (84.3)	24 (15.7)	153 (100)		
Diarrhea	Yes	12 (75)	4 (25)	16 (100)	0.349	0.555
	No	268 (81)	63 (19)	331 (100)		
CD4 count	<200	25 (54.3)	21 (45.7)	46 (100)	27.333	0.000*
	200-499	81 (78.6)	22 (21.4)	103 (100)		
	≥500	174 (87.9)	24 (12.1)	198 (100)		

N= number, X^2= Chi-square value

*parameters with p-value < 0.25 (to be used in multivariate analysis).

4.2. Prevalence of Intestinal Parasites in HIV/AIDS Patients on HAART

Out of the 347 participants enrolled into the study, at least one intestinal parasite was identified in 67 participants giving a 19.3% (CI = 15.3%-23.9%) prevalence (Table 2). Out of the 347 consented individuals enrolled in this study, 28 (8.1%) were infected with helminths while 42 (12.1% (CI = 8.9%-15.9%)) were infected with protozoan giving a higher prevalence of protozoan infections (12.7% (CI = 5.2%-11.0%)) as compared to helminthic infections (8.6%) (Table 2).

Eleven (11) different Parasites were identified in this study which were; *Taenia spp, Ascaris lumbricoides, Hookworm, Schistosoma mansoni, Entamoeba histolytica/dispar, Cryptosproridum spp, Blastocystis hominis, Cyclospra spp, Isospora belli, Gardia intestinalis, and Entamoeba coli (1.2%). Entamoeba histolytica/dispar* was the most prevalent (9.8%) intestinal parasite in this study (Figure 1). The number of individuals infected with individual parasites and their corresponding percentages are shown in Table 2.

Table 2. *Prevalence of intestinal parasites in HIV/AIDS patients on HAART.*

Parasites	Number of positive cases (N=347)	Prevalence (%)
Intestinal parasite*	67	**19.3**
Protozoa*	42	12.1
Isospora spp	2	0.6
Cryptosporidium spp	11	3.2
Cyclospora spp	6	1.7
Entamoeba coli	4	1.2
Blastocytis hominis	4	1.2
Entamoeba histolytica/dispar	32	9.2
Gardia intestinalis	2	0.6
Helminth*	28	8.1
Ascaris lumbricoides	7	2.0
Schistosoma mansoni	3	0.9
hookworm	11	3.2
Taenia spp	9	2.6

*Participants infected with at least one parasite in category.

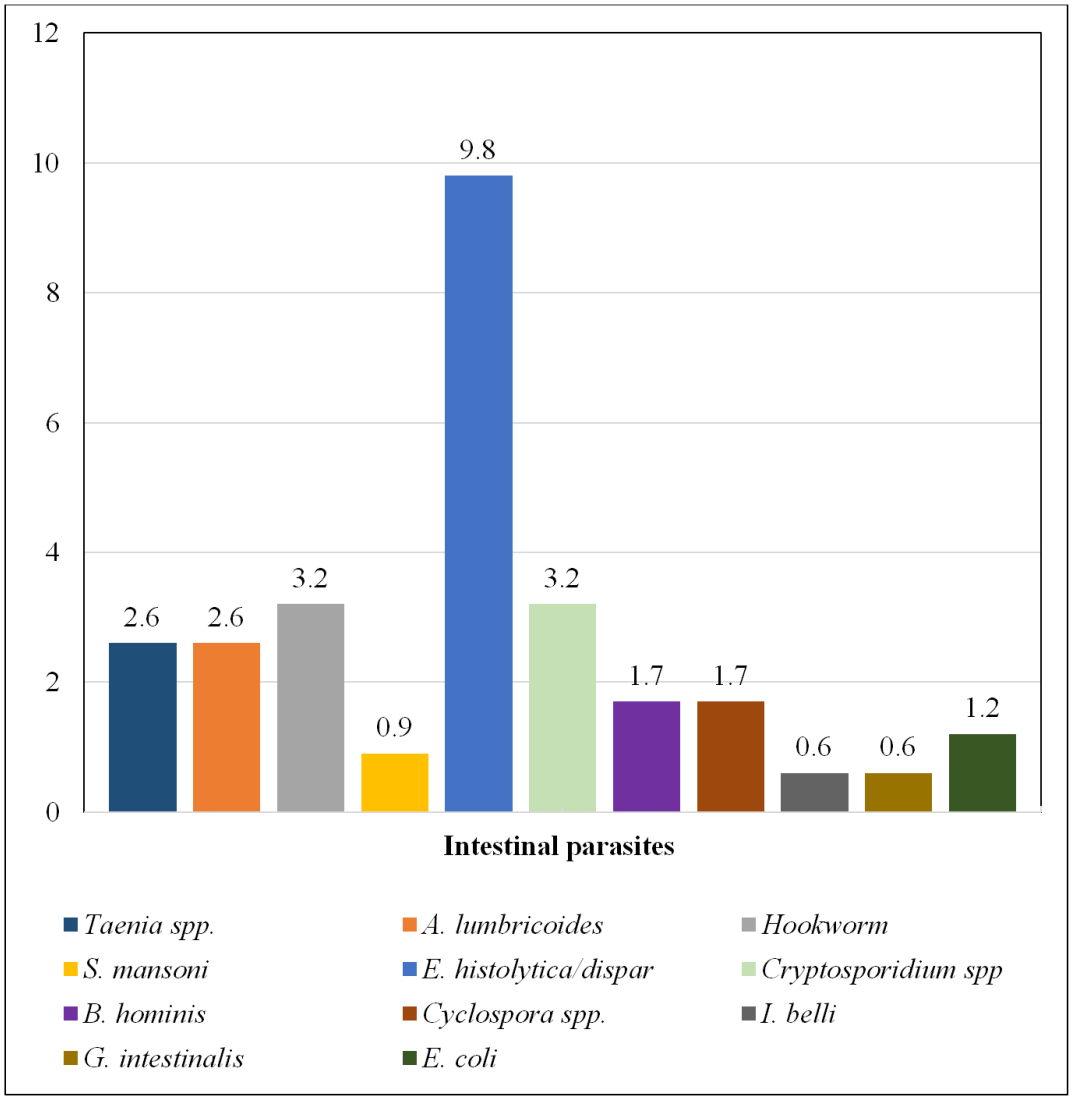

Figure 1. *Different Parasites identified in this study.*

4.3. Association and Distribution of Intestinal Parasites Within Different CD4+ T Lymphocyte Cell Count Categories of HIV/AIDS Patients on HAART

Generally, Intestinal parasites showed a statistically significant relationship in this study with CD4+ T lymphocyte cell counts > 200 cells/ul having the highest intestinal parasitic prevalence (that is 45.7%) compared to 21.2%, and 12.2% for Participants with CD4+ T lymphocyte cell counts between 200 to 499 cells/µl and ≥ 500cells/ul respectively (P < 0.001) (Fable 3).

A larger spectrum of intestinal parasites was found at CD4+ T lymphocyte cell counts of 200-499 (10 different organisms) followed by CD4+ T lymphocyte cell counts of less than 200 and greater than 500 (with 5 and 6 different organisms in each category respectively) (Figure 2).

Protozoa infections were more prevalent in participants with CD4+ T cell counts less than 200cells/µl. Parasites such as Taenia species, *Entamoeba histolytica/dispar*, *Cyclospra spp* cryptosporidium spp, *Entamoeba coli,* and hookworm were more prevalent in those with CD4+ T cell counts less than 200cells/µl. *Ascaris lumbricoides and Schistosoma mansoni* were found to be more prevalence at CD4+ T lymphocyte cell counts of 200-499cells/µl (Figure 2).

Participants with CD4+ T lymphocyte cell counts less than 200cells/ul were about 8.5 times (AOR=8.531 (3.758-19.366)) more likely to be infected with intestinal parasites as compared to those with CD4+ T lymphocyte cell counts greater than or equal to 500cells/µl (P < 0.005). Those having CD4+ T lymphocyte cell counts from 200 to 499 cells/ul were about 2 times (AOR=2.15 (1.090-4.250)) more likely to be infected with intestinal parasites as compared to those with CD4+ T lymphocyte cell counts greater than or equal to 500cells/µl (p < 0.005) (Table 3).

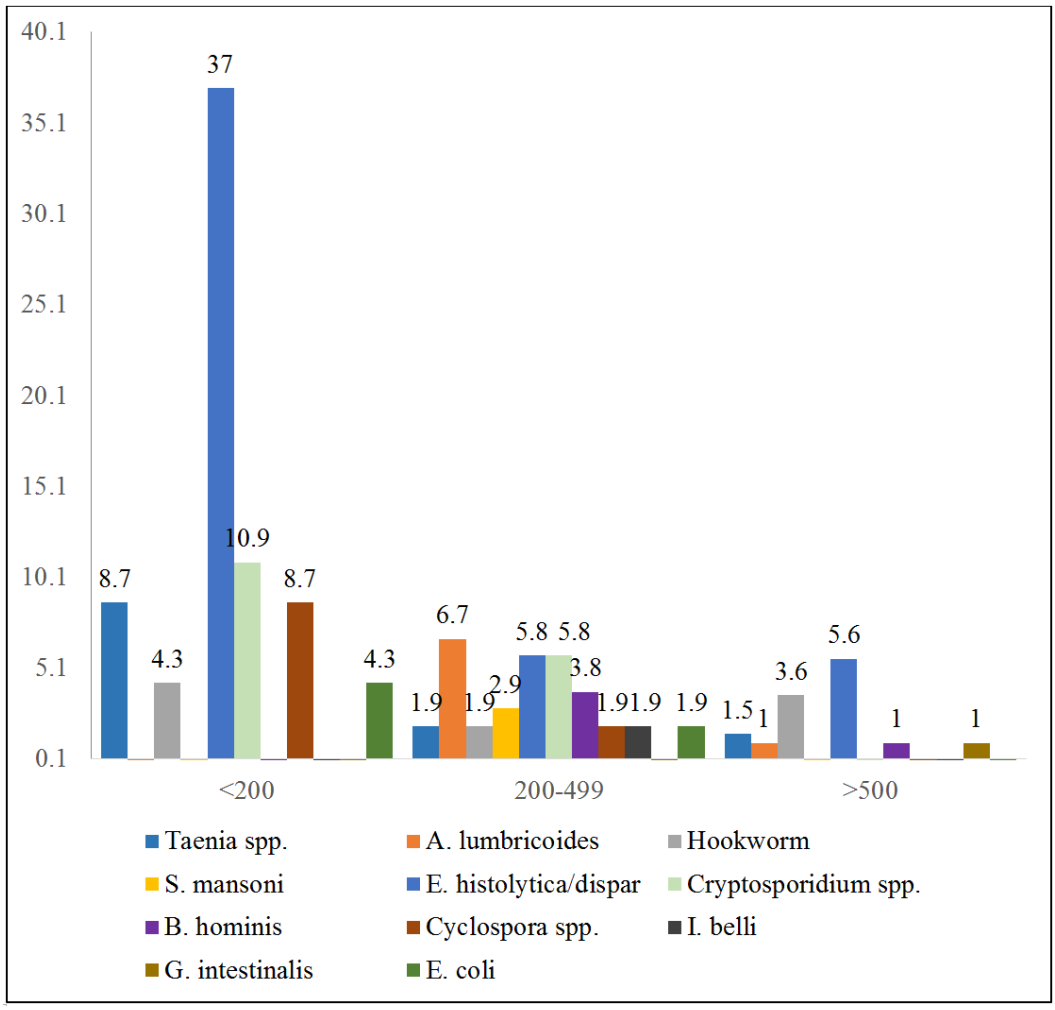

Figure 2. *Different organisms in each category.*

4.4. Association Between Intestinal Parasites and Diarrhea

Generally intestinal parasites had no statistically significant relationship (P = 0.555) with diarrhea. One-point two percent (1.2%) of study participants presented with diarrhea which was associated with *Entamoeba histolytic/dispar* complex infection which was also the most prevalent parasite in this study (p = 0.026) (Table 4).

Table 3. *Association and distribution of intestinal parasites within different CD4+ T lymphocyte cell count categories of HIV/AIDS patients on HAART.*

Characteristic		Intestinal parasites		AOR (95%CI)	P-value
		Absent N (%)	Present N (%)		
Sex	Male	55 (75.3)	18 (24.7)	1.964 (0.897-4.298)	0.091
	Female	225 (82.1)	49 (17.9)	1	
Marital status	Single	68 (84.0)	13 (16.0)	0.377 (0.161-0.880)	0.101
	Married	141 (82.9)	29 (17.1)	0.484 (0.236-0.993)	
	Divorced	2 (100.0)	0 (0.0)	0.000	
	Widow or Widower	69 (73.4)	25 (26.6)	1	
Religion	Christian	238 (80.7)	57 (19.3)	$4.144x10^{8}$	0.054
	Muslim	25 (71.4)	10 (28.6)	$1.237x10^{9}$	
	Pagan	17 (100.0)	0 (0.0)	1	
Walking barefooted in the farms	No	65 (83.3)	13 (16.7)	0.706 (0.302-1.651)	0.059
	Sometimes	86 (74.1)	30 (25.9)	1.813 (0.902-3.642)	
	Always	129 (84.3)	24 (15.7)	1	
CD4 count	<200	25 (54.3)	21 (45.7)	8.531 (3.758-19.366)	<0.0001**
	200-499	81 (78.6)	22 (21.4)	2.152 (1.090-4.250)	
	>/=500	174 (87.9)	24 (12.1)	1	

AOR = Crude odd ratio for the association between intestinal parasites and possible risk factors
95% CI= 95% confidence interval of AOR
** = statistically significant result ($p<0.05$).

Table 4. *Association between intestinal parasites and diarrhea.*

		Diarrhea		Total	X^2	p-value
		No No (%)	Yes No (%)	No (%)		
Helminth	*Taenia spp.*	9 (2.7)	0 (0.0)	9 (2.6)	1.587	0.504
	Ascaris lumbricoides	9 (2.7)	0 (0.0)	9 (2.6)	0.447	0.504
	Hookworm	11 (3.3)	0 (0.0)	11 (3.2)	0.459	0.590
	Schistosoma Mansoni	3 (0.9)	0 (0.0)	3 (0.9)	0.146	0.702
	Total infected with helminth	28 (8.1)	0 (0.0)	28 (8.1)	1.587	0.225
Protozoa	*Entamoeba histolytica*	30 (9.1)	4 (25.0)	34 (9.8)	4.386	0.036*
	Cryptosproridum spp.	11 (3.3)	0 (0.0%)	11 (3.2)	0.549	0.459
	Blastocystis hominis	4 (1.2)	0 (0.0)	4 (1.2)	0.295	0.685
	Cyclospra	6 (1.8)	0 (0.0)	6 (1.7)	0.295	0.587
	Isospora belli	2 (0.6)	0 (0.0)	2 (0.6)	0.097	0.755
	G. intestinalis	2 (0.6)	0 (0.0)	2 (0.6)	0.097	0.755
	Entamoeba coli	4 (1.2)	0 (0.0)	4 (1.2)	0.196	0.658
	Total infected with protozoa	38 (11.0)	4 (1.2)	42 (12.1)	2.012	0.084
Total infected with intestinal parasites		66 (94.0)	4 (6.0)	347 (100)	0.349	0.555

X^2 = Chi square values for the association between intestinal parasites and Diarrhea.

5. Discussion

Intestinal parasites infect man causing symptoms generally associated with gastrointestinal tract disorders [18]. These gastrointestinal infections pose a serious public health problem in developing countries which are faced with poor sanitation and high prevalence of HIV/AIDS [18].

This study revealed the prevalence of intestinal parasites in HIV/AIDS patients on Highly Active Antiretroviral Therapy (HAART) and their association with socio-demographic variables, diarrhea and CD4+ T lymphocyte cell count levels among HIV/AIDS patients receiving HAART at the Ndop Health District. Parasites were not quantified which made the study limited to the presence or absence of IPs in study participants. Critically ill patients were not included in the study as they were not available at the treatment centers.

An intestinal parasitic prevalence of 19.3% (CI = 15.3%-23.9%) among HIV/AIDS patients on HAART at the NHD was observed, this was similar to a study by Akinbo and colleagues [21] in Kogi state, Nigeria but lower than that reported by Voukings and colleagues [7] in Younde, Cameroon and Nsagha and colleagues in Buea and Limbe, Cameroon [8]. These differences in the prevalence of intestinal parasite may be due to the less cosmopolitan nature of the NHD which is found in Ngoketunjia a Division of the NW Region of Cameroon compared to Yaounde, and Buea which are respectively the Regional Capitals of the Centre and SW Regions of Cameroon not forgetting Limbe, which is an area with an extensive coast line acting as home for tourists and business men, this may explain the high prevalence of intestinal parasites observed in those studies compared to that in the Ndop Health District.

There was a higher prevalence of protozoa infections (12.7%) compared to helminthic infections (8.6%) (Table 2), this was in line with a study by Nsagha and colleagues [8] in Buea and Limbe, Cameroon but contrary to other studies such as that by Assefa and colleagues and also Missaye and colleagues [22, 23] who registered a higher prevalence of helminthic infections. The difference may be due the

difference in geographical locations as that in this study and that by Nsagha and colleagues [8] were carried out in parts of Cameroon but the others were carried out in different countries.

Amoebiasis caused by *Entamoeba histolytica/dispar* is one of the most problematic parasitic infections around the world particularly in developing countries were contamination of food and water is high [24]. *Entamoeba histolytica/dispar* was the most prevalent (9.8%) intestinal parasite in this study (Table 2). This was in conformity with previous studies on HIV/AIDS patients in some parts of Nigeria [25, 26] where *Entamoeba histolytica/dispar* was the most prevalent intestinal parasite. This observation was contrary to studies by other authors [22, 23, 27] who recorded *Cryptosporidium spp* as the most prevalent intestinal parasite in HIV/AIDS patients. Other Studies, such as that by Frederick and colleagues [28] had observations contrary to the findings in this study with helminths being the most prevalent compared to protozoa and the most prevalent intestinal parasites identified being *Ascaris lumbricoides.* These differences may have also been due to geographical location as these studies were carried out in different locations.

Several immune mechanisms suggest that immune responses to parasites are deleterious to immune control of intracellular pathogens such as HIV [6]. The interaction between intestinal parasite and HIV in a dually infected host may either increase susceptibility or enhance cell-cell infection and virus replication thereby indirectly increasing transmission [6, 29]. Intestinal parasites showed a statistically significant relationship in this study with CD4+ T lymphocyte cell counts (Table 3). Those with CD4+ T lymphocyte cell counts < 200cells/µl had the highest intestinal parasitic prevalence (that is 45.7%), compared to 21.2%, and 12.2% for Participants with CD4+ T cell counts between 200-499 cells/µl and ≥ 500cells/µl respectively ($P < 0.001$). There was an increasing prevalence of intestinal parasite with decreasing $CD4^+$ T lymphocyte cell count (table 3). This trend is similar to that reported in previous studies in Cameroon [4, 8], Nigeria [21] and Ethiopia [30] in which increased parasite prevalence was found in patients with CD4+ T lymphocyte cell counts less than 200cells/µl (table 1). This could be explained by the fact that as CD4+ T lymphocyte cell counts reduces, HIV patients on HAART are predisposed to intestinal parasitic infections which normally do not pose problems to immunocompetent individuals. Cellular immunity is the major defense against intestinal parasitic infections [29], therefore reduction in CD4+ T lymphocyte cell counts by the HIV virus predispose this patients to opportunistic infection such as *Cryptosporidium spp and Cyclospora spp* which were more prevalent at CD4+ T lymphocyte cell counts < 200cells/µl compared to other CD4+ T cell counts categories in this study (figure 2), this has also been observed in other studies in Cameroon [6, 8] and Ethiopia [31]. No opportunistic intestinal parasite was observed at CD4+ T lymphocyte cell counts ≥ 500 cells/µl in this study this is because of the existence of a stronger immune system which prevented the growth of opportunistic parasites which could only be seen in those with CD4+ T lymphocyte cell counts < 500 cells/µl in this study.

E. histolytica/dispar was the only parasite that was found to have a statistically significant associated with diarrhea (Table 4), this was contrary to that observed in a study by Nsagha and colleague [8] in the Buea and Limbe Regional hospitals of Cameroon in which parasites that were significantly associated with diarrhea were *Crytosporidium spp* and *Blastocystis hominis.* The difference between these observations may be due to the fact that our study was limited to HIV patients on HAART both that by Nsagha and colleagues [8] were carried out both on HIV patients on HAART and HIV patients not on HAART and more to that, the study sites were different. Absence of diarrhea in those infected with parasites such as Cryptosporidium and Cyclospora may had been because there was a low density of these parasites in infected individuals, consequently the threshold density to cause symptoms of diarrhea was not reached.

6. Conclusion

There was an intestinal parasitic prevalence of 19.3% among HIV/AIDS patient on HAART at the Ndop Health District. The spectrum of intestinal parasites included; *Taenia* species*, Ascaris lumbricoides*, *Hookworm*, *Schistosoma mansoni*, *Entamoeba histolytica, Cryptosproridum parvum, Blastocystis hominis, Cyclospra spp, Isospora belli, Gardia intestinalis, and Entamoeba coli,* with *Entamoeba histolytica/dispar being* the most occurrent parasite.

Intestinal parasitic infections were more prevalent at lower $CD4^+$ cell count categories (<500cells/µl), with opportunistic infections such as *cryptosporidium spp, Isospora belli* and *Cyclospora spp* were found only at low CD4+ T lymphocyte cell count categories of <500cells/µl.

Entamoeba histolytica/dispar complex was associated with diarrhea in HIV/AIDS patients on HAART.

List of Abbreviations

AIDS: Acquired Immunodeficiency Syndrome, BBMHC: Babessi Medicalised Health Center, BLMHC: Balikumbat Medicalised Health Center, CD: Cluster: of Differentiation, CI: Confidence Interval, AOR: Adjusted Odd Ratio, HAART: Highly Active Antiretroviral Therapy, HIV: Human Immunodeficiency Virus, IHC: Integrated Health Center, IPs: Intestinal Parasites, NDH: Ndop District Hospital, NHD: Ndop Health District, NW: North West, SD: Standard Deviation, STH: Soil transmitted helminths, SW: South West.

Declaration

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Institutional Review Board (IRB) of the Faculty of Health Sciences

(FHS). Next, we obtained administrative clearance from the regional delegate of public health for the South West Region, asking for authorization to carryout research in health centres in the South west region.

An informed consent was obtained from participants before being enrolled in the study.

Consent for Publication

Not applicable.

Availability of Data and Materials

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

SBN, NDS, AEA, NFA and TPB, conceived and designed the study, SBN implemented the study, NDS and AEA supervised the study, SBN, NFA, NL and TPB collected and processed study specimens. SBN conducted analyzed research data: SBN, NDS, AEA, NFA, TPB and NL interpreted study results: SBN wrote the first draft of the manuscript, NFA, NL and TPB, reviewed and corrected the manuscript. All authors read and approved the final manuscript for publication.

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