Intestinal parasitic infections among HIV infected patients on antiretroviral therapy attending Debretabor General Hospital, Northern Ethiopia: a cross-sectional study

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Abstract

Background: Parasitic infections are known causes of morbidity among HIV infected patients with low $CD4^+$ counts who are on antiretroviral therapy; mainly as a result of immune suppression. Thus, this study aimed to assess the extent of intestinal parasitic infection and its related risk factors among HIV infected patients attending ART clinic of Debretabor General Hospital, Northern Ethiopia.

Patients and methods: A health facility based cross sectional study was conducted on a total of 383 HIV infected patients attending ART clinic of Debretabor General Hospital, Northern Ethiopia from December 2018 to March 2019. An interview based structured questionnaire were used to gather socio-demographic and risk factor data. About 5 grams of fresh stool specimen and 4 ml of venous blood sample were collected, then transported and tested in accordance with the laboratory standard operating procedures. The obtained data was entered into SPSS version 22.0; and analyzed. P-value <0.05 with 95% confidence interval was considered statistically significant.

Result: The overall prevalence of intestinal parasites was 25.3%; with 18% and 23.8% by direct wet mount and formol-ether concentration technique respectively. 8 (2.1%) patients were infected by multiple parasites in concentration technique. *Ascaris lumbricoides,* 23(25.3%) was the most frequently identified parasite. Parasitic infection was significantly higher among illiterates (*P=0.011*); patients with a CD4 count of <200 cells/mm^3 (*P<0.001*) and among patients who did not have latrine (*P=0.049*) than their counter parts.

Conclusion: Relatively higher prevalence of intestinal parasitic infection was found among HIV/AIDS patients. The distribution of intestinal parasites is greatly affected by illiteracy, reduced $CD4^+$ counts and absence of toilet. Thus, HIV/AIDS patients with low $CD4^+$ counts should be diagnosed consistently for intestinal parasites and routine stool examination and awareness creation should be advocated to be included as an essential component of the ART monitoring strategy for improved patient care.

Introduction

Human immunodeficiency virus (HIV) is a challenging health problem worldwide. Based on a joint report from WHO and USAID, about 38 million individuals were living with HIV virus by the end of the year 2019 globally; and more than 1 million people died due to AIDS related complications and diseases; in which about 69% of them residing in the sub-Saharan Africa region.[1] The Africa region is most harshly affected by the virus; WHO reports revealed that approximately 1 per 25 adults (3.7%) are currently living with the virus which is grossly estimated to be more than two-third of the global burden of HIV.[1] Mainly due to the subsequent heightened immune suppression which usually occur at the late phase of the disease, opportunistic infections are among the major health problems affecting HIV/AIDS patients globally. Such immunosuppression most commonly expose HIV patients to a wide range of parasitic and microbial attacks.

Parasitic infections, particularly intestinal parasites are widely distributed globally where about 3.5 billion individuals are infected with intestinal parasites globally.[2] Intestinal parasites are the main treat in developing countries such as Ethiopia which have been noticeably heightened with the co-existence of large burden of HIV/AIDS and malnutrition in the area. The extent of intestinal parasitic infection is highest in sub-Sahara African countries, where the highest proportion of HIV/AIDS cases are located. Evidences showed that HIV infected patients are the most vulnerable risk groups for acquiring parasitic and microbial infections than those who are non-infected.[3,4,5] Thus, opportunistic infections, in particular parasitic infections commonly affect people with HIV/AIDS infections in which about 80% of AIDS patients die as a result of AIDS related infections including the commonly occurring intestinal parasites rather than due to the HIV infection itself. These opportunistic infections most commonly occur at the later stages of HIV infection when the amount of Cluster of Differentiation ($CD4^+$) T cells is declined mostly below 200 cells/mm^3.[6]

Despite anti-retroviral treatment (ART) upsurges the length of stay, improves the quality of life and reduces the occurrence of opportunistic infections among HIV/AIDS patients,[1] those patients taking ART treatments who have depleted $CD4^+$ counts commonly suffer from intestinal parasitic infections due to the immune suppression. Malnutrition, poor waste management, ignorance (illiteracy), unhygienic source of drinking water and depleted $CD4^+$ counts (<200 cell/mm^3) among HIV/AIDS patients are the most common determinant factors for parasitic infections.[4,7-9]

The distribution of parasitic infection in developing countries is estimated to be as high as 95% among HIV infected patients.[10] In the same way as many other developing countries, particularly African countries, intestinal parasites are extensively distributed in Ethiopia; mainly associated with malnutrition, low socio-economic status, poor personal and environmental hygiene, food contamination and lack of potable water supply in rural and urban areas majorly resulted from inappropriate human excreta disposal systems and lack of awareness regarding common health promotion practices.[9,11] Some studies have been conducted targeting the prevalence of intestinal parasites in different areas of Ethiopia;[2,3,7-9,12,13] however, epidemiological data on the prevalence of intestinal parasitic infection among HIV/AIDS patients is still inadequate in the study area. Thus; this study aimed to investigate the magnitude of intestinal parasitic infection and its related risk factors among HIV infected patients attending ART clinic of Debretabor General Hospital, Northern Ethiopia.

Methods And Materials

Study design, period and area

A health facility based cross sectional study was conducted from December 2018 to March 2019 at Debretabor General Hospital, Northern, Ethiopia. Debretabor is located 654 km Northwest from the capital city, Addis Ababa, Ethiopia. This town is situated at 11.85° North latitude and 38.02° East longitude / 11.833; 39.6 with an average temperature of 14.8°C. Debretabor General Hospital is one of the

governmental health institutions which provide health care service to over one million people and had 4326 HIV infected patients attending ART during the study period.

Sample size determination and sampling technique

Single population proportion formula was employed to determine sample size of the study, taking 47.8% previous prevalence of intestinal parasites among HIV/AIDS patients[7] with the corresponding 5% margin of error and 95% CI. In line with this, a total of 383 HIV/AIDS patients were included in this study. The study participants were selected and recruited using systematic sampling technique taking the ART clinic registration book as a sampling frame. HIV/AIDS patients who took any of the anthelminthic drugs within the past 4 weeks from the time of data collection were excluded from the study.

Data collection and laboratory processing

An interview based structured questionnaire was deployed to gather information related to socio-demographic and health related risk factor data of study participants. About 5 gm of freshly passed stool sample was received from study participants after being collected using pre-labelled, leak proof, plastic container with screw-on lid and attached spoon (FL Medical, Italy) by study participants after appropriate collection instructions were given to avoid specimen contamination. Moreover, about 4 ml of venous blood sample was collected from each study participants following appropriate collection procedures using EDTA anti-coagulated vacuum tube (WEGO Ltd, China) by an experienced laboratory personnel. Immediate processing had been performed for the specimens in the hospital laboratory. Stool and blood specimen collection and processing were performed by strictly following the standard operating procedures (SOPs).

Stool examination of intestinal parasites

Direct examination of stool sample was carried-out by emulsifying a portion of stool (about 1-2 mg) in a drop of physiological saline (0.85% sodium chloride solution) and Lugol's iodine solution (for detecting the cystic stage of intestinal protozoan parasites). The remaining faeces specimen, after direct wet mount preparation, was preserved using 10% formalin; and subsequently examined using formol-ether concentration technique.

Formol-ether concentration technique

In order to further detect different stages of the intestinal parasites, Formol-ether concentration technique was performed by taking about pea sized portion (estimated to be 1gram) of representative stool sample using an applicator stick and emulsifying it in about 4 ml of 10% formol water within a screw capped tube. Additional 4 ml of 10% formol-water was added and mixed using vortex shaker. The suspension

was then sieved (filtered) into a conical centrifuge tube; and about 3–4 milliliters of diethyl ether was added and mixed for 1 minute. The tube was centrifuged at 3000 revolutions per minute for about 1 minute. Finally, a portion of the sediment was examined microscopically using 10x and 40x objectives after being placed on a microscopic slide and covered using a coverslip.[14] Each positive findings of stool examination and parasitic species identification were approved by a senior medical laboratory technologist.

CD4 T cells determination

Using the collected anti-coagulated blood sample from each study participants, $CD4^+$ count (cells/mm^3) analysis was performed using FACS count automated machine (Becton Dickinson, USA) after quality control was performed and passed. Once the reagent pair of tube was labeled and mixed using vortex with the pair upright and upside down for about 5 seconds; the tubes were then mixed with patient's blood sample by inverting the tube five times after being opened using coring station. About 50ml of blood was pipetted in to each tube; and the pair of tubes were vortexed in the upright position for 5 sec. Then, the tubes were incubated at room temperature in the dark place for 60-120 minutes and 50ml of fixative solution was added into each tube; and mixed using vortex upright for 5 seconds. After 30 minutes incubation time, FACSC count was run and results were printed out.[15]

Quality assurance

Standardized quality checks were performed throughout the data collection steps intended to obtain reliable and quality research data. The entire queries in the interview based structured questionnaire were prepared precisely and clearly; and translated into the local language (Amharic). Training was given for all data collectors. Furthermore, all laboratory-based assays were performed based upon the Standard Operating Procedures (SOPs) and quality control procedures were strictly maintained throughout data collection process of the study.

Statistical analysis

The collected data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 22 (IBM, USA). Descriptive statistics, binary as well as multivariate logistic regression methods were used to analyze the data. Binary logistic regression was employed to show the correlation of the dependent variable with the individual independent variable. Besides, multivariate logistic regression analysis was used to avoid confounders and identify risk factors that autonomously impact the occurrence of the dependent variable. P-value <0.05 with 95% confidence interval was considered statistically significant.

Ethics approval and consent to participate

After being thoroughly evaluated and checked for appropriateness, the study got approval by the Research Ethics Review Committee (RERC) of College of Health Sciences, Debretabor University, and ethical clearance was attained. Then official collaboration and willingness were obtained from Debretabor General Hospital. Besides, a written and signed informed consent was obtained from the individual study participants prior to commencing data collection. Positive results of study participants were immediately communicated with the ART clinic physician mentioning the parasitic species and they were treated with appropriate treatment protocol. Moreover, this study was conducted in accordance with the Declaration of Helsinki.

Results

Socio-demographic and clinical characteristics of study participants

In this study, a total of 383 study participants were enrolled and investigated during the study period. The age of the study participants ranged from 18 - 65 years, with a mean age of 37.1±11.5 years. Majority (50.9%) of study participants were in the age range of 18 to 35 years. Of the total participants, 157(41%) were males and 226(59%) were females. Nearly three-fourth 281(73.4%) of study subjects were urban dwellers; and 169(44.2%) were married while 150(39.1%) were single. The educational status of majority of them 110(28.7%) was primary levels. Moreover, almost all (92.4%) had toilet, 97.1% had pipe water supply in their home, and 26(6.8%) study participants had animal contact (Table 1). Concerning WHO clinical staging, about 248(64.8%) participants were found in stage I. The mean $CD4^+$ count was 507 cells/mm^3 ranging from 28–2417 cells/mm^3 where majority, 156(40.7%) of participants had a $CD4^+$ count of 200-500 cells/mm^3 (Table 1).

Table 1: Socio-demographic and clinical characteristics of HIV/AIDS patients attending ART clinic of Debretabor General Hospital (n=383), from December 2018 to March 2019

Variable	Category	Frequency (N=383)	Percent (%)
Age in years	18-35	195	50.9
	36-53	144	37.6
	54-65	44	11.5
Sex	Male	157	41
	Female	226	59
Residence	Urban	281	73.4
	Rural	102	26.6
Marital status	Single	150	39.1
	Married	169	44.2
	Divorce	30	7.8
	Widowed	34	8.9
Educational Status	Illiterate	88	23.0
	read and write	39	10.2
	Primary education	110	28.7
	Secondary education	89	23.2
	college and above	57	14.9
Water source	Pipe water	372	97.1
	Well water	11	2.9
Presence of latrine	Yes	354	92.4
	No	29	7.6
Animal contact	Yes	26	6.8
	No	357	93.2
WHO clinical stage	Stage I	248	64.8
	Stage II	103	26.9
	Stage III	23	6.0
	Stage IV	9	2.3
$CD4^+$ T Cells count (cells/mm^3)	<200 cells/ mm^3	77	20.1
	200-500 cells/mm^3	156	40.7

	>500 cells/mm^3	150	39.2

Prevalence of intestinal parasites

The overall prevalence of intestinal parasites among HIV/AIDS patients in this study was found to be 25.3%. The prevalence rate of intestinal parasitic infection with one or more intestinal parasite using direct wet mount and formol-ether concentration technique was 69/383 (18%) and 91/383 (23.8%) respectively (Table 2). Unlike direct wet-mount, mixed (double) infection was seen in formol-ether concentration technique; 8(2.1%) participants were infected by more than one parasite. Twelve species of intestinal parasites were identified in this study. Of these (positive by fomol-ether concentration), *A. lumbricoides* 23(25.3%), *S. stercoralis* 15(16.5%), and *Taenia species* 12(13.2%) were predominantly detected (Table 2).

Table 2: Distribution of specific parasites by different diagnostic techniques from HIV/AIDS patients attending ART clinic of Debretabor General Hospital (n=383), from Dec 2018 to March 2019

Type of parasites detected	Diagnostic method		
	Direct Wet-mount; No. (%)	Formol-ether Concentration; No. (%)	Over all; No. (%)
Entamoeba histolytica trophozoite	3 (4.3)	0 (0)	3 (3.1)
Entamoeba histolytica/dispar cyst	4 (5.8)	4 (4.4)	4 (4.1)
Giardia lamblia trophozoite	3 (4.3)	0 (0)	3 (3.1)
Giardia lamblia cyst	5 (7.2)	5 (5.5)	5 (5.2)
Ascaris lumbricoides	17 (24.6)	23 (23.1)	23 (23.7)
Enterobius vermicularis	4 (5.8)	5 (5.5)	5 (5.2)
Hymenolepis nana	4 (5.8)	6 (6.6)	6 (6.2)
Hook worm species	4 (5.8)	4 (4.4)	4 (4.1)
Schistosoma mansoni	3 (4.3)	3 (3.3)	3 (3.1)
Strongyloides stecoralis	12 (17.4)	15 (15.4)	15 (15.5)
Trichuris trichiura	5 (7.2)	6 (6.6)	6 (6.2)
Taenia species	5 (7.2)	12 (13.2)	12 (12.4)
A. lumbricoides and H. nana	0 (0)	3 (3.3)	3 (3.1)
A. lumbricoides & Taenia species	0 (0)	2 (2.2)	2 (2.1)
E. vermicularis & Taenia species	0 (0)	1 (1.1)	1 (1.0)
T. trichiura & Taenia species	0 (0)	1 (1.1)	1 (1.0)
A. lumbricoides & E. histolytica	0 (0)	1 (1.1)	1 (1.0)
Total	69 (18.0)	91 (23.8)	97 (25.3)

Majority of the intestinal parasitic infections were found among HIV patients with $CD4^+$ counts <200 cells/mm^3. Moreover, regarding the pattern of intestinal parasites among HIV patient study participants in relation to their $CD4^+$ counts, in this study, the occurrence of *Entamoeba histolytica* infections were significantly associated with $CD4^+$ T-cell counts <200 cells/mm^3 (P = 0.037) (Table 3).

Table 3: Prevalence of intestinal parasites among HIV infected individuals in relation to their $CD4^+$ counts at ART clinic of Debretabor General Hospital, Northern Ethiopia.

Type of parasites detected	$CD4^+$ category			
	<200 cells/mm^3 No. (%)	200-500 cells/mm^3 No. (%)	>500 cells/mm^3 No. (%)	P-value
Giardia lamblia	4 (50)	1 (12.5)	3 (37.5)	0.201
Entamoeba histolytica	7 (100)	0 (0)	0 (0)	0.035*
Ascaris lumbricoides	11 (47.8)	2 (8.7)	10 (43.5)	0.497
Enterobius vermicularis	2 (40)	0 (0)	3 (60)	0.631
Hymenolepis nana	2 (33.3)	1 (16.7)	3 (50)	0.521
Hook worm species	2 (50)	0 (0)	2 (50)	0.784
Schistosoma mansoni	1 (33.3)	0 (0)	2 (66.7)	0.308
Strongyloides stecoralis	6 (40)	1 (6.7)	8 (53.3)	0.087
Trichuris trichiura	2 (33.3)	2 (33.3)	2 (33.3)	0.161
Taenia species	2 (16.7)	2 (16.7)	8 (66.6)	0.090
A. lumbricoides and H. nana	2 (66.6)	1 (33.4)	0 (0)	0.310
A. lumbricoides & Taenia species	1 (50)	0 (0)	1 (50)	0.402
E. vermicularis & Taenia species	1 (100)	0 (0)	0 (0)	0.140
T. trichiura & Taenia species	0 (0)	1 (100)	0 (0)	0.212
A. lumbricoides & E. histolytica	1 (100)	0 (0)	0 (0)	0.180

Note:

* Statistically significant at P<0.05

Risk factors associated with intestinal parasitic infection

The prevalence of intestinal parasites was 28.2% in the age category 18-35 years and 29.5% for the age group 54-65 years; but the difference was not statistically significant (*P*=0.193). Despite no statistically

significant differences existed between intestinal parasites and gender; the prevalence of parasitic infection was relatively higher among males than females (29.3% vs 22.6%; AOR=1.025, 95% CI: (0.558-1.882), P=0.937). Similarly, despite not statistically significant (P=0.565), relatively higher prevalence of intestinal parasitosis was found among rural dwellers (Table 4).

Almost one-third of positivity rate 28(31.8%) was found among illiterate study participants and it was found to be significantly associated with occurrence of intestinal parasites than their counter parts (AOR=4.165; 95%CI:(1.394-12.450); P=0.011). Moreover, having an educational level of 'only read and write' (AOR=9.329, 95%CI: (2.626, 33.140), P=0.001), absence of home latrine (AOR=2.595; 95%CI:(1.003-6.712), P=0.049) and $CD4^+$ count of HIV patients <200 cells/mm^3 (AOR=3.359; 95%CI:(1.793-6.293), P<0.001) were found to have statistically significant association with intestinal parasitosis (Table 4).

Table 4: Factors associated with intestinal parasites among HIV/AIDS patients attending ART clinic of Debretabor General Hospital (n=383), from Dec 2018 to March 2019

Category	Intestinal parasitosis		COR (95% CI)	P-value	AOR (95% CI)	P-value
	Positive, N (%)	Negative, N (%)				
Age group						
18-35	55 (28.2)	140 (71.8)	1.067 (0.520, 2.191)	0.859	NA	
36-53	29 (20.1)	115 (79.9)	1.66 (0.774, 3.574)	0.293	NA	
54-65	13 (29.5)	31 (70.5)	1			
Sex						
Male	46 (29.3)	111 (70.7)	1.271 (0.799, 2.023)	0.212	1.025 (.558, 1.882)	0.937
Female	51 (22.6)	175 (77.4)	1		1	
Level of education						
Illiterate	28 (31.8)	60 (68.2)	4.853 (1.748, 13.470)	0.002*	4.165 (1.394, 12.450)	0.011*
Read & write	16 (41)	23 (59)	7.235 (2.366, 22.120)	0.001*	9.329 (2.626, 33.14)	0.001*
Primary	31 (28.2)	79 (71.8)	4.081 (1.490, 11.170)	0.006*	3.515 (1.192, 10.36)	0.063
Secondary	17 (19.1)	72 (81.1)	2.456 (0.850, 7.080)	0.096	1.822 (0.592, 5.608)	0.296
College & above	5 (8.8)	52 (91.2)	1		1	
Water source						
Tape water	93 (25)	279 (75)	1			
Well water	4 (36.4)	7 (63.6)	1.714 (0.490, 5.988)	0.398	NA	
Presence of latrine						
Yes	85 (24)	269 (76)	1		1	
No	12 (41.4)	17 (58.6)	2.234 (1.206, 4.846)	0.043	2.595 (1.003, 6.712)	0.049*
Animal contact						
Yes	8 (30.8)	18 (69.2)	1.33 (0.560, 3.184)	0.510	NA	

No	89 (24.9)	268 (75.1)	1			
WHO clinical stage						
I /II	87 (24.8)	264 (75.2)	1			
III/IV	10 (31.3)	22 (68.7)	1.379 (0.629, 3.020)	0.422	NA	
CD4+ cells/mm^3						
<200	44 (57.1)	33 (42.9)	3.42 (1.929, 6.094)	0.000	3.359 (1.793, 6.293)	0.000*
200-500	11 (7.1)	145 (92.9)	0.195 (0.090, 0.396)	0.002	0.168 (0.079, 0.354)	0.072
>500	42 (28)	108 (72)	1		1	

Notes:

* Statistically significant at P<0.05.

AOR = adjusted odds ratio, $CD4^+$ = cluster of differentiation, COR = crude odds ratio, 1 = reference group, 95% CI = 95% confidence interval, WHO = world health organization, NA = not applicable

Discussion

HIV infection is a major global public health problem with the highest rates of the disease found in sub-Saharan region of Africa.[16] Intestinal parasitic infections are among the leading causes of morbidity and mortality in peoples living with HIV.

The overall prevalence of intestinal parasites among HIV/AIDS patients in this study was found to be 25.3% which is comparable with reports from Axum 26.4%,[17] Gondar, Ethiopia 24.3%,[18] Mozambique 26.5%[19] and Brazil 24%.[20] However, it was found to be higher than findings reported from Kombolcha, Dessie, Gondar and Kobo regions of Ethiopia, and Benin and Makurdi regions of Nigeria 13.9%, 17.6%, 20%, 16%, 18%, 20.9% respectively.[21,12,22-24,5] However, our finding was lower than the prevalence reports from Cameroon 57.48%,[25] Kenya 50.9%,[26] Burkina Faso 73.3%[27] and some studies conducted in different parts of Ethiopia including Jimma 44.8%,[3] Jimma University Specialized Hospital 45.0%,[28] Hawassa 47.8%[7] and Shahura 56.9%.[9] This variation could be due to differences in socio-demographic characteristics, sample size differences and time period variation. Additionally, implementation of relevant health intervention programs and improvement of health service coverage with the active involvement of health extension workers in some places might contribute for this variation.

Despite not being statistically significant, in the present study, the majority of intestinal parasites were detected among HIV/AIDS patients who were in the age range 18-35 years, the most productive and reproductive group in society which is in line with study reports from Gondar.[22] The possible reasons

might be due to frequent contact among each other, over-crowding in classrooms, poor personal hygiene, and habit of sharing of materials which facilitates the spread of the parasites.

In this study, the most predominant parasite was *A. lumbricoides* (23.8%). This is in line with findings from previous studies in Jimma,[29] Cameroon[25] and Southeast Nigeria.[30] In contrast to our finding *E. histolytica* was the predominant parasite detected in the ART clinics of Kombolcha health center,[21] Northwestern Ethiopia,[9] Gondar[22] and Axum[17] regions of Ethiopia; and Kenya.[26] Ubiquitous distribution of the parasite, higher durability of *A. lumbricoides* eggs in diversified external environmental settings, the distinct feature of the parasite towards laying much number of eggs and poor socioeconomic status may contribute for an increased distribution of *A. lumbricoides* in the study area.

In this study, among HIV/AIDS patients infected with intestinal parasites, about 41.4% did not have toilet in their home. Our study further revealed that not having a toilet at home is significantly associated with occurrence of intestinal parasitic infection among HIV patients, which is in line with similar study from Gondar (AOR=5.21, 95% CI: 1.82, 16.03).[22] This is mainly due to the fact that absence of toilet results in open field defecation in residence vicinity which lead to easy feco-oral transmission of intestinal parasites. Similarly, this study also revealed that the prevalence of intestinal parasitic infections is significantly affected by level of education among HIV/AIDS patients. Thus, illiterate patients had the highest prevalence of parasitic infection which goes in agreement with study conducted in Nigeria.[4] Moreover, significantly higher prevalence of intestinal parasites was found among HIV/AIDS patients with a $CD4^+$ count <200 cells/mm^3 ($P<0.0001$); which is in agreement with study reports from Gondar,[22] Nigeria[31] and Mozambique.[19] Hence, reduction of $CD4^+$ count (<200 cells/mm^3) in HIV patients increases the likelihood of acquiring opportunistic intestinal parasitic infections This is mainly because reduction in $CD4^+$ cells due to HIV infection results in diminished cellular immunity which is the major host defense mechanism against intestinal parasitic infection.

Despite not statistically significant, relatively increased rate of intestinal parasitic infections were detected among HIV patients categorized under WHO clinical stage I or II. This finding is in contrast with study reports from western Ethiopia,[32] southern Ethiopia[33] and northeastern Ethiopia[12] which reported significantly higher proportion of intestinal parasitic infections from HIV patients categorized under WHO clinical stage III.

Conclusions

In this study, there was a moderately higher overall prevalence of intestinal parasites among HIV/AIDS patients in contrast with other similar studies in the country. The distribution of intestinal parasites in the study area is greatly affected by illiteracy, lower immune status ($CD4^+$ T cells count less than 200 cells/mm^3) and absence of home toilet. Thus, HIV/AIDS patients with low $CD4^+$ counts should be diagnosed consistently for intestinal parasites and routine stool examination and awareness creation should be advocated to be included as an essential component of the ART monitoring strategy for

improved patient care. Moreover, large-scale longitudinal studies assessing all associated risk factors and continuous surveillance should be conducted to halt the spread of intestinal parasites among HIV patients.

Limitations

Species specific special techniques such as Modified Zeehl-Nelson staining techniques, Kato- katz, Bearman's method and water-ether sedimentation method for *Microsporidia* and intestinal *Coccidia* were not done due to lack of resources in the research laboratory setup. Hence, the burden of intestinal parasites in this study might probably be underestimated.

List Of Abbreviations

AOR: Adjusted Odds Ratio; AIDS: Acquired Immune Deficiency Syndrome; ART: Anti-Retroviral Therapy; CD4: Cluster of Differentiation; CI: Confidence Interval; COR: Crude Odds Ratio; DGH: Debretabor General Hospital; FACS: Fluorescence-activated Cell Sorting; HIV: Human Immunodeficiency Virus; SOPs: Standard Operating Procedures; SPSS: Statistical Package for Social Sciences; UNAID: United Nations Programme on HIV and AIDS; WHO: World Health Organization.

Declarations

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Disclosure

The authors report no conflicts of interest in this work.

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Authors' contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed on the journal to which the article will be submitted; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

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