Gyang M, Mshelia SE, Meshak D, et al. Human intestinal helminths among HIV sero-positive and sero-negative adults in rural settings in Plateau state, Nigeria. *Journal of Global Health Reports*. 2021;5:e2021039. doi:10.29392/001c.22241

Research Articles

Human intestinal helminths among HIV sero-positive and sero-negative adults in rural settings in Plateau state, Nigeria

Mark Gyang[1], Suleiman E Mshelia[2], Daniel Meshak[1], Danjuma Salihu[1], Hadiza Agbo[3], Halima Sule[1], Jonathan Daboer[3], Gideon Amuga[4], Musa Dankyau[5], Aboi Madaki[1]

[1] Department of Family Medicine, College of Health Sciences, University of Jos, Plateau State, [2] Department of Community Medicine, Jos University Teaching Hospital, Jos, Plateau State, [3] Department of Community Medicine, College of Health Sciences, University of Jos, Plateau State, [4] Department of Biological Sciences, Nassarawa State University, Keffi, Nasarawa State, [5] Department of Family Medicine, College of Medicine and Health Sciences, Bingham University, Karu, Nasarawa State

Keywords: hiv sero-negative, hiv sero-positive, determinants, hiv, parasites, intestinal helminths, infection

https://doi.org/10.29392/001c.22241

Journal of Global Health Reports

Vol. 5, 2021

Background

There appears to be a bilateral relationship between HIV infection and intestinal helminthic infection. However, there is a paucity of data comparing the determinants of intestinal helminthic infection in the human immunodeficiency virus (HIV) sero-positive and sero-negative adults.

Methods

A cross-sectional study was conducted where eight hundred HIV sero-positive adults were recruited with an equal number of matched controls from two sites into the study from January to December 2015. Data were collected using a structured interviewer-administered questionnaire and stool samples were screened for intestinal helminths using the Kato-Katz method.

Results

The prevalence of intestinal helminths was 16.3% and 16.4% among the HIV sero-positive and sero-negative population respectively. Bivariate analysis showed that there was a significant association between treatment of drinking water and presence of intestinal helminthiasis in the HIV sero-positive population (OR=0.67, 95% confidence interval, CI 0.45-1.00 *P*=0.05) whereas the location of residence (OR=1.77, CI=1.21-2.58 *P*=0.00) and whether fruits and vegetables are washed or not before eating (OR=2.84, CI=1.18-6.83 *P*=0.04) were associated with having intestinal helminths in the HIV sero-negative population. A binary logistic regression showed that in the HIV infected arm, drinking untreated water (OR=1.60, CI=1.06 – 2.42) was a determinant of intestinal helminths infection. Having more than a primary school education (OR=0.61, CI=0.38-0.97) and residing in the rural area (OR=1.78,CI=1.21-2.60) were determinants in the HIV sero-negative arm.

Conclusions

There was no significant difference in the prevalence of intestinal helminths between the HIV sero-positive and sero-negative populations. However, the determinants associated with human intestinal helminthic infection differed significantly between the two populations. Strategies to eliminate intestinal helminths in these populations have to be contextualised appropriately taking into account wider social determinants.

Intestinal helminths are amongst the most prevalent chronic human infestations worldwide.[1,2] The World Health Organization (WHO) estimates that around 2 billion people are currently infested, particularly the rural poor in the developing world. About 300 million people have suffered severe and permanent impairment as a consequence.[3] Infestations caused by these soil-transmitted helminths (STH) are listed among the Neglected Tropical Diseases (NTDs) that cause substantial illness for more than one billion people globally.[4] The main species that infest humans are the round worms *Ascaris lumbricoides*, the whipworm *Trichuris trichiura* and the hookworms *Necator americanus* and *Ancylostoma duodenale*.[5–7] Determinants of Intestinal helminth infestation include environmental factors like water source, sanitary facilities and waste disposal methods; personal hygiene; food hygiene; geographical distribution; socioeconomic status; educational level; walking barefoot and other factors like a routine medical check-up. Thus, persons infested can be continually re-infested as long as they are exposed despite short term interventions of giving chemotherapy to at-risk groups.[1,8]

Human immunodeficiency virus (HIV) which is also a chronic infection is common in many of these countries where intestinal helminths are prevalent and both conditions can co-exist thereby maintaining the cycle of poverty and disease.[9] Several earlier studies reported that Helminth infections were more common in HIV infected than in HIV-uninfected patients.[10] Also, the HIV program in this region is wholistic, such that HIV patients are not only given drugs for the treatment of the disease but other interventions like health talks which expectedly, influence positive health behaviour. Therefore, knowing the determinants of intestinal helminths infection among HIV patients will aid in integrating appropriate interventions into the existing HIV program. On the other hand, assessing the determinants among the HIV negative cohort will give further insights into the wider community factors within the same context and region.

Studies of the interaction between HIV infection and intestinal parasitic infections have suggested that HIV-infected patients who are coinfected with helminths experience a shift in their immune system from a T helper type 1 (Th1) response to a predominantly T helper type 2 (Th2) response as well as an increase in immune system activation.[11] Also, the concomitant infection of HIV and intestinal parasites may potentiate the severity and progression of both within the infected person.[11] Th1 cells are essential in eradicating intracellular pathogens, and inflammatory responses. Th2 cells, on the other hand, target extracellular pathogens and produce cytokines, which enhance antibody production. The increased Th2 and diminished Th1 responses as well as the chronic immune activation found in patients with intestinal helminth infection have been hypothesised to lead to an increased susceptibility to HIV infection and enhanced HIV replication in helminth-infected individuals.[12,13]

Emerging evidence provides a scientific rationale for combining treatment programs for neglected tropical diseases (NTDs) with programs for the treatment of HIV/AIDS (acquired immune deficiency syndrome). Engaging the major stakeholders to establish operational links between HIV/AIDS and NTD control and elimination activities, especially in sub-Saharan Africa, could increase the efficiency and cost-effectiveness of both HIV/AIDS and NTD efforts.[14]

A systematic review and meta-analysis to determine the distribution of soil-transmitted helminthic infection in Nigerian children found that over one-third of the studies were published from south-western Nigeria. The south-western region was the only high-risk zone for STH infections while the rest of the regions were low-risk zones.[15]

There have been a lot of locally published studies on the prevalence of helminthic infection amongst children[16–18] and a few amongst adults and yet fewer amongst HIV positive adult patients.

The aim of this study was to determine the prevalence of intestinal helminth infection among HIV sero-positive and sero-negative adults in the study area and its determinants.

METHODS

BACKGROUND OF THE STUDY AREA

The study was conducted in Vom Christian Hospital and Barkin Ladi General Hospital. Vom Christian Hospital is located in Vwang District in Jos South Local Government Area (LGA), Plateau state. The District is situated on latitude 10 ^{0} N longitude 9 ^{0} E about 35km south-west of Jos, Plateau state. Vwang covers an area of 155 km^2 with a population of 121, 284.[19] Barkin-Ladi General Hospital is located in Ropp, a district in Barkin-Ladi LGA, Plateau State. The district is situated at latitude 9^{0}32’009’‘N longitude 8^{0}54’00’'E. It has an area of 1,032 km^2 and a population of 175,267 at the 2006 census.[20] The immediate communities of Vwang and Ropp are rural and most people in the community are farmers. The dry season is between November and March while the rainy season, April to October.

STUDY POPULATION

Study participants were HIV sero-positive and sero-negative patients who were 18 years and above attending Anti-Retroviral Therapy (ART) and Outpatient clinics of Vom Christian Hospital and Barkin Ladi General Hospital respectively. They were excluded if they had been given any medicine for helminth infection in the preceding six weeks.

STUDY DESIGN AND SUBJECT RECRUITMENT

The study used a cross-sectional design to compare the prevalence and determinants of intestinal helminths in HIV sero-positive and HIV sero-negative adults. HIV sero-positive clients were enrolled from the HIV clinics of Vom Christian Hospital and General Hospital Barkin Ladi while adults who were HIV sero-negative were enrolled from the outpatient clinics of the same hospitals. The study was conducted between January to December 2015.

SAMPLE SIZE

This was a survey of all eligible clients in the study sites and their corresponding controls in the same ratio.

DATA COLLECTION

Data was collected from study participants using a structured interviewer-administered questionnaire. Four hundred HIV sero-positive participants were recruited each from Vom Christian Hospital and General Hospital Barkin-Ladi with matched controls giving a total of one thousand six hundred participants. Information collected included socio-demographic characteristics and relevant risk factors for STHI such as the source of drinking water, treatment of drinking water, the practice of washing fruits and vegetables before eating, type of toilet facility and hand washing after toilet use. Stool samples were obtained on the same visit and microscopy was done using the Kato-Katz method.[20]

DATA ANALYSIS

Data was entered into the IBM SPSS version 25 for analysis. Frequency tables were used to present the bio-socio-demographic and clinical characteristics. A bivariate analysis, (Chi-square test) was used to test for association between the independent (age, sex, educational qualification, occupation, location of residence, main source of drinking water, water treatment and daily hygiene practices) and the dependent variable (the presence or absence of intestinal helminthic infection on stool microscopy). A binary logistic regression was used to assess the determinants of helminthic infection by imputing variables from the bivariate analysis that had a p $\leq$ 0.25 or variables known from theory to be relevant.

ETHICS CONSIDERATION

Ethical approval was obtained from the Ethics Committee of the Jos University Teaching Hospital, Jos. All participants gave written informed consent or a thumbprint using indelible ink on the consent form. Confidentiality of all information obtained from participants was assured. Participants were at liberty to withdraw from the study at any point with no negative consequence to the care they were already receiving. Patients diagnosed to have intestinal helminths were treated.

RESULTS

The study had 400 HIV sero-positive clients recruited from Vom Christian Hospital and 400 HIV sero-positive clients from Barkin Ladi General Hospital with an equal number of matched controls in the two sites. The prevalence of intestinal helminths was found to be 16.3% in the HIV seropositive population and 16.4% in the HIV sero-negative population. The median age of the study participants was 40 years with an interquartile range (IQR=31-50). In the HIV sero-positive population, the age group with the highest rate of STH infection was 31-45 years; 421(52.6%) while the 76-90 years age group had the lowest; 6(0.8%). In the HIV sero-negative arm, the age group with the highest rate of STH infection was 46 -60 years; 236 (29.5%) while the 76 -90 years age group had the lowest; 30 (3.8%). Secondary school education had the highest level of infestation; 316(39.5%) in the HIV sero-positive arm while those with primary school education had the highest level of infestation in the HIV sero-negative arm. About three fifths; 494 (61.7%) of the HIV sero-positive participants were forty years old or below while slightly over two fifths; 345 (43.1%) in the HIV sero-negative arm were forty years and below. About a quarter; 211(26.4% were male and about two fifths; 317(39.6%) were farmers in the HIV sero-positive arm. The HIV sero-negative arm had a quarter as males 204(25.5%) and about two thirds; 527(65.9%) were farmers. Approximately three fifths; 479 (59.9%) did not have more than primary school education and a third; 264 (33.0%) lived in the rural area among HIV sero-positive participants whereas less than two fifths; 307 (38.4%) did not go beyond primary school and about two fifths; 339 (42.4) resided in rural communities in the HIV sero-negative category (**Table 1**).

Bivariate analysis showed a statistically significant association between the treatment of drinking water and intestinal helminthic infestation in the HIV sero-positive arm. In the HIV sero-negative arm, there was a statistically significant association between the location of residence and the washing of fruits and vegetables before consumption and intestinal helminthic infestation (**Table 2**).

Binary logistic regression revealed that those that drink untreated water were more likely to be infected with intestinal helminths compared with those that do not (OR=1.60, CI=1.06-2.42) in the HIV sero-positive respondents. In the HIV sero-negative arm, those that had more than a primary school education were less likely to have intestinal helminths compared with those that did not (OR=0.61, CI=0.38–0.97) and those that reside in rural areas were more likely to be infected with intestinal helminths compared with those that do not (OR=1.78, CI=1.21-2.60) (**Table 3**).

DISCUSSION

We found that the prevalence of intestinal helminths among the HIV sero-positive population was 16.3% whereas that in the HIV sero-negative population was 16.4% and there was no statistically significant difference between the two. The prevalence of intestinal helminths in our study is much lower than that obtained in an earlier study in Plateau State, Nigeria which documented a prevalence of 33.3% among HIV- seropositives and 21.9% in HIV-seronegatives.[21] Subjecting this difference to further statistical analysis (chi-square test), showed that this difference in prevalence is statistically significant. In recent years, there has been more education on the risk factors of intestinal helminths, routine deworming, the use of Anti-Retroviral Therapy (ART) and the use of Sulphdoxine-Trimethoprim as prophylaxis and these may explain the reduction in prevalence particularly among HIV patients.[22] Most importantly, the uptake of ART and linkage to care of HIV patients has significantly increased over the past couple of years in this region. HIV treatment and prevention programs provide several health-related benefits to clients via health education on diverse topics, counselling and home visits. These have led to an improvement in their immunity and a reduction of opportunistic infection. Some participants in the study may not have been treatment naïve to antihelminths and this may have affected the results obtained in the study.

The prevalence of intestinal helminths found in this study is comparable to that obtained in Nairobi Kenya where the prevalence of intestinal helminth among HIV sero-positive adults was found to be 16.1%,[23] while that in a district facility was 19.3%.[24] The finding in this study is also comparable to the prevalence of intestinal parasites obtained in North-East Ethiopia where 16.0% was found in HIV sero-positive persons and 10.0% in HIV sero-negative persons.[25]

Table 1. Bio-socio-demographic and clinical characteristics of study participants

Variables	HIV sero positive		HIV sero negative	
	N	(%)	N	(%)
Age				
16 – 30	181	22.6	201	25.1
31 – 45	421	52.6	221	27.6
46 – 60	165	20.6	236	29.5
61 - 75	27	3.4	112	14.0
76 - 90	6	0.8	30	3.8
Age 2				
41 - 89	306	38.3	455	56.9
18 - 40	494	61.7	345	43.1
Sex				
Female	589	73.6	596	74.5
Male	211	26.4	204	25.5
Educational qualification				
No formal education	53	6.6	199	24.9
Primary	268	33.5	294	36.8
Secondary	316	39.5	196	24.5
Tertiary	163	20.4	111	13.9
Educational Qualification				
Primary or less	321	40.1	493	61.6
More than primary	479	59.9	307	38.4
Main occupation				
Artisan	89	11.1	41	5.1
Driver	15	1.9	7	0.9
Farmer	317	39.6	527	65.9
Professional	124	15.5	124	15.5
Trader	255	31.9	1O1	12.6
Main occupation				
Others	483	60.4	273	34.1
Farmer	317	39.6	527	65.9
Location				
Rural	264	33.0	339	42.4
Semi Urban	439	54.9	445	55.6
Urban	97	12.1	16	2.0
Location 2				
Semi Urban/Urban	536	67.0	461	57.6
Rural	264	33.0	339	42.4
Monthly Income				
More than average	241	30.1	106	13.3
Less than average	559	69.9	694	86.8
Do you Farm				
No	113	14.1	60	7.5
Yes	687	85.9	740	92.5
If yes, how frequent?				

Variables	HIV sero positive		HIV sero negative	
Always	311	38.9	357	44.6
Often	142	17.8	99	12.4
Rarely	97	12.1	131	16.4
Sometimes	137	17.1	153	19.1
Main source of drinking water				
Bore hole	208	26.0	116	14.5
Satchet	36	4.5	5	0.6
Stream	51	6.4	50	6.3
Tap	83	10.4	69	8.6
Well	422	52.8	560	70.0
Others	717	89.6	731	91.4
Water treatment				
Yes	579	72.4	603	75.4
No	221	27.6	197	24.6
If yes, in what way?				
Alum/Chemical	113	14.1	83	10.4
Boiling	76	9.5	93	11.6
Filtration	32	4.0	21	2.6
Wash fruits/vegetable before eating them?				
Yes	795	99.4	777	97.1
No	5	0.6	23	2.9
If yes, how frequent?				
Often	124	15.5	16	2.0
Rarely	37	4.6	16	2.0
Sometimes	142	17.8	181	22.6
Always	492	61.5	564	70.5
Hand washing before eating				
Yes	795	99.4	798	99.7
No	5	0.6	2	0.3
If Yes, how frequent?				
Often	144	18.0	45	5.6
Rarely	7	0.9	2	0.3
Sometimes	55	6.9	55	6.9
Always	589	73.6	696	87.0
Hand washing after toilet				
Yes	793	99.1	788	98.5
No	7	0.9	12	1.5
If yes, how frequent?				
Often	170	21.3	54	6.8
Rarely	4	0.5	8	1.0
Sometimes	121	15.1	145	18.1
Always	498	62.3	581	72.6
Type of toilet				
Near bush/open	271	33.8	331	41.4
Pit Latrine	262	32.8	281	35.2
Water Closet	267	33.4	188	23.5

Variables	HIV sero positive		HIV sero negative	
Type of toilet 2				
Water closet	267	33.4	188	23.5
Bush and pit	533	66.6	612	76.5
Do you swim				
Yes	59	7.4	59	7.4
No	741	92.6	741	92.6
If yes, how frequent?				
Often	8	1.0	3	0.4
Rarely	17	2.1	7	0.9
Sometimes	33	4.1	36	4.5
Always	1	0.1	13	1.6
Do you go about barefooted?				
Yes	456	57	384	48
No	344	43.0	416	52.0
If yes, how often do you go about barefooted?				
Often	24	3.0	4	0.5
Rarely	120	15.0	22	2.8
Sometimes	300	37.5	312	39.0
Always	12	1.5	46	5.7

Table 2. A cross tabulation of the study variables versus intestinal helminthic infection

Variables	HIV SERO POSITIVE							HIV sero negative						
	N	(%)	Stool test positive		OR	95% CI	P	N	(%)	Stool test positive		OR	95% CI	P
Age (Years)														
41 - 89	306	38.3	261 (85.3)	45 (14.7)	0.83	0.56 - 1.23	0.38	455	56.9	386 (84.8)	69 (15.2)	0.82	0.56 - 1.19	0.29
18 - 40	494	61.7	409 (82.8)	85 (17.2)				345	43.1	283 (82.0)	62 (18.0)			
Sex														
Female	589	73.6	491 (83.4)	98 (16.6)	0.90	0.58 - 1.38	0.67	596	74.5	496 (83.2)	100 (16.8)	0.89	0.57 - 1.38	0.66
Male	211	26.4	179 (84.8)	32 (15.2)				204	25.5	173 (84.8)	31 (15.2)			
Educational Qualification														
Primary or less	321	40.1	261 (81.3)	60 (18.7)	0.74	0.51-1.09	0.14	493	61.6	405 (82.2)	88 (17.8)	0.75	0.50 -1.11	0.17
More than primary	479	59.9	409 (85.4)	70 (14.6)				307	38.4	264 (86.0)	43 (14.0)			
Main Occupation														
Farmer	317	39.6	264 (83.3)	53 (16.7)				527	65.9	444 (84.3)	83 (15.7)			
Others	483	60.4	406 (84.1)	77 (15.9)	1.06	0.72 - 1.55	0.77	273	34.1	225 (82.4)	48 (17.6)	0.88	0.59 - 1.29	0.55
Location														
Semi Urban/Urban	536	67.0	454 (84.7)	82 (15.3)	1.23	0.83 -1.82	O.31	461	57.6	401 (87.0)	60 (13.0)	**1.77**	**1.21 - 2.58**	**0.00**
Rural	264	33.0	216 (81.8)	48 (18.2)				339	42.4	268 (79.1)	71 (20.9)			
Monthly Income														

More than average	241	30.1	197 (81.7)	44 (18.3)	0.81	0.55 -1.21	0.35	106	13.3	90 (84.9)	16 (15.1)	1.11	0.63 - 1.97	0.78
Less than average	559	69.9	473 (84.6)	86 (15.4)				694	86.8	579 (83.4)	115 (16.6)			
Do you Farm														
No	113	14.1	89 (78.8)	24 (21.2)	0.68	0.41 - 1.11	0.13	60	7.5	55 (91.7)	5 (8.3)	2.26	0.89 - 5.75	0.10
Yes	687	85.9	581 (84.6)	106 (15.4)				740	92.5	614 (83.0)	126 (17.0)			
Main Source of Drinking Water														
Tap	83	10.4	71 (85.5)	12 (14.5)				69	8.6	59 (85.5)	10 (14.5)			
Others	717	89.6	599 (83.5)	118 (16.5)	0.86	0.45 - 1.63	0.75	731	91.4	610 (83.4)	121 (16.6)	0.85	0.43 - 1.72	0.74
Water Treatment														
Yes	579	72.4	494 (85.3)	85 (14.7)	**0.67**	**0.45 -1.00**	**0.05**	603	75.4	501 (83.1)	102 (16.9)	1.18	0.75 - 1.85	0.51
No	221	27.6	176 (79.6)	45 (20.4)				197	24.6	168 (85.3)	29 (14.7)			
Do you wash fruits/Vegetable before eating them? 2														
No	5	0.6	4 (80.0)	1 (20.0)	1.29	0.14 - 11.64	0.59	23	2.9	15 (65.2)	8 (34.8)	2.84	1.18 - 6.83	**0.04**
Yes	795	99.4	666 (83.8)	129 (16.2)				777	97.1	654 (84.2)	123 (15.8)			
Hand Washing before Eating														
No	5	0.6	5 (100.0)	0 (0.0)	0.84	0.81 - 0.86	1.00	2	0.3	2 (100.0)	0 (0.0)	0.84	0.81 - 0.86	1.00
Yes	795	99.4	665 (83.6)	130 (16.4)				798	99.7	667 (83.6)	131 (16.4)			

Hand Washing after Toilet														
No	7	0.9	6 (85.7)	1 (14.3)	0.85	0.10 - 7.19	1.00	12	1.5	11 (91.7)	1 (8.3)	0.46	0.06 - 3.60	0.70
Yes	793	99.1	664 (83.7)	129 (16.3)				788	98.5	658 (83.5)	130 (16.5)			
Type of Toilet														
Water Closet	267	33.4	233 (87.3)	34 (12.7)	1.51	0.99 - 2.30	0.07	188	23.5	163 (86.7)	25 (13.3)	1.37	0.85 - 2.19	0.22
Bush and Pit	533	66.6	437 (82.0)	96 (18.0)				612	76.5	506 (82.7)	106 (17.3)			
Do you Swim														
No	741	92.6	621 (83.8)	120 (16.2)	0.95	0.47 - 1.92	0.86	59	7.4	44 (74.6)	15 (25.4)	0.54	0.29 - 1.01	0.07
Yes	59	7.4	49 (83.1)	10 (16.9)				741	92.6	625 (84.3)	116 (15.7)			
Do you go about barefooted?														
No	344	43.0	290 (84.3)	54 (15.7)	0.93	0.64 - 1.36	0.77	416	52.0	355 (85.3)	61 (14.7)	0.77	0.53 - 1.12	0.18
Yes	456	57.0	380 (83.3)	76 (16.7)				384	48.0	314 (81.8)	70 (18.2)			

Table 3. Bivariate logistic regression of predictors of intestinal helminthic infection

Variables	HIV sero positive			HIV sero negative		
	OR	95% CI	*P*	OR	95% CI	*P*
Socio-demographic variables						
18 - 40 years	0.80	0.54-1.21	0.29	0.72	0.48-1.09	0.12
Male	0.93	0.59-1.48	0.76	0.92	0.57-1.47	0.72
More than Primary School Edu	0.72	0.48-1.07	0.10	**0.61**	**0.38-0.97**	**0.04**
Occupation (Farming)	0.98	0.65-1.47	0.92	0.70	0.45-1.11	0.13
Rural Residence	1.31	0.87-1.96	0.20	**1.78**	**1.21-2.60**	**0.00**
Monthly Income < Mean	0.73	0.48-1.12	0.15	1.19	0.65-2.17	0.58
Daily activities/practices						
Does not treat Drinking Water	**1.60**	**1.06-2.42**	**0.02**	0.90	0.57-1.42	0.65
Does not wash Fruits and Vegetables	0.68	0.46-1.02	0.06	1.38	0.90-2.12	0.14
Uses open Bush Toilet	0.90	0.60-1.35	0.61	0.89	0.61-1.31	0.56
Does not Swim in Open Water	0.98	0.48-2.01	0.96	1.78	0.94-3.34	0.08
Does not walk Bare Foot	0.99	0.67-1.47	0.96	1.10	0.73-1.66	0.65

Some studies had a higher prevalence than ours but these studies examined intestinal parasites as a whole and therefore more likely to have many more pathogens.[26–31] The prevalence values obtained in our study were nonetheless higher than those from other studies carried out where intestinal parasites were evaluated.[32–34] This is difficult to explain but may be related to a relatively lower level of the helminths in such geographical locations, differences in methodology or host risk factors.

In most of the studies where the prevalence of intestinal parasites was assessed amongst adult HIV sero-positive and sero-negative sub-populations, the prevalence was found to be higher and often significantly so in the HIV sero-positive arm compared to the HIV sero-negative arm.[25,27–29,31–33,35–37] HIV sero-positive adults with low immunity are predisposed to gastro-intestinal opportunistic infections accounting for a higher prevalence of intestinal parasites compared to HIV sero-negative adults. This implies the importance of ensuring that HIV patients are tested and linked to ART particularly in rural settings where the risk of getting intestinal helminths is prevalent. Regarding HIV care, treatment centres must integrate treatment of intestinal helminths in high-risk rural areas as part of routine care, especially for newly enrolled clients. This is in line with the UNAIDS 2025 targets which emphasizes that 90% of people living with HIV are linked to context specific-integrated services.[38]

We found an association between having drinking water treated or not and intestinal helminthiasis in the HIV sero-positive population and this was also found in the studies in Benin and Kenya.[33,39] The location of residence and whether fruits and vegetables are washed or not before eating were associated with having intestinal helminths in the HIV sero-negative population. This is also corroborated by findings in the study done in Kenya.[39] Drinking adequate amounts of water and the intake of fruits and vegetables are very important in the maintenance of the body's biological processes however, food hygiene is critical for the prevention of intestinal helminths.[40,41] It appears that because the HIV sero-positive population had a higher proportion of person who lived in urban/semi-urban locations and had more access to potable water, a lesser proportion treat their drinking water and this may have resulted in the association between having water treated or not and intestinal helminths. The HIV sero-negative population had a higher proportion of persons who used the bush and pit latrines and also had more farmers and persons involved in farming activities and this may be responsible for the association between the intake of fruits and vegetables and intestinal helminths. Studies have shown that between 42.6 – 57.8% of fruits and vegetables collected in the market were contaminated with intestinal parasites.[42,43] This typifies how wider social determinants like potable drinking water, availability of sewage disposal facilities, food and personal hygiene underpin the prevalence of intestinal helminths in rural settings. This underscores the urgent need for interventions in this regard to reduce this social inequality in low- and middle-income countries. Such interventions will positively impact both HIV positive and negative people as a broader community benefit.

Similar studies had found HIV sero-positive status as a determinant of intestinal parasitic infection in Benin while HIV status, poor educational status and the quality of water for drinking were determinants in Cameroun.[33,37,44] Rural residence and lack of flush toilets were determinants in Kenya,[23,24] while poor personal hygiene were determinants in Eastern Ethiopia.[25] A recent visit to a rural area, food shortage and prior history of helminth infection were predictors of existing helminth infection in Zambia,[45] whereas HIV sero-positive status and poor personal hygiene were determinants in rural China.[34] In Zambia, a recent visit to a rural area, food shortage, and prior history of helminth infection were significant predictors of current helminth status,[45] while in China, an HIV sero-positive status, poor personal hygiene habits were determinants.[34] This highlights the opinion that the determinants of intestinal helminths seem to be related to the rural poor and are recurrent.

There is a paucity of studies that compared the determinants of intestinal helminth in the HIV sero-positive and sero-negative sub-populations and reported the findings of the sero-negative population as such implying that future research needs to focus on this gap.

LIMITATION OF THE STUDY

The Kato-Katz technique is a highly accurate and rapid method for *Ascaris lumbricoides* and *Trichuris trichiura*; however not so much for hookworm due to the fast degeneration of the rather delicate eggs if the slides are viewed beyond I hour of preparation. Kato-Katz technique is preferred because it is the WHO standard for the diagnosis of STHI. This limitation is not likely to influence the study results since deliberate efforts were made in reading the slide within the recommended time frame of 1 hour. The study duration was longer than envisaged because of some civil disturbances that occurred at the time of the study which affected patient turn out in the hospitals.

The study groups were matched in age, sex, educational qualification, main occupation and a number of other variables, however the study design, observational, may not be able to control for some possible indices for good health. Even though persons who had taken an antihelminth in the previous six weeks before the study commenced were excluded, some participants in the study may not have been treatment naïve to anti-helminths and this may have affected the results obtained in the study.

CONCLUSIONS

The prevalence of intestinal helminths was found to be similar among HIV positive and HIV negative arm, but they differed in the risk factors. The HIV programs in rural areas should intensify efforts to increase uptake of ART and integrate intestinal helminths treatment into ongoing care. Wider social problems and living conditions need to be urgently addressed as a broader benefit to improve the health status of rural populations.

ACKNOWLEDGEMENTS

We are grateful to the facilities where the study was conducted, the clients, research assistants and notably, the microscopists, Mr Emmanuel Richard of the Plateau State Epidemiological Unit and Mr Sati Bitrus of Vom Christian Hospital. Thanks to AIDS Prevention Initiative in Nigeria who have supported HIV treatment, prevention and support at the study sites.

FUNDING

The authors are most appreciative of the Tertiary Education Trust Fund (TETFUND) Nigeria who provided funds for the study and the University of Jos for managing the entire grant process.

AUTHORSHIP CONTRIBUTIONS

M.G., H.A., G.A., M.D., and A.M designed the study, contributed to the acquisition of data, analysed the data and co-wrote the manuscript. S.M., and J.D., contributed to the analysis of data and co-wrote the manuscript. D.M., D.S., and H.S., appraised the study and co-wrote the manuscript. All authors provided critical feedback and approved the final version of the manuscript.

COMPETING INTERESTS

The authors completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available upon request from the corresponding author) and declare no conflicts of interest.

CORRESPONDENCE TO:

Dr Suleiman E Mshelia MBBS, MPH(Sheffield), DiPM (Uk)
Department of Community Medicine
Jos University Teaching Hospital
Plateau State, Nigeria.
suleimanmshelia@gmail.com

Submitted: March 12, 2021 GMT, Accepted: April 07, 2021 GMT

REFERENCES

1. World Health Organisation. Soil transmitted helminth infections. *World Health Organisation*. Published online 2021. Accessed March 1, 2021. http://www.who.int/news-room/fact-sheet/detail

2. Adeleke OA, Yogeswaran P, Wright G. Intestinal helminth infections amongst HIV-infected adults in Mthatha General Hospital, South Africa. *Afr J Prim Health Care Fam Med*. 2015;7(1):910. doi:10.4102/phcfm.v7i1.910

3. The Millennium Development Goals. The evidence is in: Deworming helps meet the millennium development goals. Accessed March 1, 2021. http://www.who.int

4. Centre for Disease Control. World NTD Day 2020: Innovation to Elimination. World Health Organisation. Accessed March 1, 2021. https://www.who.int/teams/control-of-neglected-tropical-diseases

5. Wright JE, Werkman M, Dunn JC, Anderson RM. Current epidemiological evidence for predisposition to high or low intensity human helminth infection: A systematic review. *Parasites Vectors*. 2018;11(1). doi:10.1186/s13071-018-2656-4

6. Mohammed K, Abdullah MR, Omar J. Intestinal Parasitic Infection and Assessment of Risk Factors in North-Western , Nigeria : A Community Based Study. *Int J Pharm Med Bio Sci*. 2015;4(2):141-145.

7. Lankowski AJ, Tsai AC, Kanyesigye M, et al. Empiric Deworming and CD4 Count Recovery in HIV-Infected Ugandans Initiating Antiretroviral Therapy. Walson JL, ed. *PLoS Negl Trop Dis*. 2014;8(8):e3036. doi:10.1371/journal.pntd.0003036

8. Tefera E, Mohammed J, Mitiku H. Intestinal helminthic infections among elementary students of Babile town, eastern Ethiopia. *Pan Afr Med J*. 2015;20(50). doi:10.11604/pamj.2015.20.50.5251

9. Dybul AM. Neglected tropical diseases and HIV/AIDS. *Lancet*. 2006;368(9550):1865. doi:10.1016/s0140-6736(06)69764-x

10. Karp CL, Auwaerter PG. Coinfection with HIV and Tropical Infectious Diseases . II . Helminthic , Fungal , Bacterial , and Viral Pathogens. *HIV AIDS*. 2007;45:1208-1213.

11. Clerici M, Declich S. African Enigma: Key Player in Human Immunodeficiency Virus Pathogenesis in Developing Countries? *Cli Diag Lab Imm*. 2001;8(5):864-866.

12. Bourke CD, Maizels RM, Mutapi F. Acquired immune heterogeneity and its sources in human helminth infection. *Parasitology*. 2011;138(2):139-159. doi:10.1017/s0031182010001216

13. Borkow G, Bentwich Z. Chronic Immune Activation Associated with Chronic Helminthic and Human Immunodeficiency Virus Infections: Role of Hyporesponsiveness and Anergy. *Cli Micro Rev*. 2004;17(4):1012-1030. doi:10.1128/cmr.17.4.1012-1030.2004

14. Noblick J, Skolnik R, Hotez PJ. Linking Global HIV/AIDS Treatments with National Programs for the Control and Elimination of the Neglected Tropical Diseases. *PLoS Negl Trop Dis*. 2011;5(7):e1022. doi:10.1371/journal.pntd.0001022

15. Karshima SN. Prevalence and distribution of soil-transmitted helminth infections in Nigerian children: A systematic review and meta-analysis. *Infect Dis Poverty*. 2018;7(1):69. doi:10.1186/s40249-018-0451-2

16. Salawu AS, Asaolu SO, Sowemimo OA. Transmitted helminths among school-aged children in Saki , Oyo State. *Nigeria J Pub Health Epidemiol*. 2014;6(12):417-423.

17. Odinaka KK, Nwolisa EC, Mbanefo F, Iheakaram AC, Okolo S. Prevalence and Pattern of Soil-Transmitted Helminthic Infection among Primary School Children in a Rural Community in Imo State, Nigeria. *J Trop Med*. 2015;2015(349439):1-4. doi:10.1155/2015/349439

18. Ezeagwuna D, Okwelogu I, Ekejindu I, Ogbuagu C. The Prevalence And Socio-Economic Factors of Intestinal Helminths among primary School pupils in Ozubulu, Anambra State Nigeria. *Int J Epidemiol*. 2009;9(1):1-5.

19. Plateau State Government. *Jos South Local Government Area*. Plateau State ICT Development Agency. Plateau State Government; 2019. Accessed February 26, 2021. https://www.plateaustate.gov.ng/government/lgas/jos-south

20. Plateau State Government. Barkin Ladi LGA Plateau State Government Website. Accessed February 26, 2021. https://www.plateaustate.gov.ng

21. Abelau M, Goselle ON, Udeh EO, D-Popova DD, Popov TV. A comparative study of the prevalence of helminth parasites on HIV seropositive and seronegative individuals in Plateau State, Nigeria. *Niger Ann Nat Sci*. 2011;11(1):22-32.

22. Cerveja BZ, Tucuzo RM, Madureira AC, Langa IA, Buene T, Banze L, et al. Prevalence of Intestinal Parasites among HIV infected and HIV uninfected Patients treated at the 1 De Maio Health Centre in Muputo, Mozambique. *EC Microbiol*. 2017;9(6):231-240.

23. Martinello R. HIV-1 and Helminth Co-Infection in Adults in Kenya. Published online 2009. Accessed February 26, 2021. http://elischolar.library.yale.edu/ymtdl/368

24. Walson JL, Stewart BT, Sangaré L, et al. Prevalence and Correlates of Helminth Co-infection in Kenyan HIV-1 Infected Adults. Lyke KE, ed. *PLoS Negl Trop Dis*. 2010;4(3):e644. doi:10.1371/journal.pntd.0000644

25. Bugssa G, Dimtsu B, Tarekegn H, Kassaw M, Tafete A. 100. The Prevalence of Intestinal Parasites in HIV Positive and HIV Negative Individuals in Kobo Health Center , Northeastern Ethiopia : Comparative Cross Sectional. *British BioMed Bulletin*. Published online 2014.

26. Udeh EO, Obiezue RNN, Okafor FC, Ikele CB, Okoye IC, Otuu CA. Gastrointestinal Parasitic Infections and Immunological Status of HIV/AIDS Coinfected Individuals in Nigeria. *Ann Global Health*. 2019;85(1):1-7. doi:10.5334/aogh.2554

27. Obateru OA, Bojuwoye BJ, Olokoba AB, Fadeyi A, Fowotade A, Olokoba LB. Prevalence of intestinal parasites in newly diagnosed HIV/AIDS patients in Ilorin, Nigeria. *Alexandria J Med*. 2017;53(2):111-116. doi:10.1016/j.ajme.2016.04.001

28. Babatunde SK, Salami AK, Fabiyi JP, Agbede OO, Desalu OO. Prevalence of intestinal parasitic infestation in HIV seropositive and seronegative patients in Ilorin, Nigeria. *Ann Afr Med*. 2010;9(3):123-128. doi:10.4103/1596-3519.68356

29. Sanyaolu AO, Oyibo WA, Fagbenro-beyioku AF, Gbadegeshin AH, Iriemenam NC. Comparative study of entero-parasitic infections among HIV sero-positive and sero-negative patients in Lagos, Nigeria. *Acta Trop*. 2011;120(3):268-272. doi:10.1016/j.actatropica.2011.08.009

30. Assefa S, Erko B, Medhin G, Assefa Z, Shimelis T. Intestinal Parasitic Infections in relation to HIV/AIDS status, diarrhea and CD4 T-cell count. *BMC Infect Dis*. 2009;9(155). doi:10.1186/1471-2334-9-155

31. Hailemariam G, Kassu A, Abebe G, Abate E, Damte D, Mekonnen E. Intestinal Parasitic Infections in HIV/AID and HIV seronegative individuals in a Teaching Hospital in Ethiopia. *J Infect Dis*. 2004;57(2):41-43.

32. Oguntibeju OO. Prevalence of Intestinal Parasites in HIV-Positive/AIDS Patients. *Malaysian J Med Sc*. 2006;13(1):68-73.

33. Jegede EF, Oyeyi ETI, Bichi AH, Mbah HA, Torpey K. Prevalence of intestinal parasites among HIV/AIDS patients attending Infectious Disease Hospital Kano, Nigeria. *Pan Afr Med J*. 2014;(17):295. doi:10.11604/pamj.2014.17.295.3707

34. Akinbo FO, Okaka CE, Omoregie R. Prevalence of Intestinal Parasitic Infections among HIV patients in Benin City, Nigeria. *Libyan J Med*. 2010;5(5506). doi:10.3402/ljm.510.5506

35. Tian LG, Chen JX, Wang TP, et al. Co-infection of HIV and intestinal parasites in rural area of China. *Parasit Vectors*. 2012;5(1):36. doi:10.1186/1756-3305-5-36

36. Nkoa T, Yimagou EK, Nana RD, Kamga HG, Ketchia F, Moyou-somo R. Comparison of Intestinal Parasitic Infection among Adults with or Without HIV/ AIDS in Yaoundé and Effect of HAART and CD4 Cells Counts. *J Bacteriol Parasitol*. 2015;6(s1). doi:10.4172/2155-9597.1000208

37. Nkenfou CN, Nana CT, Payne VK. Intestinal Parasitic Infections in HIV Infected and Non-Infected Patients in a Low HIV Prevalence Region, West-Cameroon. Sued O, ed. *PLoS ONE*. 2013;8(2):e57914. doi:10.1371/journal.pone.0057914

38. 2025 AIDS Targets: 2025 Target setting and 2020-2030 resource needs and impact estimation. UNAIDS. Accessed March 8, 2021. http://www.unaids.org/en/topics/2025_target_setting

39. Centre for Disease Control and Prevention. Soil-transmitted Helminths. Global Haealth, Division of Parasitic Diseases. Accessed March 1, 2021. http://www.cdc.gov

40. International Association for Assistance to Travellers. Nigeria General Health Risks, Soil-Transmitted Helminths. Accessed March 1, 2021. http://www.iamat.org

41. Nery SV, Pickering AJ, Abate E, Asamare A, Barrett L, Benjamin-chung J, et al. The role of water, sanitation and hygiene interventions in reducing Soil-transmitted Helminths: Interpreting the evidence and identifying next steps. *BMC Parasites Vectors*. 2019;12(273). doi:10.1186/s1307.1.019.3532.6

42. Bekele F, Shumbej T. 123. Fruit and vegetable contamination with medically important helminths and protozoans in Tarcha town, Dawuro zone, South West Ethiopia. *Res Reports Trop Med*. 2019;10:19-23. doi:10.2147/rrtm.s205250

43. Tefera T, Biruksew A, Mekonnen Z, Eshetu T. Parasitic Contamination of Fruits and Vegetables Collected from Selected Local Markets of Jimma Town, Southwest Ethiopia. *Int Scholarly Res Notices*. Published online August 10, 2014:1-7. doi:10.1155/2014/382715

44. Nsagha DS, Njunda LA, Jules N, Assob C, Ayima CW, Tanue EA, et al. Prevalence and Predisposing Factors to Intestinal Parasitic Infections in HIV / AIDS Patients in Fako Division of Cameroon. *Am J Epid Infect Dis*. 2017;5(3):42-49. doi:10.1136/bmjgh-2016-000260.109

45. Modjarrand K, Vermund SH, Freedman DO, Njobvu L, Redden DT, Zulu I. Prevalence and Predictors of Intestinal Helminth Infections among Human Immunodefficiency Virus Type 1 - Infected Adults in an urban African Setting. *Am J Trop Med Hyg*. 2005;73(4):777-782. doi:10.4269/ajtmh.2005.73.777