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Prevalence of enteric parasitic infection among people living with HIV in parts of southeastern Nigeria

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Abstract:

Background: Intestinal parasites in HIV/AIDS patients increase the risk of gastroenteritis, adding to the complexity of the disease. The interactions of intestinal parasites are one of the factors leading to HIV replication and progression of AIDS. Chronic immunosuppression caused by HIV infection makes people vulnerable to parasitic infestations, and this is associated with a $CD4^+$ cell count of less than $200/mm^3$. This study is aimed at determining the prevalence of enteric parasitic infection among people living with HIV in southeast Nigeria.

Methodology: This was a cross-sectional study of 535 patients recruited from Government owned tertiary health institutions with HIV referral and center for HIV/AIDS management under the Presidents Emergency Plan for Aids Relief (PEPFAR) in the 5 states of southeast Nigeria (Abia, Anambra, Ebonyi, Enugu and Imo) from September 2018 to December 2023. The institutions included FMC-Umuahia, NAUTH-Nnewi, FMC-Abakaliki UNTH-Enugu and FMC-Owerri. Stool and blood samples collected from the participants were examined using standard methods for parasitological and haematological assessment according to the guidelines of the World Health Organization. Clinical and laboratory data were analysed using the statistical software INSTAT and SPSS version 22.0, with statistical significance set at $p<0.05$.

Results: The prevalence of intestinal parasites among the 535 patients was 43.2% (n=231). *Ascaris lumbricoides* followed by hookworm emerged as the most prevalent parasites identified with 33.3% (77/231) and 29.9% (69/231) respectively while *Schistosoma japonicum, Trichuris trichiura, and Enterobius. vermicularis* had very low prevalence of 0.9% (2/231) each. Imo State had the highest prevalence of intestinal parasitic infection (48.0%, 48/100), followed by Anambra State (46.0%, 46/100), Abia State (44.4%, 60/135), Ebonyi State (42.0%, 42/100) and Enugu State (35.0, 35/100) but the prevalence was not significantly different between the States (p=0.3870). Patients in the age groups 21-30, 31-40, 41-50 and 51-60 years had statistically significant higher prevalence and egg burden (p=0.000). The $CD4^+$ T cell count of the participants showed a statistically significant decrease ($p<0.05$) as the egg burden increases.

Conclusion: In view of the high prevalence and egg burden of intestinal parasites among HIV infected patients in this study, serious efforts must be made by appropriate government authorities to institute a regular deworming process for the populace, to reduce the egg burden of intestinal parasitosis in southeast Nigeria.

Keywords: Enteric Parasite; HIV/AIDS; $CD4^+$ T cell: egg burden; southeast Nigeria

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Prévalence des infections parasitaires entériques chez les personnes vivant avec le VIH dans certaines régions du sud-est du Nigéria

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Résumé:

Contexte: Les parasites intestinaux chez les patients atteints du VIH/sida augmentent le risque de gastro-entérite, ce qui complexifie la maladie. Les interactions entre parasites intestinaux sont l'un des facteurs favorisant la réplication du VIH et la progression du sida. L'immunosuppression chronique causée par l'infection par le VIH rend les personnes vulnérables aux infestations parasitaires, ce qui est associé à un taux de $CD4^+$ inférieur à 200/mm^3. Cette étude vise à déterminer la prévalence des infections parasitaires entériques chez les personnes vivant avec le VIH dans le sud-est du Nigéria.
Méthodologie: Il s'agissait d'une étude transversale portant sur 535 patients recrutés dans des établissements de santé tertiaires publics avec référence VIH et centre de gestion du VIH/SIDA dans le cadre du Plan d'urgence du Président pour la lutte contre le sida (PEPFAR) dans les 5 États du sud-est du Nigéria (Abia, Anambra, Ebonyi, Enugu et Imo) de septembre 2018 à décembre 2023. Les institutions comprenaient FMC-Umuahia, NAUTH-Nnewi, FMC-Abakaliki UNTH-Enugu et FMC-Owerri. Les échantillons de selles et de sang prélevés sur les participants ont été examinés à l'aide de méthodes standard d'évaluation parasitologique et hématologique conformément aux directives de l'Organisation mondiale de la santé. Les données cliniques et de laboratoire ont été analysées à l'aide du logiciel statistique INSTAT et SPSS version 22.0, avec une signification statistique fixée à p<0,05.
Résultats: La prévalence des parasites intestinaux parmi les 535 patients était de 43,2% (n=231). Français *Ascaris lumbricoides* suivi de l'ankylostome sont apparus comme les parasites les plus répandus identifiés avec respectivement 33,3% (77/231) et 29,9% (69/231) tandis que *Schistosoma japonicum, Trichuris trichiura* et *Enterobius vermicularis* avaient une très faible prévalence de 0,9% (2/231) chacun. L'État d'Imo avait la plus forte prévalence d'infection parasitaire intestinale (48,0%, 48/100), suivi de l'État d'Anambra (46,0%, 46/100), de l'État d'Abia (44,4%, 60/135), de l'État d'Ebonyi (42,0%, 42/100) et de l'État d'Enugu (35,0%, 35/100) mais la prévalence n'était pas significativement différente entre les États (p=0,3870). Les patients des tranches d'âge 21-30, 31-40, 41-50 et 51-60 ans présentaient une prévalence et une charge en œufs significativement plus élevées (p=0,000). Le taux de lymphocytes T $CD4^+$ des participants diminuait significativement (p<0,05) à mesure que la charge en œufs augmentait.
Conclusion: Compte tenu de la prévalence et de la charge en œufs élevées des parasites intestinaux chez les patients infectés par le VIH participant à cette étude, les autorités gouvernementales compétentes doivent déployer des efforts importants pour instaurer un déparasitage régulier auprès de la population afin de réduire la charge en œufs des parasitoses intestinales dans le sud-est du Nigéria.

Mots-clés: Parasite entérique; VIH/SIDA; cellules T $CD4^+$: charge en œufs; sud-est du Nigéria

Introduction:

Enteric parasitic infections are significant health concern among people living with the human immunodeficiency virus (PLWHIV) and accounts for up to 80% of HIV-related death (1). HIV exposes a person to so many opportunistic infections by side-stepping and suppression of the immune system leading to high morbidity and mortality. Enteric parasitic infections in HIV infected individual weakens the immune system faster and hasten the progression of HIV to AIDS (2). Helminthes and intestinal protozoa are the mostly implicated enteric parasite globally and have a high negative effect among HIV/AIDS patients. Co-infections of HIV/AIDS and enteric parasite is a crucial health issue in Africa where HIV infection is endemic (2). These enteric parasitic infections cause lingering diarrhea, weight loss, malnutrition making it a health threat in people living with HIV/AIDS (1).

The immunopathologic activities of enteric parasite involve the activation of T helper cells. Research has shown that HIV/AIDS infected individuals are the most vulnerable to enteric parasite infestation and a greater percentage die as a result of HIV related issues than from HIV infection alone. A decrease in the number of $CD4^+$ T helper cells below 200/mm^3 exposes the patients to opportunistic infections (3).

Enteric parasites have been reported to be the cause of diarrhea that cut across all age groups with severe impact among people with weaken immune system or life treating diseases as well as in children (1). These enteric parasites such as *Cryptosporidium parvum, Isospora belli, Microsporidia* spp, *Strongyloides stercoralis* and *Trichuris trichiura* causes severe diarrhea in immunocompromised individuals which can lead to dehydration, loss of electrolytes, malnutrition and in some cases, death (1). The mode of transmission of these enteric parasites is through fecal-oral ingestion of contaminated water or food, penetration of unbroken skin and person to person transmission (4).

There is paucity of information on the dynamics of parasitic infection in HIV/AIDS patients in southeastern part of Nigeria. The objective of this study is to determine the prevalence of enteric parasitic infection among people living with HIV/AIDS in southeastern Nigeria.

Materials and method:

Study design and setting:

A descriptive cross-sectional study was carried out to determine the prevalence of enteric parasitic infections among people living with HIV/AIDS attending the HIV clinics of selected tertiary hospitals with referral status and center for HIV/AIDS in southeast Nigeria. The hospitals are University of Nigeria Teaching Hospital (UNTH)-Enugu, Federal Medical Center (FMC)-Abakaliki, Nnamdi Azikiwe University Teaching Hospital (NAUTH)-Nnewi, Federal Medical Center (FMC)-Umuahia and Federal Medical Center (FMC)-Owerri.

Ethical approval:

Ethical clearance was obtained from the Ethics Committee of University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu State, Nigeria

Sample size calculation:

A single population-proportion was used to determine the sample size with the formula; $n = Z^2 P (1-P)/d^2$, where n = sample size, p = prevalence of intestinal parasitic infection of 40% (0.4) from a previous study determined by Abdulkadir et al., (5), d = margin of error, and Z = standard deviation at 95% confidence interval corresponding to 1.96. To account for attrition arising from the likelihood of non-compliance, 10% of the calculated sample size was adjusted to give a total of 535 patients for the study.

Inclusion/exclusion criteria and method of sampling:

The inclusion criteria for the study were patients confirmed with HIV attending the HIV clinic at the time of the study, who were willing to participate by signing the informed consent form, and who have not taken anti-parasitic drug in the one month preceding the study.

Participants were recruited using systematic sampling technique, taking the ART clinic registration book as a sampling frame. Participants who had taken any anti-parasitic drugs within the prior 4weeks were excluded.

Data collection:

A pre-designed structured questionnaire was used to collect socio-demographic characteristics of the participants in a face-to-face interview. Information such as age, sex, occupation, hand washing hygiene practices, marital status educational status etc were collected from each participant

Sample collection and processing:

Freshly voided faecal sample was collected by each participant into a stool specimen container and 5 ml of venous blood into EDTA bottle. The bottles were properly labeled with patient identification number and transported to the laboratory for processing.

Laboratory analysis of specimen:

Macroscopic examination of the stool sample was done to observe adult worms of enteric parasites, and to note the consistency and colour of the stool samples. Microscopic examination of the stool samples for parasite ova, larva, cysts or trophozoites was done using wet mount, concentration methods (formolether concentration and brine floatation method), Gram-chromotrope staining technique for *Microsporidia* and modified Ziehl Neelsen staining technique as described by Abayneh et al., (3).

The Stoll's egg count was carried out on all the faecal samples that were positive for parasitic ova in wet preparation in order to determine the egg count burden of the parasite per gram faeces of the participants as described by Jawetz et al (6).

Flow cytometer (Partec Immunocytometry system, Singapore) was used to analyze the $CD4^+$ T lymphocyte estimation as described by Flynn and Gorry (7), and haemoglobin estimation using autoanalyzer (Zybio Full Automation) according to manufacturer's instruction.

Data analysis:

Data obtained were analysed with the Chi-square (x^2) test and Odds ratio (OR) for qualitative variables and ANOVA and Student's '*t*' test for quantitative variables using the statistical software INSTAT and SPSS version 22.0. Statistical significance was set at 95% level of significance.

Results:

A total of 535 patients (167 males, 368 females) were recruited for sample collection, 231 (43.2%) were infected with one or two enteric parasites, giving an overall prevalence of intestinal parasitosis of 43.2% in the study population (Table 1).

Table 1: Prevalence of Intestinal parasitic infection in the study population

Characteristics	No of participants recruited	No of participants positive for parasite (prevalence in %)	Chi square (X^2)	Odds ratio (95% CI)	p-value
Gender					
Male	167	71 (42.5)	0.01305	0.962 (0.6643-1.391)	0.8511
Female	368	160 (43.5)			
Total	535	231 (43.2)			
Age group (years)					
<10	9	2 (22.2)	4.306	NA	0.8285
11 – 20	24	11 (45.8)			
21 – 30	49	23 (46.9)			
31 - 40	172	72 (41.9)			
41 – 50	172	77 (44.8)			
51 – 60	76	29 (38.2)			
61 - 70	26	14 (53.8)			
71 – 80	5	2 (40.0)			
81 – 90	2	1 (50.0)			
Total	535	231 (43.2)			
State					
Abia	135	60 (44.4)	4.143	NA	0.3870
Anambra	100	46 (46.0)			
Ebonyi	100	42 (42.0)			
Enugu	100	35 (35.0)			
Imo	100	48 (48.0)			
Total	535	231 (43.2)			

NA = Not applicable; CI = Confidence interval

Table 2: Frequency distribution of intestinal parasites in people living with HIV/AIDS in southeast Nigeria.

Parasites	Frequency	Percentage (%)
Ascaris lumbricoides	77	33.3
Hookworm	69	29.9
Giardia lamblia	24	10.4
Entamoeba histolytica	19	8.2
Strongyloides stercoralis	17	7.4
Cryptosporidium parvum	8	3.5
Microsporidia spp	6	2.6
Isospora belli	5	2.2
Schistosoma japonicum	2	0.9
Trichuris trichiura	2	0.9
Enterobius vermicularis	2	0.9
Total	**231**	**100.0**

Ascaris lumbricoides was the most frequently identified parasite in 77 (33.3%) of the 231 positive patients, followed closely by hookworm from 69 (29.9%), *G. lamblia* from 24 (10.4%) and *E. histolytica* from 19 (8.2%) patients. Other parasites included *S. stercoralis* from 17 (7.4%), *C. parvum* from 8 (3.5%), *Microsporidia* spp from 6 (2.6%), *I. belli* from 5 (2.2%) and *Schistosoma japonicum*, *T. trichiura*, and *Enterobius vermicularis* from 2 (0.9%) patients each (Table 2).

Table 3 provides the frequency of patients in each State who were positive for specific parasites, offering a comparative view of parasitic infection rates across the regions. Hookworm and *A. lumbricoides* were the most frequently detected parasites among the participants across the States. For example, the frequency of hookworm infection was relatively similar among the States, ranging from 23.8% in Ebonyi to 33.3% in Abia. *Ascaris lumbricoides* also shows high frequency, especially in Imo (39.6%) and Ebonyi (35.6%).

Other parasites such as *E. histolytica, S. stercoralis*, and *G. lamblia* were moderate in frequency, with *G. lamblia* showing the highest frequency in Enugu at 17.1%. *Microsporidia* spp and *S. japonicum,* showed low frequency across the States, and sometimes entirely absent, indicating that they are of less concern in the population. The frequency of other parasites such as *I. belli, T. trichiura,* and *E. vermicularis* was very low but consistent in a few States.

Table 3: Frequency distribution of intestinal parasites detected from study participants across the States

Parasites	**Abia (%)**	**Anambra (%)**	**Ebonyi (%)**	**Enugu (%)**	**Imo (%)**
Hookworm	20 (33.3)	13 (28.3)	10 (23.8)	11 (31.4)	15 (31.3)
Ascaris lumbricoides	19 (31.7)	14 (30.4)	15 (35.6)	10 (28.6)	19 (39.6)
Entamoeba histolytica	5 (8.3)	4 (8.7)	4 (9.5)	3 (8.6)	3 (6.3)
Strongyloides stercoralis	5 (8.3)	4 (8.7)	4 (9.5)	1 (2.9)	3 (6.3)
Giardia lamblia	4 (6.7)	4 (8.7)	5 (11.9)	6 (17.1)	5 (10.4)
Microsporidia spp	2 (3.3)	2 (4.3)	1 (2.4)	1 (2.9)	0
Cryptosporidium parvum	3 (5.0)	2 (4.7)	1 (2.4)	1 (2.9)	1 (2.1)
Schistosoma japonicum	0	0	0	1 (2.9)	1 (2.1)
Isospora belli	1 (1.7)	1 (2.2)	1 (2.4)	1 (2.9)	1 (2.1)
Trichuris trichiura	1 (1.7)	1 (2.2)	0	0	0
Enterobius vermicularis	0	1 (2.2)	1 (2.4)	0	0
Total	**60 (100.0)**	**46 (100.0)**	**42 (100.0)**	**35 (100.0)**	**48 (100.0)**

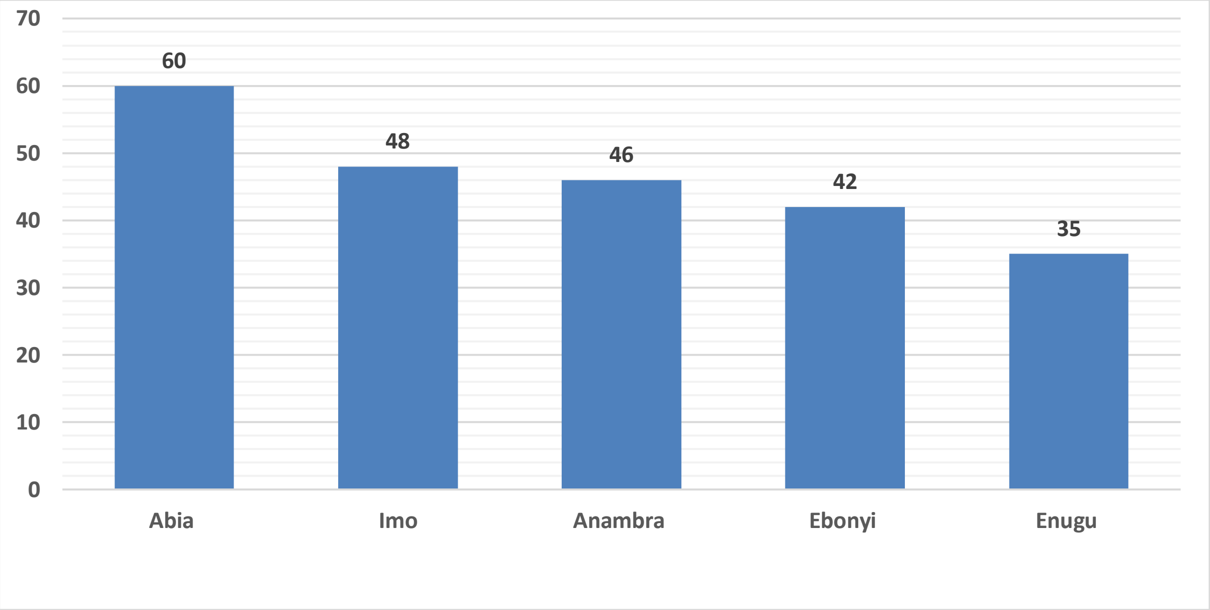

Fig 1: Frequency distribution of intestinal parasites from the study participants with respect to States

The number of participants with parasitic infection from each State (ranging from 35 in Enugu to 60 in Abia) show no statistically significant difference in the distribution of parasites across the states (p= 0.3870). This uniformity suggests that common environmental or socio-economic factors across these states might influence the overall distribution of parasitic infections among HIV/AIDS patients (Fig 1).

The frequency distribution of various parasites from HIV/AIDS patients according to sex is shown in Table 4. The total number of participants with intestinal parasitic infection in the study is 231, giving an overall prevalence of 43.2%, with a slightly higher prevalence in the females (43.5%, 160/368) than in the males 42.5%, 71/167) but no significant difference (p=0.8511). The most prevalent parasites among the patients are *A. lumbricoides* (77, 33.3%) and hookworm (69, 29.9%), with both being more frequent in females (36.9% and 31.3%) than in males (25.4% and 26.8%).

Other parasites such as *E. histolytica*, *S. stercoralis*, and *G. lamblia* show varied distributions but are less common. There is no statistically significant difference in the distribution of parasites between male and female patients (p=0.34). As shown in Fig 2, females are more frequently infected than the males across all the 5 States.

Table 4: Frequency distribution of intestinal parasites in people living with HIV/AIDS according to gender

Parasites	**Male (%)**	**Female (%)**	**Total (%)**	**X²**	***p*-value**
Hookworm	19 (26.8)	50 (31.3)	69 (29.9)	0.622	0.430
Ascaris lumbricoides	18 (25.4)	59 (36.9)	77 (33.3)	5.110	0.024
Entamoeba histolytica	8 (11.3)	11 (6.9)	19 (8.2)	0.511	0.475
Strongyloides stercoralis	5 (7.0)	12 (7.5)	17 (7.4)	0.000	0.998
Giardia lamblia	10 (14.1)	14 (8.8)	24 (10.4)	3.373	0.338
Microsporidia spp	1 (1.4)	5 (3.1)	6 (2.6)	0.598	0.439
Cryptosporidium parvum	3 (4.2)	5 (3.1)	8 (3.5)	0.149	0.699
Schistosoma japonicum	1 (1.4)	1 (0.6)	2 (0.9)	0.330	0.566
Isospora belli	4 (5.6)	1 (0.6)	5 (2.2)	5.595	0.018
Trichuris trichiura	1 (1.4)	1 (0.6)	2 (0.9)	0.330	0.566
Enterobius vermicularis	1 (1.4)	1 (0.6)	2 (0.9)	0.330	0.566
Total	**71 (30.7)**	**160 (69.3)**	**231 (100.0)**		

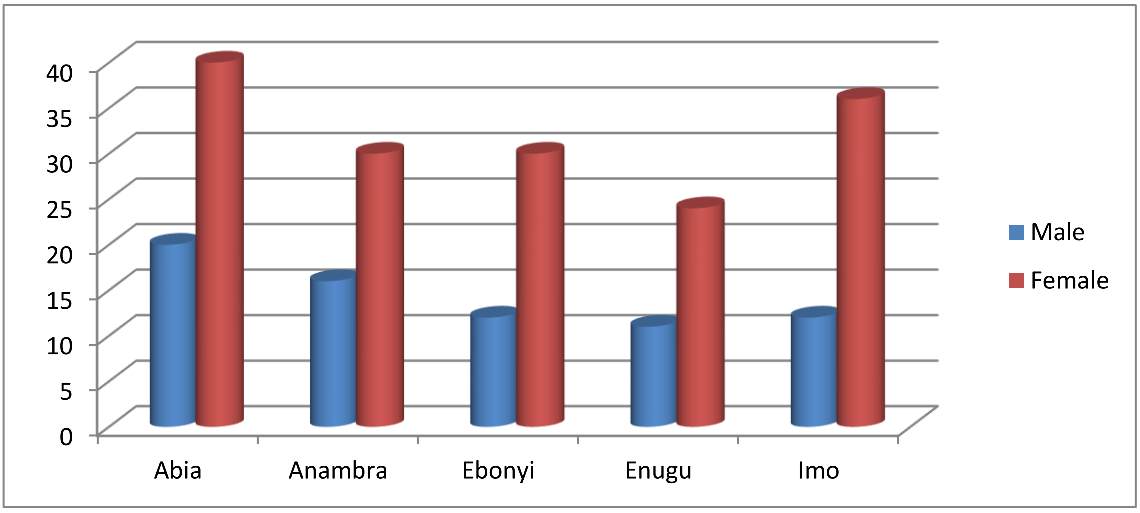

Fig 2: Frequency distribution of intestinal parasites in people living with HIV/AIDS according to States and gender

The distribution of parasitic egg burdens in relation to the CD4⁺ T cell count of the HIV/AIDS patients is presented in Fig 3. Patients with lower CD4⁺ T cell counts (100-500 cells/mm^3) had higher percentages of egg burdens, suggesting that a weaker immune system is associated with a higher load of parasitic eggs. For instance, patients with CD4⁺ T cell count in the range of 801-900/mm^3 have 66.7% egg burden, which significantly increases to 100.0% with CD4⁺ T cell count in the range of 1001-1100/mm^3, indicating severe parasitic infections as the immune system further weakens. Conversely, as CD4⁺ T cell counts increase, the percentage of parasitic egg burden generally decreases, indicating better immune responses capable of controlling parasitic infections.

The highest CD4⁺ T cell counts range of 1101-1500/mm^3 show minimal to no egg burden in the stool of the participants. The ANOVA test showed statistical significance (p=0.0005) between egg burden and CD4⁺ T cell count.

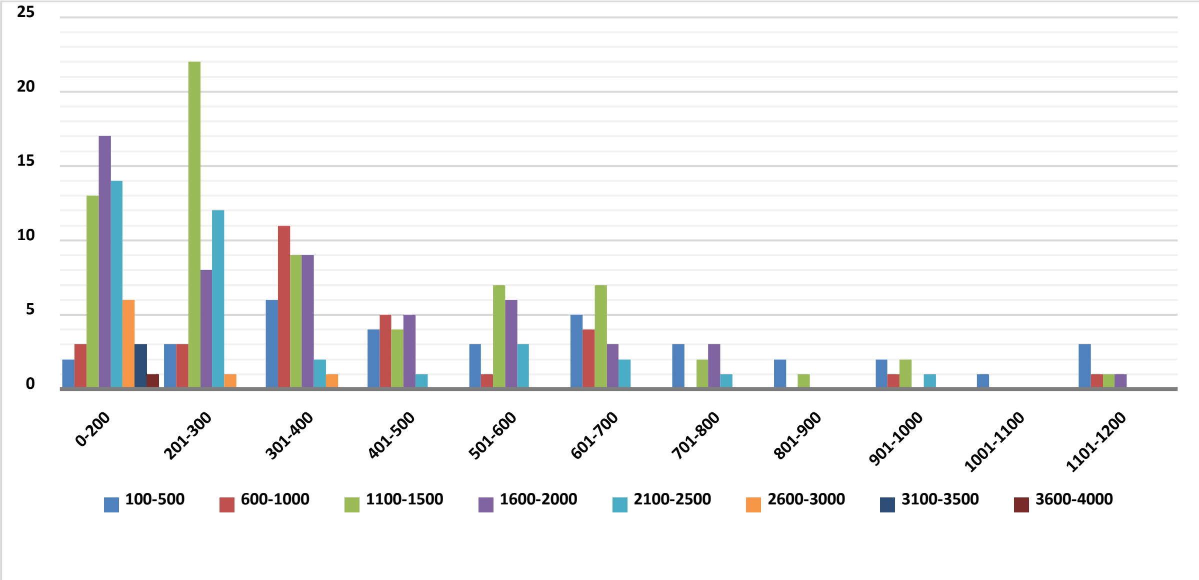

Fig 3: Distribution of egg burden with respect to CD4+ T cell count

The distribution of parasitic egg burdens among HIV/AIDS patients with respect to levels of hemoglobin (Hb) is shown in Fig 4, with a critical measure of blood health, across several defined ranges of 3 - >20.9 g/dl. The figure categorized patients into Hb level groups and related these with the intensity of their parasitic egg burdens, expressed in percentages within specific egg burden ranges (100-4000). A notable trend observed is the concentration of higher egg burdens within intermediate Hb levels, particularly in the 9-11.9% and 12-14.9% Hb ranges, where parasitic egg burdens are most prevalent. For instance, patients with Hb levels between 9-11.9% and 12-14.9% display significant percentages of egg burdens.

As Hb levels increase, (15-17.9% and 18-20.9%), there is a notable decrease in the egg burden percentages, except for a 100% occurrence in the highest Hb level (18-20.9%) within the 600-1000 egg burden range. Conversely, very low and very high Hb levels show fewer incidences of egg burdens. The ANOVA test showed statistically significant association (p=0.0001) between egg burden across different Hb levels, suggesting a complex interaction between parasitic infections and patient health as reflected in Hb levels.

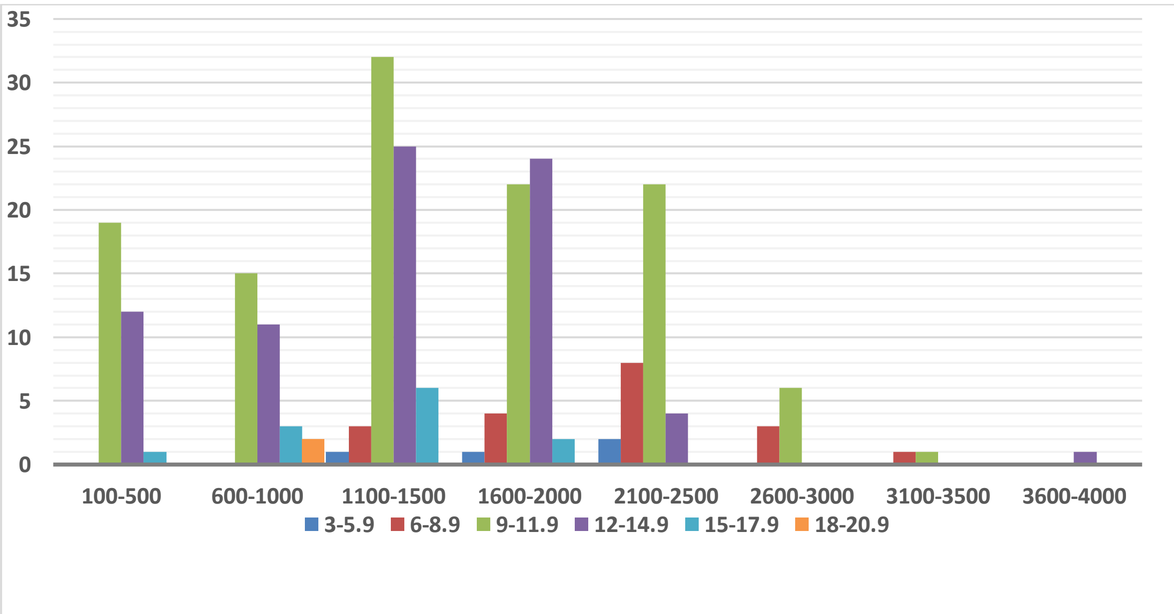

Fig 4: Distribution of egg burdens with respect to haemoglobin level

The distribution of parasitic egg burdens among various age groups, highlighting how these burdens vary across different stages of life is shown in Table 5. The highest concentrations of egg burdens are found in the middle age brackets, particularly from 21-60 years. For instance, individuals aged 21-30, 31-40, 41-50 and 51-60 years show significantly higher percentages of egg burdens (30.4%, 24.0%, 27.3% and 44.4% respectively in the 1100-1500/gram of faeces).

The table also reveals that the youngest (0-10 years) and oldest (81-90 years) age groups have lower frequencies of parasitic eggs. There was a sharp decrease in egg burdens for those above 60 years, except for a few cases in the 51-60 years age brackets. ANOVA test indicates that there is a statistically significant difference in the parasitic egg burdens across the age groups (p= 0.000).

Fig 5 provides an analysis of parasitic egg burdens across different ranges with respect to gender. The distribution indicates that females generally have higher frequency of egg burden across almost all ranges compared to males. For instance, in the 100-500 range, females show a higher frequency of 16.3% compared to 8.5% for males. This trend continues across other burden ranges, with female consistently showing higher frequency, particularly noticeable in the 1100-1500 range where females have 26.3% frequency compared to 35.2% for males.

Although males show a substantial presence in the mid to high burden ranges (1100-2000), their frequencies taper off sharply above the 2100-2500 range, indicating fewer high burden cases among males as compared to females. The Students' 't' test showed no significant difference (p=0.09) in the egg burdens between gender.

Table 5: Distribution of egg burden according to age group

Egg burden (g)/ Age group (years)	**100-500**	**600-1000**	**1100-1500**	**1600-2000**	**2100-2500**	**2600-3000**	**3100-3500**	**3600-400**
<10 (n=2)	1 (50.0)	1 (50.0)	0	0	0	0	0	0
11-20 (n=10)	1 (10.0)	0	2 (20.0)	3 (30.0)	3 (30.0)	1 (10.0)	0	0
21-30 (n=23)	3 (13.0)	2 (8.7)	7 (30.4)	6 (26.1)	4 (17.4)	1 (4.3)	0	0
31-40 (n=75)	14 (18.7)	8 (10.7)	18 (24.0)	18 (24.0)	13 (17.3)	3 (4.0)	1 (1.3)	0
41-50 (n=77)	7 (9.1)	15 (19.5)	21 (27.3)	18 (23.4)	12 (15.6)	3 (3.9)	1 (1.3)	0
51-60 (n=27)	3 (11.1)	4 (14.8)	12 (44.4)	4 (14.8)	2 (7.4)	1 (3.7)	0	1 (3.7)
61-70 (n=14)	3 (21.4)	0	6 (42.9)	4 (28.6)	1 (7.1)	0	0	0
71-80 (n=2)	0	1 (50,0)	0	0	1 (50.0)	0	0	0
81-90 (n=1)	0	0	1 (100.0)	0	0	0	0	0
Total (n=231)	**32 (13.9)**	**31 (13.4)**	**67 (29.0)**	**53 (22.9)**	**36 (15.9)**	**9 (3.9)**	**2 (0.9)**	**1 (0.4)**

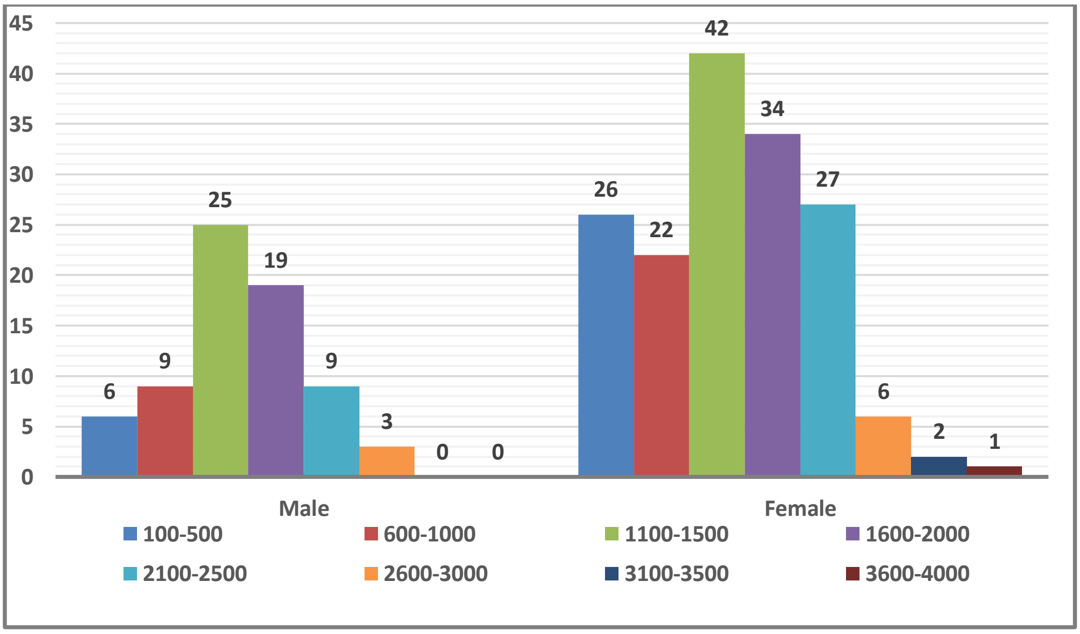

Fig 5: Distribution of egg burdens with respect to gender

Discussion:

Enteric parasitic infections are among the leading causes that intensify the condition of HIV/AIDS patients and a major cause of morbidity and mortality (8). HIV/AIDS significantly weaken the body immune system, rendering it susceptible to various opportunistic parasitic infections (9). The prevalence of enteric parasite in this study is 43.2%. This rate is similar to the study of Obature et al., (10) with 42.6%, but higher than the rate of 35.1% reported by Abanye et al., (3) in southwest Nigeria and 11.4% in a study from northern Nigeria (11). The prevalence reported is lower than those reported from other parts of the world such as 68.2% in Gabon by Legongo et al., (12), 57.5% in Cameroun (13) and 50.9% in Kenya (14), although higher than 21.1% reported by Feleke et al., (2). The variation in prevalence rates could be attributed to different sociocultural differences, parasite distribution, period of study, method of diagnosis used hygiene practices of the participants, awareness on the knowledge of prevention and control of enteric parasite in each locality.

Imo State had the highest prevalence of intestinal parasitic infection (48.0%, 48/100), followed by Anambra State (46.0%, 46/100), Abia State (44.4%, 60/135), Ebonyi State (42.0%, 42/100) and Enugu State (35.0, 35/100) but the prevalence was not significantly different between the States (p= 0.3870). This indicates that the prevalence of these parasites is relatively uniform across the regions studied. This uniformity suggests that common environmental or socio-economic factors across these States.

Ascaris lumbricoides was the most prevalent parasite identified from stool samples of people living with HIV in this study with 33.3%, followed by hookworm (29.9%), *G. lamblia* (10.4%) and *E. histolytica* (8.2%). This agrees with the work of Dibua et al., (15) in Nsukka, Nigeria, which reported *A. lumbricoides* prevalence of 28.0% and hook worm of 20.0%. Akinbo et al., (16) in Benin City, Nigeria also reported *A. lumbricoides* as the most predominant parasite amongst HIV patients and controls but contradicted the study by Akinbo and Omoregie (15) which reported a low prevalence of 5.3% for intestinal parasitic infection in HIV patients in Benin City.

The frequency of identifications of *S. stercoralis* (7.4%), *C. parvum* (3.5%), *Microsporidia* spp (2.6%), *I. belli* (2.2%), *S. japonicum* (0.9%), *T. trichiura* (0.9%) and *E. vermicularis* (0.9%) were very low, which contrasts the study by Faleke et al., (2) who reported *E. histolytica* and *E. vermicularis* as the most frequent enteric parasites and the study by Miressa et al., (17) which reported *G. lamblia* as the most frequent enteric parasite. The discrepancy could be as a result of the time of study and different parasite burden in each locality.

In this study, the prevalence of intestinal parasitic infection of 43.5% (160/368) in the females was slightly higher than 42.5% (71/167) in the males, but this was not statistically significant (p=0.8511). This agrees with the studies by Udeh et al., (18) and Jegede et al., (11) in Nigeria, who reported higher prevalence in females than males but disagrees with the study of Hotez (19) in the United States of America, where overall prevalence and intensity were higher in males than females, attributed to males being more exposed to environment conducive to the parasite vectors in agricultural settings. The slightly higher prevalence in females in our study may be due to exposure frequency because females are more engaged in agricultural activities, household activities and rural dwelling in our setting.

The effect of the parasite egg burden across different $CD4^+$ T cell and haemoglobin (Hb) ranges were demonstrated. The result indicated that there is a statistically significant relationship between $CD4^+$ T cell counts (200 cell/cm^3) and anaemia (p<0.05). The egg burden is high when $CD4^+$ T cell count and haemoglobin ranges decreases, and low as the $CD4^+$ T cell count increases. Thus, these parameters decrease in proportion to the intensity of the parasite infection. It was observed from the study, that in chronic moderate or heavy infection, there were remarkable loss of blood and depletion of the immune system resulting in marked reduction in $CD4^+$ T cell count and haemoglobin level, which leads to fatigue, loss of appetite, weight loss, gastrointestinal disorder, cough, pica, facial and peripheral edema, anaemia and other pathological features. It was also observed from the study that the higher the intensity and duration of egg burden, the worse the symptoms and pathological features observed in infected patients. Our findings agree with the studies of Abarver et al., (12), Akinbo et al., (17) and Amoo et al., (1), who reported that there are correlations between parasite intensity and reduction in haemoglobin level and $CD4^+$ T cell count.

The frequency of enteric parasites was higher in patients whose $CD4^+$ T cell counts were lower than 200 cells/µl. This observation is in line with similar studies conducted elsewhere (1,17,20). Poor immune status predisposes patients to opportunistic pathogen (3). Decreased $CD4^+$ T cell count weakens the immune system making it very difficult for patients to overcome infections they would ordinarily have overcome thus are difficult to eliminate once established (21). Wakokoo et al., (22) reported that the baseline for CD4$^+$ T cell is 500/µl and is linked to significant suppression of viral load.

The findings of our study on egg burden with respect to the age of the participants indicated that participants in the age brackets 21-30 (30.4%), 31-40 (32.5%), 41-50 (33.3%) and 51-60 (44.4%) years had statistically significant higher egg burden than other age groups ($p<0.05$). This suggests the influence of factors such as immune system variability, exposure risks, and social or environmental conditions unique to this specific age group. It could also be due to that fact that participants in these age groups were mainly youths who may be active and adventurous in life and therefore involved in activities that encourages transmission of infections. Also, there is the possibility that participants may come from poor rural home and filthy environment characterized by open defecation, bushy surroundings and habit of walking barefooted, which increase contact with contaminated soil that predisposes to parasitic infection. This is in line with the reports of previous studies (23,24).

Conclusion:

In this study, a high prevalence of enteric parasitic infection of 43.2% is reported and low CD4$^+$ T cell count was associated with high parasite egg burden. Therefore, regular screening of persons living with HIV/AIDS for enteric parasite and appropriate treatment for those positive should be encouraged to help reduce the burden and associated morbidity and mortality.

Contributions of authors:

ACC designed the study, wrote the protocol and contributed to the literature search, performed statistical analysis of data, wrote the initial manuscript draft and the final manuscript; ACC and ONF performed the laboratory works and contributed to the discussion; ONF supervised the study and proof read the manuscript. Both authors approved the final manuscript submitted for publication.

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Authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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