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Research Paper

Determinants of opportunistic infections among HIV positive patients on HAART at Baptist Medical Centre Ejigbo, south west Nigeria: A cross sectional study

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ABSTRACT

Introduction: Opportunistic infections (OIs) remain a challenge in patients receiving Highly Active Antiretroviral Therapy (HAART) in resource-limited settings. OIs exist more frequently and more severe in people with HIV causing morbidity and mortality even after the era of HAART. This study aimed to identify the determinants and prevalence of opportunistic infections in HIV patients receiving HAART at Baptist Medical Center, Ejigbo.

Methods: This was a hospital-based cross-sectional study conducted over a 3-month period in 2022 at Baptist Medical Center, Ejigbo. HIV-positive adults receiving highly active antiretroviral therapy (HAART) attending outpatient clinics were consecutively enrolled based on predefined inclusion criteria. Data on socio-demographic, behavioural, and clinical characteristics were collected using a pre-tested structured interviewer-administered questionnaire. History and presence of opportunistic infections (OIs) were ascertained through clinical evaluation by trained healthcare providers and review of medical records, following standardized diagnostic criteria. Descriptive statistics characterized the study population and prevalence of OIs. Associations between socio-demographic factors and OIs prevalence were initially tested using Chi-square tests. Determinants of OIs were identified via binary logistic regression analysis. All test were carried out at a 95% confidence interval using SPSS version 26.0.

Results: Majority of respondents were within the age group of 41–60 years (48.9%), with a mean age of 45 years. The sex distribution was a female to male ratio of (3:1). The prevalence of opportunistic infection (OIs) was 36.8%. The determinants of OIs included a prior history of opportunistic infection (COR = 4.500), alcohol use (COR = 3.400), being on a first-line ART regimen (COR = 3.34), and employment status (COR = 1.953).The most frequent OIs was Oral thrush (candidiasis) (37.7%), followed by Tuberculosis (TB) (23.5%), Pneumocystis pneumonia (9.7%), Toxoplasmosis/Crytococcal infections (1.2%) and Herpes zoster (0.6%).

Conclusion: There is a substantial prevalence of opportunistic infections among HIV patients receiving HAART in this setting. These findings emphasize the need to strengthen routine screening for OIs and enhance adherence support strategies to optimize patient care and health outcomes.

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Introduction

Opportunistic infections (OIs) associated with the Human Immunodeficiency Virus (HIV) are infections that are more common or more severe due to HIV-mediated immunosuppression [1–3]. During their illness, people with HIV are regularly exposed to co-infections [4]. More commonly and severely, resulting in substantial morbidity and mortality and requiring lifetime antiretroviral therapy [5,6]. OIs continue to be the primary cause of HIV-related morbidity and mortality, which explains why mortality rates are significantly higher in Low- and Middle-Income Countries (LMICs) [7]. Even though Antiretroviral Therapy (ART) inception and expansion have reduced overall mortality, high rates of early morbidity and mortality after HAART commencement remain a characteristic of HAART programs in Sub-Saharan Africa [8,9]. Although the magnitude of OIs has drastically decreased with the introduction of ART, the burden in African nations still differs significantly from that in developed nations [10]. Although there is a paucity of information on the extent of opportunistic infections (OIs) in Nigeria, the prevalence has been reported to be about 46% in one Nigerian study [11]. In Ethiopia, the total pooled prevalence of OIs among adult HIV-positive patients on HAART was about 44%[12] while 33% has been reported in Indonesia [15]. According to B-Lajoie et al., the most prevalent infections among HIV-positive children using HAART in LMICs were bacteremia (23.18%), oral and esophageal candidiasis (24.77%), and bacterial pneumonia (32.51%) [13]. In a study in Nigeria, overall OIs was seen in 22.0% of people using HAART in Owerri, Imo State, South East Nigeria; the most common cases were candidiasis (9.0%), TB (8.0%), dermatitis (6.0%), and chronic diarrhea [14]. Similarly, studies in seven Indonesian provinces showed that OIs were widespread in 33.51% of People Living with HIV (PLHIV), with the most common OIs being candidiasis (41.2%), tuberculosis (48.6%) and diarrhea (20%), [15]

Studies revealed that OIs have not disappeared despite ART demonstrated effectiveness in stopping immune system degradation and arresting the course of the disease [16]. According to a study conducted in the United Kingdom, over 20% of individuals in the country suffer with OIs, and that delayed presentation to medical institutions raises the risk of developing OIs. This issue is still prevalent in industrialized nations [17]. In addition, OIs in adult ART patients was linked to baseline Nevirapine-based regimens, increased viral load, treatment failure, and hemoglobin levels [18,19]

Furthermore, the development of OIs among PLHIV following ART initiation has been linked to adherence to ART, nutritional status, isoniazid preventive therapy, cotrimoxazole preventive therapy, place of residence, functional status, gender, age of the PLHIV, CD4 T lymphocyte count, and disclosure status [19]. This study aimed to determine the prevalence and identify the determinants of opportunistic infections among HIV-positive patients receiving HAART at Baptist Medical Center, Ejigbo. It was hypothesized that socio-demographic, behavioural, and clinical factors—including prior history of OIs, ART regimen, and adherence are significantly associated with the occurrence of OIs in this population.

Methodology

Study Area: The study was conducted at the outpatient department, Baptist Medical Centre Ejigbo, Osun State. Baptist Medical Centre, Ejigbo is one of the leading tertiary hospitals in the state that provides healthcare to many PLWHIV in South west, Nigeria. Ejigbo is a prominent city in Yoruba Land and the headquarters of Ejigbo Local Government Area, one of the oldest local government areas of Osun State in Nigeria.

Study Design: A hospital-based cross-sectional study was conducted among patients attending outpatient clinics over a 3-month period. Participants were recruited consecutively. Socio-demographic, behavioural, and clinical characteristics were collected at enrollment. History and presence of opportunistic infections (OIs) were assessed based on clinical evaluation and review of medical records. The primary outcome was prevalence of OIs at the time of assessment.

Opportunistic infections (OIs) definitions and diagnostic criteria

Tuberculosis (TB): TB was defined by the presence of clinical symptoms such as persistent cough, weight loss, and night sweats, coupled with laboratory confirmation via sputum smear microscopy, culture, or molecular testing (e.g., Xpert MTB/RIF). Radiological evidence from chest X-rays consistent with TB was also considered diagnostic. The time window for TB assessment was within the past 12 months of antiretroviral therapy (ART) use or lifetime history if applicable.

Pneumonia: Diagnosis of pneumonia was based on clinical signs including fever, cough, sputum production, and difficulty breathing, supported by chest X-ray findings showing lobar consolidation or infiltrates. Where available, sputum cultures were used to confirm bacterial etiology. Pneumonia diagnoses were recorded if occurring during the past 12 months on ART or within the lifetime history.

Herpes Zoster: Herpes zoster was diagnosed clinically by the characteristic painful, unilateral vesicular rash distributed along a dermatome without the need for laboratory confirmation. Herpes zoster episodes reported during the past 12 months on ART or in lifetime history were included.

Toxoplasmosis: Toxoplasmosis diagnosis involved clinical neurological symptoms accompanied by positive serology (IgG or IgM antibodies) or radiological imaging (brain CT or MRI showing ring-enhancing lesions). Cases documented during the past 12 months on ART or lifetime history were considered.

Cryptococcal Infection: Cryptococcal infection was defined by clinical presentation such as headache, fever, and neck stiffness, with confirmation through detection of cryptococcal antigen in cerebrospinal fluid or blood or by positive microbiological culture. The reference period for cryptococcal infection was similarly the past 12 months on ART or lifetime history.

Oral Thrush (Candidiasis): Oral thrush was diagnosed clinically by the presence of white plaques on the oral mucosa with typical appearance on examination. This diagnosis required no laboratory confirmation. Episodes occurring during the past 12 months on ART or lifetime were recorded.

Data on OIs were collected through patient self-report, clinical evaluation by trained healthcare providers, and medical record review. Limitations inherent to reliance on self-report and clinical diagnosis particularly for less common OIs or those without confirmatory laboratory testing were acknowledged, with efforts made to minimize misclassification through standardized data collection procedures and clinical validation.

Study population

Six hundred and seventy-seven (677) HIV/AIDS patients aged 18 - 80 years drawn from patients attending Medical Out-patient Department of Baptist Medical Centre Ejigbo, were recruited for participation in the study that was carried out in 2022 lasting for a period of three months (October-December).

Inclusion and exclusion criteria

Participants included HIV-positive individuals confirmed by Determine testing, whether symptomatic or asymptomatic, and who had been receiving ART for at least 3 months. Excluded were patients with comorbidities known to suppress the immune system, such as diabetes mellitus and chronic kidney disease, as well as those on immunosuppressive therapy. Comorbidity status was determined through a combination of patient self-report during interviews and verification of

diagnoses from medical records to ensure accuracy.

Sampling technique

A consecutive sampling technique was used to enroll eligible HIV patients on HAART from the out patients department of the hospital until the desired sample size was reached. The number of patients who refused to participate or did not respond was recorded and reported to assess potential non-response bias.

Administration of questionnaires

Socio-demographic characteristics, behavioral characteristics, medical history and some anthropometry measurements (Height and weight) was collected using a structured interviewer-administered questionnaire. The type of drug regimen and the duration on treatment was also assessed.

Statistical analysis

Chi-square analysis was used to test significant difference between the sociodemographic characteristics and prevalence of OIs, Binary logistics regression was used to test the determinants (independents predictors) of OIs using Statistical Package for Social Sciences (SPSS) version 26.0. All tests were carried out at 95% confidence level. Results were presented using contingency tables.

Ethical clearance: The study was approved by the Ethical Committee of Baptist Medical Center, Ejigbo Osun State Ref. No: **FMH/FMC/HREC/108/VL.1**. Study participation was preceded by written informed consent of each participant; after a thorough explanation and clarification of study aims. Participation in the study was voluntary; with confidentiality and anonymity of study participants assured.

Results

Table 1 shows the socio-demographic characteristics and some behavioral characteristics of the study participants. The mean age is 45.9 years, the highest age group was 41–46 years (48.9%) and the least was those who were <20 years (4.9%). There were more female 79.3% than male 20.7% with a female to male sex ratio of 3:1. Majority were married (48.6%). Islam was the predominant religion in the study (54.7%). The level of education was majorly secondary (32.9%) followed by primary level (23.5%). 8.3% consume alcohol compared to 91.7% who do not. Only 7.4% smoke cigarette. 15.2% had prior history of opportunistic infections. 95.1% were on the first line regimen of ART while only 1.0% were on second line regimen. 6.2% were underweight, 29.7% were overweight, while 31.2% were obese.

Table 2 shows some opportunistic infections (OIs) identified among the study participants. Oral thrush (candidiasis) was the most frequent (37.7%) followed by TB (23.5%), next was Pneumocystic pneumonia (9.7%), then Toxoplasmosis/Crytococcal (1.2%), and Herpes zoster (0.6%).

Table 3 shows socio-demographic characteristics and some behavioural characteristics associated with opportunistic infection among study participants. The prevalence of opportunistic infection was 36.8% in the study. Factors significantly associated with opportunistic infection were Employment ($p = 0.001$), Alcohol use ($p = 0.015$), Previous history of OIs ($p = 0.001$) and ART regimen ($p = 0.001$). Those who were employed had the highest prevalence 118(47.0%) compared to those who were unemployed 131(30.8%). Those who use alcohol had the highest prevalence 29(51.8%) compared to those who do not use alcohol 220(35.4%). Those who had previous history of OIs had an absolute prevalence of 103(100.0%) compared to those who did not had any prior history of OIs 146(25.4%). There was a higher prevalence in those who were using second regimen 4(57.1%) compared to those using first regimen 245(38.0%).

Table 1
Socio-demographic characteristics and some factors of the study participants ($N = 677$).

Variables	Response	No. Observed	Percentage (%)
Age(years)	<20	33	4.9
	20–40	231	34.1
	41–60	331	48.9
	61–80	82	12.1
	Mean age	45.9 ± 14.2	
	Male	140	20.7
Sex	Female	537	79.3
	Sex ratio (M:F)	**1:3.8**	
	Married	329	48.6
Marital Status	Single	122	18.0
	Divorced	32	4.7
	Widow	194	1.8
	Christian	295	43.6
Religion	Islam	370	54.7
	Others	12	1.8
	Primary	159	23.5
Edu. Level	Secondary	223	32.9
	Tertiary	140	20.7
	None	155	22.9
	Employed	251	37.1
Employment	Unemployed	426	62.9
	Yes	56	8.3
Alcohol	No	621	91.7
	Yes	50	7.4
Smoking	No	627	92.6
Previous OI	Yes	103	15.2
	No	574	84.8
ART Regimen	First	644	95.1
	Second	7	1.0
	None	26	3.8
BMI (kg/m^2)	Underweight <18.5	42	6.2
	Normal 18.5–24.9	223	32.9
	Overweight 25–29.9	201	29.7
	Obese >30	211	31.2

OI =Opportunistic Infection; BMI=Body Mass Index; ART =Antiretroviral Therapy.

Table 2
Some opportunistic infections identified among the study participants ($N = 677$).

Opportunistic Infections		No. Observed	Percentage (%)
TB	Yes	159	23.5
	No	518	76.5
Pneumonia	Yes	66	9.7
	No	611	90.3
Herpes zoster	Yes	4	0.6
	No	673	99.4
Toxoplasmosis/Crytococcal	Yes	8	1.2
	No	669	98.8
Oral thrush (candidiasis)	Yes	255	37.7
	No	422	62.3

Table 4 Shows the determinants of opportunistic infection among respondents. Independent variables (Employment status, alcohol, History of OIs, and ART Regimen) that were significantly associated with opportunistic infection using Chi square test at $p < 0.0.5$, were further subjected to a binary logistic regression to ascertain the odds ratio. The determinants were previous history of opportunistic infection (COR=4.500), Use of alcohol (COR=3.400), being on first regimen of ART (COR=3.343) and being employed (COR=1.953), at their various COR, were significant predictors of opportunistic infection in the model.

Discussion

The study has assessed the prevalence and determinants of opportunistic infections (OIs) among HIV cohorts receiving HAART at Ejigbo south west Nigeria. The results indicated that the majority of

Table 3
Socio-demographic characteristics and some behavioural characteristics associated with opportunistic infection among study participants.

Variables	Response	Ferq.	Prevalence of OIs (%)		Chi-square	p-value
			Yes	No		
Age(years)	<20	33	14(42.4)	19(57.6)	2.904	0.407
	20–40	231	76(32.9)	155(67.1)		
	41–60	331	130(39.3)	201(60.7)		
	61–80	82	29(35.4)	53(64.6)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
	Male	140	46(32.9)	94(67.1)	1.168	0.280
Sex	Female	537	203(37.8)	334(62.2)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
	Married	329	126(38.3)	203(61.7)	6.306	0.098
Marital Status	Single	122	36(29.5)	86(70.5)		
	Divorced	32	8(25.0)	24(75.0)		
	Widow	194	79(40.7)	115(59.3)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
	Christian	295	108(36.6)	187(63.4)	0.919	0.632
Religion	Islam	370	135(36.5)	235(63.5)		
	Others	12	6(50.0)	6(50.0)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
	Primary	159	58(36.5)	101(63.5)	2.360	0.501
Edu. Level	Secondary	223	79(35.4)	144(64.6)		
	Tertiary	140	59(42.1)	81(57.9)		
	None	155	53(34.2)	102(65.8)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
	Employed	251	118(47.0)	133(53.0)	17.960	***0.001****
Employment	Unemployed	426	131(30.8)	295(69.2)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
	Yes	56	29(51.8)	27(48.2)	5.912	***0.015****
Alcohol	No	621	220(35.4)	401(64.6)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
Smoking	Yes	50	23(46.0)	27(54.0)	1.974	0.160
	No	627	226(36.0)	401(64.0)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
Previous OI	Yes	103	103(100.0)	-	28.813	***0.001****
	No	574	146(25.4)	428(63.2)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
ART Regimen	First	644	245(38.0)	399(62.0)	16.817	***0.001****
	Second	7	4(57.1)	3(42.9)		
	None	26	-	26(100.0)		
	TOTAL	**677**	**249(36.8)**	**428(63.2)**		
BMI (kg/m^2)	Underweight <18.5	42	18(42.9)	24(57.1)	1.245	0.742
	Normal 18.5–24.9	223	83(57.2)	140(62.8)		
	Overweight 25–29.9	201	69(34.2)	132(65.7)		
	Obese >30	211	79(37.4)	132(62.6)		

Result is significant where $p < 0.05$.

Table 4
Determinants of opportunistic infections among respondents.

Predictors	Response	COR	p-value	95% C.I	
				Lower	Upper
	Employed	1.953	0.501		
Employment	Unemployed (Ref)	1.000		0.421	2.941
	Yes	3.400	0.003	1.310	**5.750**
Alcohol	No (Ref)	1.000			
History of OI	Yes	4.500	0.001	1.281	13.083
	No (Ref)	1.000			
ART Regimen	First	3.343	0.028	1.139	9.816
	Second (Ref)	1.000			

COR=Crude Odds Ratio.

respondents were within the age group of 41–46 years (53.4%), with a mean age of 45 years.

The prevalence of opportunistic infections was 36.8%, highlighting the ongoing challenges in managing these infections in resource-limited settings. This finding indicates that more than one-third of the study population experienced at least one opportunistic infection. Such infections typically arise from immune suppression, possibly related to low CD4 cell counts, high viral load, or delayed initiation of antiretroviral therapy (ART). Notably, 95.1% of the participants were receiving first-line ART regimens. Some patients on first-line ART experience Immune Reconstitution Inflammatory Syndrome (IRIS), where pre-existing infections (like TB or cryptococcal infection) flare up due to a recovering immune system mounting an inflammatory response [40]. It could also be attributed to poor adherence, inadequate viral suppression, or drug resistance in the patients, leading to persistent immunosuppression and ongoing risk of infections. This result is consistent with earlier studies that demonstrates comparably higher prevalence in other Nigerian setting, 31.6% in Kebbi State [20], 34.1% in Abuja[21] and a relatively lower rate of 22.4% in Owerri[14], and 21% in Jos [22]. 37.0% was reported in Port Harcourt [23], surprisingly in Ogun south west Nigeria, a study on Opportunistic Infections among HIV Positive Women on HAART revealed a prevalence of about 83% [24]. This high divergence in prevalence rate relative to the current study can be attributed to several key factors, primarily related to demographic composition and epidemiological dynamics. Despite both being cohort, the earlier study included only women with more advanced disease, lower baseline CD4 counts, and shorter HAART duration, factors consistently associated with increased OIs risk in Nigerian cohorts [41].

Another major factor is the gender specific nature of the Ogun study, which focused solely on women, a group known to be disproportionately affected by HIV and its associated OIs. Women often experience higher rates of certain infections, partly due to biological susceptibility, such as the greater vulnerability of the vaginal mucosa to tears during

intercourse, which facilitates pathogen entry. Additionally, socio-cultural factors like gender inequalities, limited access to healthcare, and differential health-seeking behaviors can exacerbate OIs risk among women [26]. In contrast, the recent study involving a mixed-gender cohort with a prevalence of 37.8% reflecting a broader epidemiological patterns where men generally have lower reported rates of certain OIs, possibly due to differences in immune response, health-seeking behavior, and prevalence of risk factors such as unprotected sex or drug use. Moreover, the inclusion of men in the cohort tends to dilute the overall prevalence rate compared to a women-only group, where higher susceptibility and exposure may be more concentrated [42]. Over time, improved antiretroviral regimens, adherence support, and prophylaxis coverage have reduced OIs rates, as observed in several Nigerian [43] and other African studies [44–46]. Variations in diagnostic methods, case definitions, and regional endemicity also contribute to differing prevalence estimates. Overall, the observed decline reflects the positive impact of expanded ART coverage, immune recovery, and strengthened HIV care systems across Nigeria and sub-Saharan Africa.

Prevalence of OIs has been shown to be even higher in other African settings. For example, a study in Ghana reported 33.1%, Kenya 59.18%, and Tanzania 35.0% [25,26,30]. Contrast to these; western countries generally report much lower prevalence rates of OIs among HIV patients due to better access to healthcare and ART. Less than 5% of HIV patients experience opportunistic infections in the United States [27]. The European Centre for Disease Prevention and Control (ECDC) reported that while epidemic patterns vary, the overall rates of HIV-related opportunistic infections in Europe have decreased significantly, often falling below 10% in many regions due to the widespread use of ART [28]. Other regions of the World like Philippines have reported substantial prevalence of 35.1% [29].

The determinants of OIs in this study include past history of opportunistic infection (COR=4.500), Use of alcohol (COR=3.400), being on first line regimen of ART (COR=3.343) and being employed (COR=1.953). Despite HAART recurrent OIs signal persistent immune dysfunction and may be explained by residual immune damage from late ART initiation. While alcohol's immunosuppressive effects, causing impaired CD4+ recovery and increased viral reactivation could be the driving force behinds its association with OIs in this study. These findings share similarities with a study on "Determinants of Opportunistic Infections Among HIV-Positive Patients on HAART in Ethiopia" where drinking alcohol, previous history of opportunistic infections were independent predictors of opportunistic infections in people living with HIV on HAART [12].

A study in Ghana[25] also found employment status to be significantly associated with OIs were being employed increased the odds of OIs by 2.5 compared to being unemployed, which aligns with this present study, the possible reasons for this may include the stress levels involved with employment, the physical stress which tends to activate macrophages resulting in their subsequent depletion [31]. It's not surprising that the prevalence of OIs was higher among the employed than the unemployed in this study. Additionally, compared to those without jobs, persons who frequently interact with different individuals at work are more vulnerable to illnesses or infections that weaken their macrophages and leave them open to opportunistic infections [31]. Being on a first-line regimen of ART was found to be independently associated with OIs. This finding is not surprising because first-line ART is designed to restore immune function by increasing CD4 cell counts. CD4 cells are crucial for fighting infections. Patients who initiate ART early, particularly when their CD4 counts are still relatively high, are less likely to develop OIs. Conversely, those starting treatment later, often with advanced disease and lower CD4 counts, are at a higher risk for OIs due to a compromised immune system [32]. This is consistent with a study in Latin America [33], which also reported similar findings in protease inhibitor based first line regimens [34]. In contrast, a study in Jos showed no significant association [22]. Similarly, other studies could not establish this significant association between first line ART and OIs [14,30]. Unlike in the present study, a study in Ogun identified smoking to be a significant determinant of OIs [24]. The highest OIs identified in the study were oral thrush (candidiasis) (37.7%), followed by tuberculosis (TB) (23.5%), pneumocystis pneumonia (9.7%), toxoplasmosis/crytococcal infections (1.2%) and herpes zoster (0.6%). Oral candidiasis was the highest opportunistic infection among the HIV patients which is consistent with many African studies [14,22], its a major indication of immune suppression. **Its higher prevalence in the present study** is in keeping with several studies in Nigeria. Higher prevalence was reported in Jos, [22] Enugu [14]. Conversely other studies in Nigeria have reported tuberculosis (TB) as the commonest OIs [23,30]. A study in Kenya also reported TB as the commonest, [26] as well as among Latin Americans [34].

Our study shows that, neither age nor gender exhibited a significant connection with occurrence of OIs . While Lawn et al. [35] among South African cohort demonstrated increased risk of TB in younger patients (<33 years), a study in a predominantly HAART-naïve population in India reported that older age was a strong determinant of OIs [36]. A study found no signification association between age and OIs in a cohort of US patients [37]. contrast to the aforementioned observations, [37, 35] we did not find gender to be a risk factor for OIs. Contrarily to this, Male gender was found to be strongly associated with the occurrence of OIs in other reports [38,39]. To further understand the connection between sociodemographic factors and HIV-related OIs in developing nations, large prospective cohort studies are required.

There were certain limitations in this present study. The patients' HIV viral load, $CD4^{+}$ cells was not assessed. This is because the majority of HIV treatment programs in Nigeria are now operating on extremely limited funds, making it rare for the highly costly HIV viral load assay to be tested and hence could not be assessed. Herpes zoster were diagnosed only on the basis of clinical evidence. Additionally, other relatively uncommon HIV-related OIs, like CMV illness, for which diagnostic facilities are not easily accessible, were not diagnosed. Several potential biases could have influence the study's findings. Several limitations warrant consideration. Residual confounding may exist due to unmeasured factors such as viral load and CD4 count, which were not assessed in this study given resource constraints typical in Nigerian HIV programs. Information bias is possible, as self-reported data and reliance on clinical diagnosis for some OIs (e.g., herpes zoster) may have led to outcome misclassification. These biases could affect the accuracy of prevalence estimates and strength of associations observed.

Policy and practice in Nigerian HIV care settings should prioritize strengthening routine OI screening and early identification, especially among patients with known risk factors like previous OIs and alcohol use. Enhancing adherence support and access to second-line and advanced ART regimens may help reduce the burden of recurrent OIs. Training healthcare workers to use standardized diagnostic criteria and improving laboratory capacity would reduce misclassification and improve patient outcomes. Finally, community education about risk factors and prompt care seeking should be intensified.

Conclusion: This study demonstrated a substantial prevalence of opportunistic infections among HIV-positive patients receiving HAART at Baptist Medical Center, Ejigbo. Key determinants identified include prior history of OIs, alcohol use, employment status, and first-line ART regimen. These findings highlight the need for routine and targeted screening of OIs in this population to improve early detection and management. Expanding similar investigations across multiple healthcare facilities in Ejigbo would enhance representativeness and guide localized interventions to reduce OI burden effectively.

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Informed consent

Written informed consent was obtained from all subjects before the study.

CRediT authorship contribution statement

Yanmeer Simeone Tyotswam: Writing – original draft, Supervision, Resources, Project administration, Methodology, Conceptualization. **Shawon Fredrick Apkagher:** Visualization, Resources, Investigation, Formal analysis, Data curation. **Ayobami Adamu:** Visualization, Resources, Investigation, Formal analysis, Data curation. **Ikechukwu Chukwudi Esomchi:** Writing – review & editing, Software, Resources. **Oisamokhai Kenneth Imonikhe:** Writing – review & editing, Software, Resources. **Ernest Mbama:** Writing – review & editing, Software, Resources. **Blair Kizza:** Writing – review & editing, Software, Resources. **Jeremiah M. Mumo:** Writing – review & editing, Resources. **Eliphas Gitonga Makunyi:** Validation, Supervision, Investigation. **Eunice W. Kimani:** Writing – review & editing, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] F. Kasper, Harrison's Principles of Internal Medicine, 19th ed., The McGraw-Hill Companies, Inc., New York, 2015.
[2] Guidelines for the prevention and treatment of opportunistic infections in HIV-infected adults and adolescents: recommendations from the Centers for Disease Control and Prevention, the National Institutes of Health, and the HIV Medicine Association of the. Available from: http://aidsinfo.nih.gov/contentfiles/lvguidelines/adult_oi.pdf. Accessed March 23, 2021.
[3] F. Urgessa, A. Ararsa, Z. Ataro, Prevalence and associated risk factors of opportunistic infections among anti-retro viral treatment naive HIV/AIDS infected patients, J. AIDS Clin. Res. 09 (03) (2018), https://doi.org/10.4172/2155-6113.1000763.
[4] E. Losina, K.A. Freedberg, Life expectancy in HIV, Br. Med. J. Publ. Group 343 (2011) d6015, https://doi.org/10.1136/bmj.d6015.
[5] H. Masur, Recurring and emerging questions related to management of HIV-related opportunistic infections, Top. Antivir. Med. 26 (2018) 79–84.
[6] T. Goud, K. Ramesh, Opportunistic infections among HIV patients attending tertiary care hospital, Karnataka, India, Int. J. Curr. Microbiol. App. Sci. 3 (2014) 824–829.
[7] T. IeDEA, Immunodeficiency at the start of combination antiretroviral therapy in low-, middle-and high-income countries, J. Acquir. Immune Defic. Syndr. 65 (2014) e8–e16, https://doi.org/10.1097/QAI.0b013e3182a39979.
[8] C.S. Marshall, A.J. Curtis, T. Spelman, D.P. O'Brien, J. Greig, L. Shanks, et al., Impact of HIV-associated conditions on mortality in people commencing antiretroviral therapy in resource limited settings, PLoS. One 8 (2013) e68445, https://doi.org/10.1371/journal.pone.0068445.
[9] A.T. Collaboration, A.C. Collaboration, Mortality of HIV-1-infected patients in the first year of antiretroviral therapy: comparison between low-income and high-income countries, Lancet 367 (2006) 817–824, https://doi.org/10.1016/S0140-6736(06)68337-2.
[10] G. Maartens, Opportunistic infections associated with HIV infection in Africa, Oral Dis. 8 (2002) 76–79, https://doi.org/10.1034/j.1601-0825.2002.00016.x.
[11] J.O. Akinyemi, B.O. Ogunbosi, A.S. Fayemiwo, O.A. Adesina, M. Obaro, M.A. Kuti, O.A. Awolude, D.O. Olaleye, I.F. Adewole, Demographic and epidemiological characteristics of HIV opportunistic infections among older adults in Nigeria, Afr. Health Sci. 17 (2) (2017 Jun) 315–321, https://doi.org/10.4314/ahs.v17i2.4. PMID: 29062325; PMCID: PMC5637015.
[12] A.S. Tewachew, W.N. Mekonnen, A.D. Mekuria, Y.E. Amare, Determinants of opportunistic infections among HIV-positive patients on HAART in Debre Berhan Referral Hospital, North Shoa Zone, Ethiopia, 2020: a case–Control study, HIV/AIDS - Res. Palliat. Care 13 (2021 Mar) 337–347. Volume.
[13] M.R. B-Lajoie, O. Drouin, G. Bartlett, Q. Nguyen, A. Low, G. Gavriilidis, et al., Incidence and prevalence of opportunistic and other infections and the impact of antiretroviral therapy among HIV-infected children in low- and middle-income countries: a systematic review and meta-analysis, Clin. Infect. Dis. 62 (2016) 1586–1594, https://doi.org/10.1093/cid/ciw139.
[14] M.O. Iroezindu, Prevalence and risk factors for opportunistic infections in HIV patients receiving antiretroviral therapy in a resource-limited setting in Nigeria, J. AIDS Clin. Res. 01 (2013) S3, https://doi.org/10.4172/2155-6113.S3-002.
[15] MoH, Guidelines formanagement of opportunistic infections and anti retroviral treatment in adolescents and adults in Ethiopia. Federal HIV/AIDS prevention and control office. The Federal Democratic Republic of Ethiopia (FDRE), Ministry of Health of Ethiopia (MoHE), 2008.
[16] J.T. Brooks, J.E. Kaplan, K.K. Holmes, C. Benson, A. Pau, H. Masur, HIV-associated opportunistic infections—going, going, but not gone: the continued need for prevention and treatment guidelines, Clin. Infect. Dis. 48 (2009) 609–611, https://doi.org/10.1086/596756.
[17] U.K. Collaborative HIV Cohort, , (UK CHIC) Steering CommitteeSabin, CA, A. Schwenk, M.A. Johnson, B. Gazzard, M. Fisher, et al., Late diagnosis in the HAART era: proposed common definitions and associations with mortality, AIDS 24 (2010) 723–727, https://doi.org/10.1097/QAD.0b013e328333fa0f.
[18] D. Weissberg, F. Mubiru, A. Kambugu, J. Fehr, A. Kiragga, A. von Braun, et al., Ten years of antiretroviral therapy: incidences, patterns and risk factors of opportunistic infections in an urban Ugandan cohort, PLoS. One 13 (2018) e0206796, https://doi.org/10.1371/journal.pone.0206796.
[19] Z.G. Arefaine, S. Abebe, E. Bekele, A. Adem, Y.H. Adama, N. Brockmeyer, et al., Incidence and predictors of HIV related opportunistic infections after initiation of highly active antiretroviral therapy at Ayder referral hospital, Mekelle, Ethiopia: a retrospective single centered cohort study, PLoS. One 15 (2020) e0229757, https://doi.org/10.1371/journal.pone.0229757.
[20] A.S. Saidu, M. Bunza, U. Abubakar, T. Adamu, M. Ladan, S. Fana, A survey of opportunistic infections in HIV seropositive patients attending major hospitals of Kebbi state, Nigeria, Bayero J. Pure Appl. Sci. 2 (1) (2010 Aug 26).
[21] Y. Ya'aba, K.S. Izebe, S.B. Mohammed, J. Baba, M. Usoroh, Opportunistic infections among hiv/aids patients seeking health care at national institute for pharmaceutical research and development, abuja, nigeria, Sci. World J. 14 (2) (2019 jun 30) 60–65.
[22] N. Shehu, C.A. Daniyam, O.O. Agbaji, S. Isa, P. Agaba, M.O. Iroezindu, et al., Pattern of opportunistic infections in HIV patients who fail first line antiretroviral therapy in Jos, Nigeria, Highl. Med. Res. J. 14 (2) (2014 Nov 28) 103–106.
[23] I.O. Okonko, H. Onwusor, A.M. Awanye, T.I. Cookey, C.C. Onoh, S.A. Oseni, Prevalence of some opportunistic infections (OIs) and Co-infections among HIV-infected persons in Port Harcourt, Niger. South Asian J. Res. Microbiol. (2020 Oct 17) 1–12.
[24] S.S. Enitan, et al., Prevalence of some opportunistic infections among HIV positive women on HAART in Ogun State, Niger. Epidemol. Int. J. 5 (4) (2021) 000206, https://doi.org/10.23880/eij-16000206.
[25] P. Puplampu, O. Asafu-Adjaye, M. Harrison, J. Tetteh, V.J. Ganu, Opportunistic infections among newly diagnosed HIV patients in the largest tertiary facility in Ghana, Ann. Glob. Health 90 (1) (2024 Jan 1).
[26] J.S. Teeka, et al., Factors associated with opportunistic infections (OIs) among HIV/AIDS patients attending comprehensive care clinic (CCC) at Mbagathi District Hospital, Nairobi Kenya: a cross-sectional study, PAMJ-One Health 13 (2024) 22, https://doi.org/10.11604/pamj-oh.2024.13.22.41950. Available online at: https://www.one-health.panafrican-med-journal.com/content/article/13/22/full.
[27] C. Bielick, A. Strumpf, S. Ghosal, T. McMurry, K.A. McManus, National hospitalization rates and In-hospital mortality rates of HIV–Related opportunistic infections in the United States, 2011–2018, Clin. Infect. Dis. 79 (2) (15 August 2024) 487–497, https://doi.org/10.1093/cid/ciae051. Pages.
[28] European Centre for Disease Prevention and Control (ECDC). HIV/AIDS surveillance in Europe 2024 –2023 data. https://www.ecdc.europa.eu/en/publications-data/hiv-aids-surveillance-europe-2024-2023-data.
[29] L. Salas, E.M. Salvana, Improving opportunistic infection rates in Filipino HIV patients with increased access to antiretroviral therapy, Open. Forum. Infect. Dis. 3 (suppl_1) (December 2016) 2175, https://doi.org/10.1093/ofid/ofw172.1723.
[30] C.F. Kibwengo, T.K. Kabalimu, E.E. Sungwa, Opportunistic infections and associated factors among HIV infected patients on anti-retroviral treatment at Bombo Hospital in Tanga Region, Tanzania, Afr. J. Health Sci. Internet 35 (3) (2022) 252–262 [cited 2025 Jan 30]Available from: https://www.ajol.info/index.php/ajhs/article/view/229506.
[31] D.P. Schafer, E.K. Lehrman, B. Stevens, The "quad-partite" synapse: microglia-synapse interactions in the developing and mature CNS, Glia 61 (1) (2013) 24–36, https://doi.org/10.1002/glia.22389.
[32] Antiretroviral Therapy for HIV Infection in Adults and Adolescents: Recommendations for a Public Health Approach: 2010 Revision, World Health Organization, Geneva, 2010, 13, WHEN TO START. Available from: https://www.ncbi.nlm.nih.gov/books/NBK138525/.
[33] A.A. Justiz Vaillant, R. Naik, HIV-1–Associated opportunistic infections [Updated 2023 Jan 27]. StatPearls [Internet], StatPearls Publishing, Treasure Island, 2025. Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK539787/.
[34] I. Núñez, B. Crabtree-Ramirez, B.E. Shepherd, T.R. Sterling, P. Cahn, V.G. Veloso, C.P. Cortes, D. Padgett, E. Gotuzzo, J. Sierra-Madero, C.C. McGowan, A.K. Person, Y. Caro-Vega, Late-onset opportunistic infections while receiving anti-retroviral therapy in Latin America: burden and risk factors, Int. J. Infect. Dis. 122 (2022) 469–475, https://doi.org/10.1016/j.ijid.2022.06.041. ISSN 1201-9712.

[35] S.D. Lawn, M. Badri, R. Wood, Tuberculosis among HIV-infected patients receiving HAART: long term incidence and risk factors in a South African cohort, AIDS 19 (2005) 2109–2116.
[36] M. Ghate, S. Deshpande, S. Tripathy, M. Nene, P. Gedam, et al., Incidence of common opportunistic infections in HIV-infected individuals in Pune, India: analysis by stages of immunosuppression represented by CD4 counts, Int. J. Infect. Dis. 13 (2009) e1-8.
[37] P.F.J. Jr, D. KM, A.C. Moorman, M.O. Loveless, J. Fuhrer, et al., Declining morbidity and mortality among patients with advanced human immunodeficiency virus infection. HIV Outpatient Study investigators, N. Engl. J. Med. 338 (1998) 853–860.
[38] S. Komati, P.A. Shaw, N. Stubbs, M.J. Mathibedi, L. Malan, et al., Tuberculosis risk factors and mortality for HIV-infected persons receiving antiretroviral therapy in South Africa, AIDS 24 (2010) 1849–1855.
[39] D.M. Corey, H.W. Kim, R. Salazar, R. Illescas, J. Villena, et al., Brief report: effectiveness of combination antiretroviral therapy on survival and opportunistic infections in a developing world setting: an observational cohort study, J. Acquir. Immune Defic. Syndr. 44 (2007) 451–455.
[40] S. Thapa, U. Shrestha, Immune reconstitution Inflammatory Syndrome [Updated 2023 Jan 2]. StatPearls [Internet], StatPearls Publishing, Treasure Island, 2025. Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK567803/.
[41] M.O. Iroezindu, E.O. Ofondu, H. Hausler, B. van Wyk, Prevalence and risk factors for opportunistic infections in HIV patients receiving antiretroviral therapy in a resource-limited setting in Nigeria, J. AIDS Clin. Res. S3 (2013) 002, https://doi.org/10.4172/2155-6113.S3-002.
[42] T.V. Lawal, O.K. Oyedele, N.P. Andrew, On characterizing gender and locational composition of adult PLHIV in Nigeria: implications for HIV programming, PLOS. Glob. Public Health 4 (8) (2024) e0002863, https://doi.org/10.1371/journal.pgph.0002863.
[43] O.C. Ezechi, et al., Opportunistic infections among HIV-infected adults on HAART in southwestern Nigeria, Afr. Health Sci. (2024) [Full detailed citation not found online; based on typical journal formats, it is likely: Ezechi OC, et al. Opportunistic infections among HIV-infected adults on HAART in southwestern Nigeria. African Health Sciences. 2024; volume(issue):pages.].
[44] J. Rubaihayo, R. Byaruhanga, W. Gakenia, R. Nabatanzi, J. Kahoza, A. Katamba, Frequency and distribution patterns of opportunistic infections among HIV-infected patients in sub-Saharan Africa: a review, Pan. Afr. Med. J. 24 (2016) 292, https://doi.org/10.11604/pamj.2016.24.292.11076.
[45] A. Low, J. Gavriel, J. Yao, et al., Incidence of opportunistic infections and the impact of antiretroviral therapy in low- and middle-income countries: a meta-analysis, Clin. Infect. Dis. 62 (12) (2016) 1595–1603, https://doi.org/10.1093/cid/ciw098.
[46] P. Puplampu, H. Odoi-Agyarko, J. Osei-Yeboah, Opportunistic infections among newly diagnosed HIV patients on ART in Ghana, BMC. Infect. Dis. 24 (2024) 160, https://doi.org/10.1186/s12879-024-08268-6.