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SEROEPIDEMIOLOGICAL EVIDENCE OF HIV/HBV COINFECTION AMONG PEOPLE LIVING WITH HIV IN ABAKALIKI, EBONYI STATE, NIGERIA.

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ABSTRACT: *Hepatitis B virus (HBV) and human immunodeficiency virus type 1 (HIV-1) remain major global public health concerns, particularly in low- and middle-income countries where both infections are highly endemic. This study investigated the seroprevalence and associated factors of HBV infection among HIV-1-infected individuals in Abakaliki, Ebonyi State, Southeast Nigeria. A cross-sectional study was conducted among HIV-1-infected patients attending the Alex Ekwueme Federal Teaching Hospital (AE-FETHA), Abakaliki. Hepatitis B surface antigen (HBsAg) was detected using commercially available enzyme-linked immunosorbent assay (ELISA) kits following the manufacturer's instructions, with appropriate positive and negative controls included in each assay. Sociodemographic and clinical variables were analysed to determine their association with HIV/HBV co-infection. The prevalence of HIV/HBV co-infection among the study participants was 33.5%, while 66.5% had HIV infection only without evidence of HBsAg. Age showed a statistically significant association with HIV/HBV co-infection ($\chi^2 = 15.88$, $p = 0.001$), indicating increased vulnerability to HBV infection with advancing age. Gender was also significantly associated with HBsAg seropositivity ($\chi^2 = 10.08$, $p = 0.001$), with males exhibiting a higher prevalence of co-infection. Marital status demonstrated a significant relationship with HIV/HBV co-infection ($\chi^2 = 5.42$, $p = 0.020$), with single individuals showing a higher risk. Educational status was strongly associated with co-infection ($\chi^2 = 44.01$, $p < 0.001$), as lower educational attainment was associated with higher HBV prevalence. However, no statistically significant associations were observed between occupation ($\chi^2 = 6.76$, $p = 0.080$) or religion ($\chi^2 = 4.35$, $p = 0.114$) and HBV infection. Clinical parameters revealed significant associations between HIV/HBV co-infection and both $CD4^+$ T-cell count ($\chi^2 \approx 9.82$, $p = 0.007$) and HIV viral load ($\chi^2 \approx 11.64$, $p = 0.003$). HBV co-infection was more prevalent among individuals with advanced immunosuppression and higher HIV viral loads, suggesting that poor immunological and virological control may facilitate HBV persistence. Overall, the findings highlight a substantial burden of HIV/HBV co-infection in Abakaliki and emphasise the need for routine HBV screening and integrated management strategies among people living with HIV.*

KEYWORDS: Coinfection, HIV, HBsAg, Serological Evidence.

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INTRODUCTION

Hepatitis B virus (HBV) and human immunodeficiency virus type 1 (HIV-1) remain two of the most significant viral pathogens affecting global public health, particularly in low- and middle-income countries. HBV infection is a leading cause of chronic liver disease, cirrhosis, and hepatocellular carcinoma, accounting for an estimated 820,000 deaths annually worldwide [1]. Similarly, HIV-1 infection continues to pose a major health burden, with sub-Saharan Africa bearing the highest proportion of people living with HIV globally [2].

HBV and HIV share common routes of transmission, including exposure to infected blood and blood products, unprotected sexual intercourse, and vertical transmission from mother to child. These overlapping transmission pathways result in a substantial burden of HBV/HIV co-infection, particularly in regions where both viruses are endemic [3]. It is estimated that approximately 5–15% of HIV-infected individuals worldwide are co-infected with chronic HBV, with higher prevalence reported in sub-Saharan Africa [4].

Recent studies have continued to demonstrate considerable heterogeneity in HBV prevalence across Nigeria. Okonko et al. [5] reported a prevalence of 6.1% among animal and non-animal handlers in Osun State, while Okonko et al. [6] reported a prevalence of 2.0% among HIV-positive fresh undergraduate students in Port Harcourt. In addition, Okonko et al. [7] reported a prevalence of 12.4% among women of childbearing age in Port Harcourt. Among HIV-infected populations, Cookey et al. [8] reported a prevalence of 3.1% in Rivers State, Innocent-Adiele et al. [9] reported 6.3% among HIV-infected individuals in Uyo, Akwa Ibom State, and Aaron et al. [10] reported a prevalence of 2.0% among HAART-experienced people living with HIV in Rivers State. Furthermore, Gidado et al. [11] reported a prevalence of 12.2% of HBV and HEV co-infection among animal and non-animal handlers in Osun State.

Abakaliki in Ebonyi State is an important urban centre in southeastern Nigeria with functional HIV treatment and care programs. However, available studies in these areas have largely focused on seroprevalence, with limited emphasis on HBV among HIV-infected individuals. The absence of localised HIV/HBV coinfection data limits the ability to design evidence-based interventions, optimise treatment regimens, and monitor the emergence of clinically relevant HBV variants. This study, therefore, seeks to investigate the seroprevalence of HBV infection among HIV-1-infected individuals in Abakaliki, Ebonyi State, Southeast Nigeria. By combining ELISA techniques with epidemiological analysis, the study aims to generate data that will enhance understanding of HBV/HIV co-infection dynamics in the region and contribute to improved clinical management and public health policy formulation.

MATERIALS AND METHODS

Study Area

The study was conducted at Alex Ekwueme Federal Teaching Hospital (AE-FETHA), Abakaliki, Ebonyi State, in the Southeast region of Nigeria. These hospitals were selected because they host major antiretroviral therapy (ART) clinics providing care for HIV-infected individuals. AE-FETHA, Abakaliki, is a tertiary referral centre serving Ebonyi State and neighbouring communities. This site has well-established HIV diagnostic and treatment facilities, making it suitable for the recruitment of study participants. The patient populations

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at this centre represent a mix of urban and peri-urban communities typical of southeastern Nigeria.

Study Design

A cross-sectional, hospital-based study design was employed. The study combined an epidemiological approach to determine the prevalence of HBV among HIV-1-infected individuals.

Study Population

The study population comprised HIV-1-infected individuals attending the ART clinics at AE-FETHA, Abakaliki. Both male and female participants, with documented HIV-1 infection, were included. Individuals who declined consent or were receiving treatment for acute hepatitis B infection were excluded.

Sample Size Determination

The minimum sample size was calculated using the formula for cross-sectional studies: $n = \underline{Z^2 \cdot p \cdot (1-p)/d^2}$. Where: n = minimum sample size, Z = standard normal deviate at 95% confidence (1.96), p = expected prevalence of HBV among HIV-infected individuals (0.10) and d = margin of error (0.05). Accounting for 20% potential non-response or sample loss, the final target sample size was approximately 200 participants.

Sampling Technique

A consecutive sampling method was used. Eligible HIV-1-infected individuals attending ART clinics at AE-FETHA were recruited consecutively until the required sample size for each site was achieved. Participants were screened for eligibility and invited to participate during routine clinic visits.

Ethical Considerations

Ethical approval was obtained from the Madonna University Nigeria Research Ethics Committee [MUN-REC] (MUN/VC/REC/14/PhD/MCB/023/001). Written informed consent was obtained from all participants. Confidentiality was maintained through the use of unique study codes. Participants were allowed to withdraw at any stage without affecting their clinical care.

Data Collection

Socio-demographic and Clinical Data

A structured questionnaire was administered to collect information on age, sex, occupation, education, marital status, duration of HIV infection, ART regimen, and previous hepatitis B vaccination.

Biological Samples

Approximately 5 mL of venous blood was collected from each participant under sterile conditions. Samples were transported on ice to the Virus & Genomics Research Unit, Department of Microbiology, University of Port Harcourt. The samples were centrifuged at

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3000rpm for 5 minutes to obtain the plasma part of the blood and stored at –20°C until processing.

Serological Analysis

The serological analysis was performed at the Virus and Genomics Research Unit of the Department of Microbiology, University of Port Harcourt. HBsAg was detected using commercially available enzyme-linked immunosorbent assay (ELISA) kits according to the manufacturer's instructions. Positive and negative controls were included in each assay. Optical density (OD) readings were recorded and used to determine antigen concentrations. To set a benchmark, the mean OD450nm value of the Negative Control (NC) is calculated using the formula: CUT-OFF = NC + 0.350. This value serves as the threshold for positivity. Additionally, the Sample / Cut-Off value (S/Co) is computed for both the Controls and the samples. These calculations help establish the relationship between the sample's measured value and the defined cut-off, aiding in categorising the results as positive or negative based on the provided guidelines. Interpretation of results for HBsAg was done using S/Co <0.9 as negative, 0.9-1.0 as equivocal and >1.1 as positive.

Data Analysis

The results of the assay summarised the demographic characteristics and behavioural features of the investigated population and calculated the prevalence of co-infection with HBsAg and HIV-infected individuals. The findings were presented using tables, charts, and descriptive statistics to convey the results effectively. Subgroup analyses were performed to compare prevalence rates between HIV-positive and HIV-negative patients, using Chi-square statistical tests to assess associations and identify potential predictors while adjusting for confounding factors such as age and gender. Analyses were conducted using SPSS version 25 software. Prevalence and socio-demographic distributions were summarised using percentages. Differences in HBV prevalence were assessed using chi-square tests. All statistical tests were performed at $p < 0.05$.

RESULTS AND ANALYSIS

Socio-Demographical Features of the Study Participants

A cumulation of 200 plasma samples was obtained from people living with HIV attending an antiretroviral clinic at Alex Ekweme Federal Teaching Hospital, Abakaliki (FETHA), Abakaliki in Ebonyi State, Nigeria. These were analysed serologically for the presence of HIV coinfection with malaria and syphilis, and 60 (30.0%) samples were randomly selected to characterise coreceptor usage among HIV-1 individuals in Ebonyi State, Nigeria. Of the samples analysed, only 22 samples (36.7%) were able to generate sequence results used for analysis. Among the study population, females were the most predominant (73.0%, n=146) than their male counterparts (27.0%, n=54), as shown in Table 1. The age group 31-40 years constitute the largest population (35.0%, n=70), followed by those less than 30 (21.5%, n=43), while the age group 51 and above were the least in the population (6.0%, n=12). As seen in Table 1. The majority of the participants in the study population were married (57.0%, n=114), in contrast to the singles (43.0%, n=86), as indicated in Table 4.1. Based on education and occupation, participants with a tertiary level of education were the majority (68.0%, n=136),

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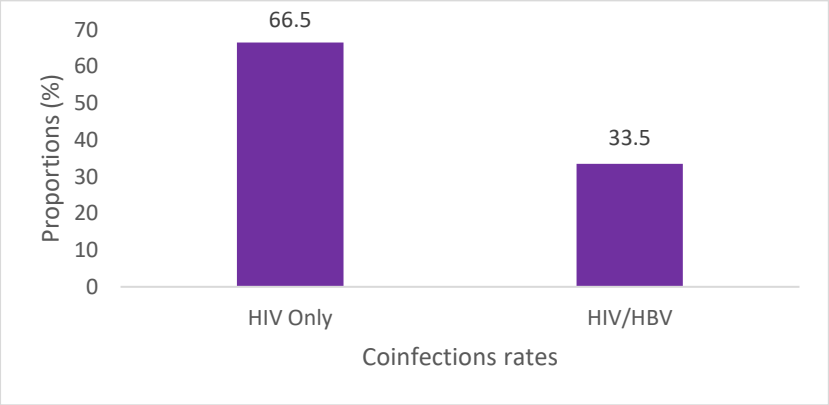
followed by secondary (22.0%, n=44), and the least were participants with primary education (10.0%, n=20). Based on occupation, folks working as civil servants were predominant (30%, n=60), followed by students (26.0%, n=52), teachers (18.0%, n=36), and traders (17.0%, n=34). The least popular were farmers and artisans (n= 10 and 8, 5.0% and 4%), respectively (Table 1).

Serological Analysis Outcome

The prevalence of HIV-HBV co-infection in Abakaliki, Ebonyi State, was 33.5%. The distribution of HIV/HBV co-infection among the study participants is presented in Figure 1. Of the total population studied, the majority (66.5%) were found to have HIV infection only, without evidence of hepatitis B surface antigen (HBsAg). In contrast, 33.5% of the participants were co-infected with HIV and HBV (HBsAg positive). This finding highlight that while HIV-only cases predominated in the study population, a considerable proportion of individuals also harboured HBV infection, underscoring the burden of HIV/HBV co-infection within this Abakaliki cohort.

Figure 1: Overall HIV/HBV Coinfection



Age-Related Association

A statistically significant association was observed between age and HIV/HBV co-infection (χ^2 = 15.88, p = 0.001). Age was a significant determinant of HIV/HBV co-infection in Abakaliki, indicating cumulative exposure risk and increased vulnerability to HBV infection with advancing age (Table 1).

Gender-Related Association

A statistically significant association was found between gender and HBsAg seropositivity (χ^2 = 10.08, p = 0.001). Male gender was a strong predictor of HBV co-infection among PLHIV, possibly reflecting higher engagement in high-risk behaviours or occupational exposures (Table 1).

Marital Status-Related Association

Marital status showed a statistically significant association with HIV/HBV co-infection (χ^2 = 5.42, p = 0.020). Single status was significantly associated with increased risk of HBV co-

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infection, suggesting potential influence of sexual behaviour patterns and reduced health-seeking practices (Table 1).

Educational Status-Related Association

A highly statistically significant association was found between educational status and HIV/HBV co-infection ($\chi^2 = 44.01$, $p < 0.001$). Lower educational attainment was strongly associated with increased HIV/HBV co-infection, highlighting the role of health literacy and awareness in HBV prevention (Table 1).

Occupation-Related Association

No statistically significant association was observed between occupation and HIV/HBV co-infection ($\chi^2 = 6.76$, $p = 0.080$), although students recorded the highest prevalence (44.4%). Occupational status did not significantly influence HIV/HBV co-infection in Abakaliki, despite observable differences in prevalence across occupational groups (Table 1).

Religion-Related Association

The association between religion and HBsAg seropositivity was not statistically significant ($\chi^2 = 4.35$, $p = 0.114$). Religion was not a significant determinant of HIV/HBV co-infection in the study area (Table 1).

Table 1: HIV/HBV Co-infection in HIV-infected persons and their demographic characteristics

Variables	Number tested	Percentage (%)	HBsAg +ve	% HBsAg +ve	X^2-value	P-value
Age						
≤30	43	21.5	11	35.6	15.88	0.001
31-40	70	35.0	27	38.6		
41-50	32	16.0	20	62.5		
≥51	12	6.0	9	75.0		
Sex						
Males	54	27.0	28	51.9	10.08	0.001
Females	146	73.0	39	26.7		
Marital Status						
Married	114	57.0	30	26.3	5.42	0.020
Single	86	43.0	37	43.0		
Others	0	0.0	0	0.0		
Educational Status						
None	0	0.0	0	0.0	44.01	0.001
Primary	20	10.0	12	60.0		
Secondary	44	22.0	30	69.5		
Tertiary	136	68.0	25	18.4		
Occupations						
Student	54	27.0	24	44.4	6.76	0.080
Unemployed	36	18.0	7	19.4		
Self Employed	46	23.0	17	36.9		

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Employed	64	32.0	19	29.7		
Religion						
Christianity	152	76.0	51	33.6	4.35	0.114
Islam	29	14.5	13	44.8		
Others	19	9.5	3	15.8		
Total	**200**	**100.0**	**67**	**33.5**		

HIV/HBV co-infection among PLHIV in Abakaliki was significantly influenced by age, sex, marital status, and educational level, with higher prevalence observed among older individuals, males, singles, and those with lower education. These findings emphasize the need for targeted HBV screening, vaccination, and health education interventions tailored to high-risk demographic groups.

HIV/HBV Co-infection and Immunological Markers ($CD4^+$ T-Cell Count)

A statistically significant association was observed between $CD4^+$ T-cell count and HIV/HBV co-infection ($\chi^2 \approx 9.82$, $p = 0.007$). HBV co-infection was significantly more prevalent among HIV-infected individuals with advanced immunosuppression, indicating that declining immune status increases susceptibility to HBV infection or reactivation (Table 2).

HIV/HBV Co-infection and Virological Markers (HIV Viral Load)

There was a highly statistically significant association between HIV viral load and HIV/HBV co-infection ($\chi^2 \approx 11.64$, $p = 0.003$). Poor virological control of HIV was strongly associated with HBV co-infection, suggesting that uncontrolled HIV replication may facilitate HBV persistence and replication (Table 2).

The findings demonstrate that HIV/HBV co-infection in Abakaliki is significantly associated with both immunological decline and high HIV viral load. Individuals with low CD4 counts and elevated viral loads were more likely to be co-infected with HBV. This underscores the clinical importance of routine HBV screening, early antiretroviral therapy, and integrated management of HIV/HBV co-infection (Table 2).

Table 2: Seroprevalence and Statistical Relationship between HIV/HBV Coinfection and Immunological/Virological Markers

Markers	No. Tested	%	HBsAg +ve	%HBsAg +ve	X^2-test	p-value
CD4 Count (cells/ul)						
≤200	14	7.0	10	54.5	9.82	0.007
201-349	20	10.0	12	27.8		
≥ 350	166	83.0	45	27.1		
Viral load (Copies/ml)						
TND	0	0.0	0	0.0	11.64	0.003
<40	138	69.0	37	26.8		
40-1000	42	21.0	18	42.9		
>1000	20	10.0	12	60.0		
Total	**200**	**100**	**67**	**33.5**		

TND: Target not detected

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DISCUSSION OF FINDINGS

The present study investigated the seroprevalence and associated factors of hepatitis B virus (HBV) infection among HIV-1-infected individuals attending the Alex Ekwueme Federal Teaching Hospital in Abakaliki, Southeast Nigeria. This study examined the HIV/HBV seroprevalence and reported a high coinfection rate (33.5%). The findings of the present study are strongly supported by a substantial body of Nigerian literature demonstrating a consistently high burden of HBV infection among people living with HIV (PLHIV), alongside evidence of complex co-infection patterns and persistent viral diversity. Multiple studies conducted across the South–South, South–West, South–East, North–Central, and North–West regions of Nigeria have reported moderate to high HBV seroprevalence among HIV-infected populations, underscoring HBV as one of the most common chronic viral co-infections complicating HIV care in the country [8, 10, 12-14].

The overall prevalence of HIV/HBV co-infection observed in this study was 33.5%, indicating a high burden of HBV infection among people living with HIV (PLHIV) in the study area. This finding underscores the continuing public health significance of HBV infection in HIV-infected populations in Nigeria, where both viruses share similar transmission routes such as exposure to infected blood, sexual contact, and vertical transmission. The high frequency of HBV co-infection reported among PLHIV in Rivers, Bayelsa, Akwa Ibom, Ogun, Oyo, Anambra, and Delta States further aligns with the present findings of extensive HBV genetic diversity in ART-experienced individuals [9, 14-22]. For instance, lower prevalence rates have been reported among blood donors in Ibadan, Oyo State, where 14.5% and 2.5% were documented by Lawal et al. [23] and Okonko et al. [24], respectively.

The prevalence observed in this study is higher than several previous reports from different populations in Nigeria. Similarly, Okonko et al. [25] reported 6.1% among patients in Abeokuta, Ogun State, while Sule et al. [26] documented 11.0% among farming and non-farming individuals in Anyigba and 14.0% among patients in Ankpa, Kogi State. Comparable moderate prevalence rates have also been reported among pregnant women in Ibadan (11.5%) by Okonko and Udeze [27], among ARFH clinic attendees (7.0%) by Okonko et al. [28], and among intending blood donors in Port Harcourt (6.7%) by Okonko et al. [29] (2015). Other studies have also reported relatively low prevalence rates among different Nigerian populations, including 1.3% among sexually active adults, 2.5% among blood donors, and 0.5% among children in Ibadan [24, 30-31].

Similarly, several studies among HIV-infected populations and other groups in Nigeria have documented lower prevalence rates compared to the present findings. These include 3.1% among HIV-infected individuals in Rivers State [8], 6.3% among HIV-infected individuals in Uyo [9], 2.0% among HAART-experienced PLHIV in Rivers State [10], 6.6% among ART-naïve HIV-infected individuals in Port Harcourt [18], and 1.0% among HIV-infected individuals in Warri [19]. Also, Okonko et al. [20] documented 3.0% prevalence among HIV-infected patients presenting at a tertiary hospital in Port Harcourt, Rivers State, Nigeria, while Okonko et al. [21] documented 8.0% prevalence among patients attending O. B. Lulu Briggs Health Centre in Port Harcourt, Rivers State, Nigeria. Other community-based and clinical studies have also reported lower prevalence rates, including 4.4% among community residents in Mbano, Imo State [32] and 10.9% among patients attending a tertiary hospital in Port Harcourt [33].

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In contrast, the prevalence observed in the present study is comparable to or slightly higher than that reported in some high-risk populations in Nigeria. For example, Ojo et al. [34] and Ogwu-Richard et al. [35] both reported a prevalence of 30.6% among HIV-infected individuals in Abeokuta, while Udeze et al. [36] reported 32.0% among HIV-positive patients in Ilorin. Higher prevalence rates have also been documented in certain populations, including 37.93% among malaria patients in Port Harcourt [37] and 34.6% among intending male blood donors in Port Harcourt [38]. Similarly, Ugwu et al. [13] reported a prevalence of 40.9% among HIV-infected patients in Onitsha, while Ugwu et al. [14] documented 17.7% among HIV-infected patients in Anambra State. Very high prevalence rates have also been reported among febrile patients in Port Harcourt, where Okonko and Chindah [39] and Okonko et al. [40] both documented 35.9% prevalence.

The variability in prevalence rates across different studies in Nigeria highlights the heterogeneous epidemiology of HBV infection in the country. Differences in prevalence may be attributed to variations in study design, population characteristics, risk behaviours, geographic location, vaccination coverage, and diagnostic methods used in different studies. The relatively high prevalence observed in the present study may also reflect the increased susceptibility of HIV-infected individuals to HBV infection due to shared transmission routes and compromised immune function.

This study also evaluated the statistical relationship between HIV/HBV co-infection and selected demographic characteristics among people living with HIV (PLHIV) in Abakaliki. The findings reveal that age, sex, marital status, and educational level were significant determinants of HBV co-infection, while occupation and religion showed no statistically significant associations. These results underscore the multifactorial nature of HIV/HBV co-infection and reflect the influence of cumulative exposure, behavioural patterns, and socio-educational factors in a high-endemic setting. With respect to sociodemographic characteristics, the present study demonstrated significant associations between HIV/HBV co-infection and age, gender, marital status, and educational level.

A statistically significant association was observed between age and HIV/HBV co-infection, with HBsAg seropositivity increasing progressively with advancing age and peaking among individuals aged 51 years and above. This trend suggests cumulative lifetime exposure to HBV, which is consistent with reports from Nigeria and other sub-Saharan African countries where HBV is endemic and transmission often occurs early in life but persists into older age as chronic infection [41, 42]. Among PLHIV, age-related immune senescence combined with prolonged duration of HIV infection may further impair viral clearance, increasing the likelihood of detectable HBsAg in older individuals [3]. The observed age gradient highlights older PLHIV as a priority group for HBV screening and long-term liver disease monitoring. The significant association between age and HBV infection suggests that cumulative exposure to risk factors over time may increase the likelihood of HBV acquisition.

The higher prevalence observed among males compared with females is consistent with findings from several previous studies and may be related to higher engagement in high-risk behaviours, occupational exposures, or lower health-seeking practices among men. Sex was a significant predictor of HIV/HBV co-infection, with male participants exhibiting nearly twice the prevalence observed among females. This finding aligns with numerous studies reporting higher HBV prevalence among men, both in the general population and among PLHIV [43, 44]. The male predominance may reflect greater engagement in high-risk sexual behaviours, higher

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likelihood of occupational exposure, injection practices, and lower healthcare utilisation among men [45]. Biological factors, including sex-based differences in immune response and viral persistence, have also been implicated in higher chronic HBV carriage among males [42]. These findings support the need for male-focused prevention strategies within HIV care programs.

Marital status showed a statistically significant association with HIV/HBV co-infection, with single participants recording a higher prevalence of HBsAg positivity compared to married individuals. This pattern may be explained by differences in sexual behaviour, including multiple partnerships and inconsistent condom use, which are more commonly reported among unmarried individuals [44]. Additionally, married status does not necessarily eliminate HBV risk, but marriage may be associated with more stable sexual networks and increased engagement with healthcare services. Similar associations between single status and HBV infection have been reported in other Nigerian studies, reinforcing the relevance of marital context in HBV transmission dynamics [45].

Educational status demonstrated a highly statistically significant association with HIV/HBV co-infection, with markedly higher prevalence among participants with primary and secondary education compared to those with tertiary education. This finding highlights the critical role of education in shaping health literacy, awareness of transmission routes, and uptake of preventive measures such as HBV vaccination [41]. Individuals with lower educational attainment may have limited access to accurate health information and reduced capacity to navigate healthcare systems, increasing vulnerability to HBV infection. Similar inverse relationships between education level and HBV prevalence have been documented across sub-Saharan Africa [42, 46-47]. These results emphasise the importance of targeted health education interventions tailored to populations with low educational attainment.

Although students recorded the highest prevalence of HIV/HBV co-infection, the association between occupation and HBsAg seropositivity was not statistically significant. This suggests that the occupational category alone may not independently predict HBV risk in this population. In endemic settings, HBV transmission is influenced more strongly by behavioural and environmental factors than by formal occupational classification [44]. Nonetheless, the relatively higher prevalence among students may warrant focused preventive interventions, including vaccination campaigns and risk-reduction education within educational institutions.

Religion was not significantly associated with HIV/HBV co-infection in Abakaliki, despite observable differences in prevalence across religious groups. This finding indicates that religion per se may not be a determinant of HBV infection in this setting. While some studies have linked HBV risk to cultural or religious practices such as traditional circumcision or scarification [41], the absence of statistical significance here suggests that such practices may not be sufficiently distinct or prevalent to drive differences in HBV transmission within the study population. This underscores the importance of avoiding religious stereotyping and focusing instead on modifiable behavioural risk factors.

The association observed between marital status and HBV infection, particularly the higher prevalence among single individuals, may reflect differences in sexual behaviour patterns and exposure to multiple partners. In addition, the strong association between educational status and HBV infection highlights the potential role of health literacy and awareness in influencing preventive behaviours, including vaccination, screening, and safe sexual practices. However, no statistically significant associations were observed between HBV infection and occupation

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or religion in this study, suggesting that these factors may have limited influence on HBV transmission within the study population.

This study also assessed the relationship between hepatitis B virus (HBV) seropositivity and key immunological and virological markers, $CD4^+$ T-cell count and HIV viral load, among people living with HIV (PLHIV). The findings demonstrate strong and highly statistically significant associations between HBV infection, advanced immunosuppression, and poor virological control of HIV, highlighting important clinical and public health implications. A highly significant association was observed between $CD4^+$ T-cell count and HBsAg seropositivity, with the highest HBV prevalence recorded among participants with CD4 counts below 200 cells/μL. This finding is consistent with extensive literature indicating that HBV co-infection is more common among HIV-infected individuals with advanced immunosuppression [3, 48]. Reduced $CD4^+$ T-cell counts impair immune-mediated viral control, facilitating HBV persistence, reactivation, and higher rates of detectable HBsAg [49].

Also, the comparatively lower prevalence of HBV infection among participants with CD4 counts above 350 cells/μL suggests a protective role of immune competence. Immune restoration following antiretroviral therapy (ART) has been shown to improve control of HBV replication and reduce the risk of liver-related complications [50]. In endemic settings such as southeastern Nigeria, where HBV infection is often acquired early in life, immunosuppression associated with HIV may unmask chronic or occult HBV infection, thereby increasing seroprevalence among individuals with low CD4 counts [41].

The lower prevalence of HBV infection among participants with viral loads below 40 copies/mL further supports the protective effect of effective HIV virological suppression. Suppressive ART, particularly regimens containing tenofovir, has been associated with reduced HBV replication and improved clinical outcomes in HIV/HBV co-infected individuals [49-50]. The absence of participants with target-not-detected (TND) viral load in Abakaliki may reflect challenges related to ART adherence, access, or monitoring, which could contribute to the observed burden of HBV co-infection.

The strong association between HBV seropositivity, low $CD4^+$ T-cell count, and high HIV viral load underscores the bidirectional interaction between HIV disease progression and HBV infection. HBV co-infection has been shown to accelerate liver disease progression, increase the risk of hepatocellular carcinoma, and complicate HIV treatment outcomes [46-47, 49]. In turn, advanced HIV disease facilitates HBV persistence and reactivation. The findings of this study also revealed significant associations between HIV/HBV co-infection and important clinical parameters, particularly $CD4^+$ T-cell count and HIV viral load. HBV co-infection was significantly more prevalent among individuals with lower $CD4^+$ T-cell counts, indicating that advanced immunosuppression may increase susceptibility to HBV infection or facilitate viral persistence and reactivation. Similarly, the higher prevalence observed among individuals with elevated HIV viral loads suggests that poor virological control of HIV may contribute to increased vulnerability to HBV infection.

Overall, the findings of this study demonstrate a substantial burden of HIV/HBV co-infection among PLHIV in Abakaliki and highlight the importance of routine HBV screening in HIV care programs. Early detection of HBV infection, integration of HBV vaccination strategies, and appropriate antiviral management are essential components of comprehensive care for HIV-infected individuals in endemic settings such as Nigeria. Strengthening integrated

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HIV/HBV prevention and treatment programs will therefore be critical in reducing the long-term morbidity and mortality associated with HIV/HBV co-infection.

CONCLUSION

The findings demonstrate that HIV/HBV co-infection among PLHIV in Abakaliki is significantly influenced by age, sex, marital status, and educational level, with higher prevalence among older individuals, males, singles, and those with lower educational attainment. These patterns reflect cumulative exposure, gendered risk behaviours, and disparities in health literacy. The results underscore the need for targeted HBV screening, vaccination, and culturally appropriate health education, integrated within HIV care services and tailored to high-risk demographic groups in Abakaliki and similar settings. This study also demonstrates that HIV/HBV co-infection in Abakaliki is significantly associated with immunological decline and poor virological control of HIV. Individuals with low CD4 counts and elevated HIV viral loads were substantially more likely to be co-infected with HBV. These findings reinforce current recommendations for integrated HIV–HBV services and highlight the importance of early diagnosis, immune restoration, and sustained viral suppression in reducing the burden of HIV/HBV co-infection. These findings emphasise the necessity of routine HBV screening at HIV diagnosis and during follow-up, particularly among patients presenting with advanced immunosuppression or poor virological control. Integrated HIV–HBV management, early initiation of ART, sustained viral suppression, and inclusion of HBV-active agents in treatment regimens are critical strategies for reducing morbidity and mortality among co-infected individuals in high-endemic settings.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the conduct of this study, the analysis of data, or the publication of the findings.

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