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Prevalence and Risk Factors of Hepatitis B and C Virus Co-Infection among Women Attending Antiretroviral Therapy Clinic in Yola, Nigeria

Maryam Adam Ibrahim[1*], James Hamuel Doughari[2]

[1]College of Nursing and Midwifery, Department of Applied Sciences, PMB 2044, Yola, Nigeria; [2]Modibbo Adama University, Faculty of Life Sciences, Department of Microbiology, PMB 2076, Yola, Nigeria

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***Correspondence**
Email: maryamadamib4real@gmail.com
Tel: +2347068878732

ABSTRACT

Introduction: Viral hepatitis represents a significant challenge to public health worldwide. Women living with HIV are at heightened risk of co-infection with hepatitis B and C due to their increased risk of exposure to bloodborne pathogens through medical interventions, potentially leading to severe health outcomes, including increased morbidity and mortality, and public health impacts through maternal transmission. This study aimed to estimate the prevalence of hepatitis B and C virus co-infection among women living with HIV attending the ART clinic in Modibbo Adama University Teaching Hospital, Yola, Nigeria. These findings will inform the development and improvement of testing, vaccination, and treatment programs to enhance health outcomes and quality of life for this population. **Method**: A cross-sectional study was conducted from January 2023 to September 2023 using a convenience sampling method to recruit 360 women aged 18 years and above attending the ART clinic. Data on socio-demographic characteristics and potential risk factors for HBV/HCV infection were collected with a structured questionnaire. The seroprevalence of HBsAg and anti-HCV antibodies was determined with Rapid Diagnostic Test (RDT) strips from Micropoint. **Results**: Among the 360 HIV-positive women tested, 9.2% (33) were co-infected with HBV, 2.2% (8) were co-infected with HCV, and 0.3% (1) had co-infection with HBV, HCV, and HIV. The prevalence of HBV co-infection was highest among women aged 39-48 (9.6%), while HCV co-infection was most prevalent in those aged 49 and above (3.4%). Logistic regression analysis showed that blood transfusion and having multiple sexual partners were significantly associated with HIV/HBV co-infection (*P*-value = 0.002). **Conclusion**: This study identified a notable prevalence of HBV (9.2%) and HCV (2.2%) co-infection among women living with HIV, underscoring the public health significance due to the potential for increased morbidity and mortality. Further studies should employ molecular techniques like PCR to confirm active infections and assess viral loads. This information is crucial for guiding treatment decisions and improving clinical outcomes for this vulnerable population.

INTRODUCTION

Human immunodeficiency virus (HIV), a blood-borne pathogen, poses a significant global public health challenge. HIV infection compromises the immune system, increasing susceptibility to opportunistic infections, particularly chronic viral hepatitis B (HBV) and hepatitis C (HCV) infections. The introduction of antiretroviral therapy (ART) has led to a significant increase in life expectancy among people living with HIV (PLWHIV). Consequently, chronic viral hepatitis, particularly HBV and HCV, has emerged as a leading cause of morbidity and mortality in this population [1]. Approximately 5%–10% of individuals with HIV also have chronic hepatitis B infection, as evidenced by ongoing detection of hepatitis B surface antigen (HBsAg), and one-third of HIV-infected individuals worldwide suffer from chronic hepatitis C [2]. Thus, there is an urgent need to address the HBV and HCV co-infection among HIV positive women as this co-infection threatens the success of antiretroviral therapy programs in developing countries.

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HIV co-infection with hepatitis B and C among women poses significant clinical challenges, including accelerated disease progression, mother-to-child transmission, and adverse pregnancy outcomes, including preterm labor, low birth weight, and increased maternal morbidity [3]. Furthermore, this co-infection can have profound psychosocial impacts, contributing to increased stigma and mental health issues [4].

According to Joint United Nations Programme on HIV/AIDS (UNAIDS), women and girls constitute fifty-four percent of all people living with HIV. In sub-Saharan Africa, they make up almost 60% of adults living with HIV. HBV and HCV co-infection can lead to economic hardship and chronic illness, which can, in turn, negatively impact women's educational opportunities and attainment. Understanding the prevalence and risk factors for HBV/HCV co-infection among women living with HIV is crucial for informing public health interventions, including targeted testing, vaccination programs, and integrated care models. These interventions can help to reduce the burden of co-infection, improve health outcomes, and enhance the quality of life for women living with HIV. HIV treatment guidelines are increasingly incorporating the management of chronic HBV infection. Moreover, highly effective direct-acting antiviral therapies for HCV are becoming more widely available. Therefore, accurate data on HBV/HCV co-infection prevalence are essential for optimizing treatment strategies and ensuring appropriate care for individuals living with HIV [5].

HIV, HBV, and HCV share similar transmission routes, including exposure to infected blood through unsafe injection practices, needle sharing, unprotected sexual intercourse, and mother-to-child transmission during childbirth. Consequently, HIV co-infection with HBV and HCV accelerates the progression of liver disease, increasing morbidity and mortality rates among women living with HIV (WLWH) [6].

Nigeria, with an adult HIV prevalence of 1.4%, also has a high prevalence of hepatitis B and C, with an estimated prevalence of 8.1% and 1.1% for HBsAg and anti-HCV antibodies, respectively [7]. However, there is limited research on the prevalence and risk factors associated with HBV and HCV co-infection among women living with HIV in Yola, Nigeria, which underscores the need for research due to the potential for unique regional or population-specific factors influencing co-infection rates. Understanding these factors is essential for developing effective and targeted interventions, improving case management strategies, and ultimately reducing the morbidity and mortality associated with these co-infections in this vulnerable population. This study aimed to estimate the prevalence and identify the risk factors for hepatitis B and C virus co-infection among women living with HIV attending the antiretroviral therapy clinic at Modibbo Adama University Teaching Hospital, Yola, Nigeria.

MATERIAL AND METHODS

Study area. This study was conducted at the Modibbo Adama University Teaching Hospital (MAUTH), a tertiary healthcare institution in Yola, Adamawa State, in northeastern Nigeria. The MAUTH Antiretroviral Therapy (ART) clinic provides comprehensive HIV management services, including ART provision, counseling, monitoring, and health education.

Study design, duration, and sample size. This was a descriptive cross-sectional study conducted from January 2023 to September 2023. The research proposal was prepared and approved from January to February 2023, with ethical approval obtained in April 2023. Data collection and laboratory analysis were conducted between May and August 2023. A convenience sampling method was used to recruit participants for this study. Eligible participants were women aged 18 years and above who provided informed consent to participate in the study. Women with intellectual disabilities were excluded due to logistical challenges in obtaining informed consent within the scope of this study.

The sample size for this study was calculated to be 369, using the formula for rare events [8,9]:

$n= Z^2 \times p(1-p)/d^2$

For rare diseases where $p < 10\%$, the margin of error (d) is set to half of the prevalence (p/2), simplifying the formula to:

$n= Z^2 \times p(1-p)/(p/2)^2$

where:

n: required sample size

z: Z-value (the number of standard deviations from the mean) corresponding to the desired confidence level

p: estimated prevalence of the outcome

Z-value (Z) is 1.96 at 95% confidence level, estimated prevalence (p) is 0.04 (4%)

Therefore,

$n= Z^2 \times p(1-p)/(p/2)^2 = (1.96)^2 \times 0.04(1-0.04)/ (0.04/2)^2$

$n= (3.8416 \times 0.0384)/0.0004 = 368.7936 \approx 369$

Ethical considerations. Ethical approval was obtained from the Health Research and Ethics Committee of the Modibbo Adama University Teaching Hospital (MAUTH), Yola (Reference number: FMCY/HREC/23/254). Participants provided written informed consent by signing a consent form. The consent form explained the study's purpose, procedures, risks, and benefits, as well as participants' rights to withdraw from the study at any time without penalty. An information sheet attached to the consent form provided details about the study, including its title and purpose, the researcher's contact information, potential benefits and risks, participant requirements, confidentiality measures, the right to withdraw, and how results would be disseminated. This sheet was reviewed with each participant, who was

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given ample time to consider the information and ask questions before consenting. Participants were assured of their right to make an informed decision about their participation.

Data collection using a questionnaire. A total of 369 women living with HIV were enrolled in the study after being approached and invited to participate during their routine visits to the ART clinic. A structured questionnaire with multiple-choice questions was developed and administered to capture sociodemographic information. The questionnaire collected information on the following sociodemographic variables: age (in years), marital status, occupation, education level, and duration of ART (in years). The questionnaire also assessed participants' risk factors for HBV and HCV transmission, including history of blood transfusion, history of intravenous drug use, history of body tattooing, number of sexual partners in the past two years, history of sexually transmitted infections, history of surgery or dental procedures, sharing personal care items, or having a mother infected with HBV or HCV at birth. For participants who were unable to read or write, the questionnaire was administered verbally by a trained research assistant. The research assistant read each question aloud and recorded the participant's responses. A pilot test was conducted with 20 women living with HIV to assess the clarity, comprehensibility, and face validity of the questionnaire. Based on feedback, minor revisions were made to improve clarity. Out of the 369 questionnaires administered, 360 were completed and included in the analysis. Nine questionnaires were excluded due to missing responses on key variables.

Sample collection. Whole blood (5mL) was collected from each participant by venipuncture and dispensed into K2EDTA (ethylenediaminetetraacetic acid) anticoagulant bottles. Each sample was assigned a unique reference number and immediately transported to the laboratory. Samples were centrifuged at 1500 x g for 15 min at room temperature. The separated plasma was used for the detection of HBsAg and anti-HCV antibodies. Plasma samples were stored at 2-8°C and analyzed in batches of 20, with each batch processed within one hour of collection.

Determination of Hepatitis B surface antigen (HBsAg) and Anti-HCV antibodies. HBsAg and anti-HCV antibodies were detected using Nantong Egens Micropoint rapid diagnostic tests (RDTs). These are qualitative chromatographic immunoassays designed for *in vitro* diagnosis. HBsAg was detected using Micropoint HBsAg rapid diagnostic test (RDT) kits (manufactured by Nantong Egens Biotechnology Co., Ltd., Nantong Economy and Technology Development Zone, China). This test is based on the principle of immunochromatography, where antibodies specific for HBsAg are immobilized on a nitrocellulose membrane. Anti-HCV antibodies were detected using a double antigen-sandwich immunoassay with Micropoint anti-HCV RDT kits (manufactured by Nantong Egens Biotechnology Co., Ltd., Nantong Economy and Technology Development Zone, China), where two HCV antigens capture anti-HCV antibodies in the plasma sample to form a sandwich complex.

The RDTs were performed according to the manufacturer's instructions. The test strip was immersed vertically into 50µL of plasma up to the marked line, not exceeding the maximum fill line. Results were read after 15 minutes and interpreted according to the manufacturer's criteria. The appearance of two distinct red lines, one in the control (C) region and one in the test (T) region, indicates a positive result. The appearance of only one red line in the control (C) region indicates a negative result. If neither a red test line nor a red control line appears, the test is considered invalid and should be repeated [10].

Statistical analysis. Data were analyzed using SPSS version 22.0. Descriptive statistics, including frequencies and percentages, were used to summarize categorical variables, such as marital status, occupation, and education level. Continuous variables, including age and duration of ART, were categorized to facilitate analysis and reduce confounding. Chi-square tests assessed associations between categorical variables. Multivariate logistic regression analysis was used to identify independent risk factors associated with HBV/HCV co-infection among women living with HIV. Statistical significance was set at a *P*-value of < 0.05.

RESULTS

General characteristics of the study population. Table 1 summarizes the sociodemographic characteristics, including age, marital status, education level, and occupation, of the 360 women living with HIV who participated in the study.

Seroprevalence of HBsAg, anti-HCV antibodies, and HBV/HCV co-infection. Among the 360 women living with HIV, 33 (9.2%) were co-infected with HBV, 8 (2.2%) were co-infected with HCV, and 1 (0.3%) had a triple co-infection with HIV, HBV, and HCV (Table 2). The prevalence of triple co-infection (HIV/HBV/HCV) was 0.3% among all participants.

Sociodemographic factors and HBsAg seroprevalence. Chi-square test was used to examine the association between HBsAg seroprevalence and sociodemographic factors. All *P*-values below 0.05 were considered statistically significant (Table 3). The prevalence of HBsAg varied across the three age groups. The highest prevalence (12.0%) was observed in the 29-38 age group (10/83), followed by the 39-48 age group (9.6%, 13/135). The lowest prevalence (8.6%) was found in the 49 and above age group (10/116). The prevalence of HBsAg did not differ significantly across age groups (X^2=3.528, df=3, P = 0.317). Regarding marital status, the highest HBsAg prevalence was observed among widows

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(11.8%, 13/110), followed by married women (7.5%, 13/173). The lowest prevalence was found among divorced women (4.2%, 1/24). The differences in the prevalence of HBsAg by marital status were not statistically significant (X^2=2.512, df=3, P = 0.473). The prevalence of HBsAg varied across education levels. The highest prevalence (13.3%) was observed among women with tertiary education (11/83), followed by those with no formal education (9.2%, 11/120). The lowest prevalence (6.9%) was found among women with secondary education (7/102). The differences in the prevalence of HBsAg by educational background were not statistically significant (X^2=2.552, df=3, P = 0.466). The prevalence of HBsAg did not differ significantly across occupations (X^2=0.928, df=3, P = 0.819). Among HBsAg positive women, HBV was most commonly found in civil servants (7/65, 10.8%), followed by those in the private sector (4/42, 9.5%) and self-employed (22/246, 8.9%). No students were HBsAg positive.

Table 1. Sociodemographic characteristics and risk factors of women living with HIV attending the ART clinic

Characteristics		n (%)
Age group (years)		
	18-28	26 (7.2)
	29-38	83 (23.1)
	39-48	135 (37.5)
	49 and above	116 (32.2)
Marital status		
	Single	53 (14.7)
	Married	173 (48.1)
	Divorced	24 (6.7)
	Widowed	110 (30.6)
Educational status		
	No formal education	120 (33.3)
	Primary	55 (15.3)
	Secondary	102 (28.3)
	Tertiary	83 (23.1)
Occupation		
	Civil servant	65 (18.1)
	Private organization	42 (11.7)
	Student	7 (1.9)
	Self-employed	246 (68.3)
Length of ART (years)		
	0-5	47 (13.1)
	6-10	89 (24.5)
	11-15	153 (42.5)
	16 or above	71 (19.7)
Risk factor		
	History of blood transfusion	20 (5.6)
	History of intravenous drug use	3 (0.8)
	Multiple sexual partners	51 (14.2)
	History of tattooing	
	None of the above	286 (79.4)

n: frequency count
%: percentage

Table 2. Prevalence of HBsAg, anti-HCV antibodies, and HBV/HCV co-infection among women living with HIV

Infection status	n (%)
HBsAg positive	33 (9.2)
HBsAg negative	327 (90.8)
Anti-HCV positive	8 (2.2)
Anti-HCV negative	352 (97.8)
HBV/HCV co-infection[a]	41 (11.4)
HIV/HBV/HCV triple infection	1 (0.3)

[a] Note: The count for HBV/HCV Co-infection includes the individual with triple infection

Anti-HCV seroprevalence and associated factors. The overall prevalence of anti-HCV was 2.2%. We used a Chi-square test to examine the association between anti-HCV seroprevalence and various sociodemographic factors. All *P*-values below 0.05 were considered statistically significant. The prevalence of anti-HCV was highest in the 49 and above age group at 3.4% (4/116), followed by the 39-48 age group at 2.2% (3/135) and the 29-38 age group at 1.2% (1/83). However, age was not significantly associated with anti-HCV prevalence (X^2=1.789, df=3, P=0.617). Among women testing positive for both HIV and HCV antibodies, 4 (2.3% of married, 4/173) were married, 2 (3.8% of single, 2/53) were single, and 2 (1.8% of widowed, 2/110) were widowed. The differences in the prevalence of HCV by marital status were not statistically significant (X^2=1.222,

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df=3, P = 0.748). Anti-HCV positive cases were observed across all educational levels: 3 (2.5% of those with no formal education, 3/120), 1 (1.0% with secondary education, 1/102), 2 (3.6% with primary education, 2/55), and 2 (2.4% with tertiary education, 2/83). The differences in the prevalence of HCV by educational level were not statistically significant (X^2=1.286, df=3, P = 0.732). Among those with both HIV and HCV antibodies, 5 (2.0% of self-employed, 5/246) were self-employed and 3 (4.6% of civil servants, 3/65) were civil servants. Occupation was not statistically associated with HCV prevalence (X^2=2.868, df=3, P = 0.412).

HBV/HCV co-infection and sociodemographic factors. Only one participant out of those tested for HBV/HCV co-infection (0.3%, 1/360) was co-infected with both HBV and HCV. This individual was in the 29-38 age group, single, had attained tertiary education, and was a civil servant. Due to the low number of co-infection cases, statistical tests for association with sociodemographic factors were not conducted as they would be unreliable.

Table 3. Seroprevalence of HBsAg, anti-HCV antibodies, and HBV/HCV co-infection in relation to sociodemographic variables

Variables	HBsAg n (%)	Anti-HCV antibodies n (%)	HBV/HCV co-infection n (%)
Age group(years)			
18-28	0 (0.0)/26	0 (0.0)/26	0 (0.0)/26
29-38	10 (12.0)/83	1 (1.2)/83	1 (1.2)/83
39-48	13 (9.6)/135	3 (2.2)/135	0 (0.0)/135
49 and above	10 (8.6)/116	4 (3.4)/116	0 (0.0)/116
P-value	0.317	0.617	N/A
Marital status			
Single	6 (11.3)/53	2 (3.8)/53	1 (1.9)/53
Married	13 (7.5)/173	4 (2.3)/173	0 (0.0)/173
Divorced	1 (4.2)/24	0 (0.0)/24	0 (0.0)/24
Widowed	13 (11.8)/110	2 (1.8)/110	0 (0.0)/110
P-value	0.473	0.748	N/A
Educational status			
No formal education	11 (9.2)/120	3 (2.5)/120	0 (0.0)/120
Primary	4 (7.3)/55	2 (3.6)/55	0 (0.0)/55
Secondary	7 (6.9)/102	1 (1.0)/102	0 (0.0)/102
Tertiary	11 (13.3)/83	2 (2.4)/83	1 (1.2)/83
P-value	0.466	0.732	N/A
Occupation			
Civil servant	7 (10.8)/65	3 (4.6)/65	1 (1.5)/65
Private organization	4 (9.5)/42	0 (0.0)/42	0 (0.0)/42
Student	0 (0.0)/7	0 (0.0)/7	0 (0.0)/7
Self-employed	22 (8.9)/246	5 (2.0)/246	0 (0.0)/246
P-value	0.819	0.412	N/A

N/A: Statistical tests for association not performed due to the low number of HBV/HCV co-infected cases.

Risk factors associated with HBV/HCV co-infection. Table 4 presents the results of a multivariate logistic regression analysis examining risk factors associated with HBV/HCV co-infection. Potential risk factors considered were based on established literature and included blood transfusion history, multiple sexual partners, history of intravenous drug use, and the presence of body tattoos. None of the participants reported having body tattoos, therefore this variable was excluded from the multivariate analysis. The Adjusted Odds Ratio (AOR) estimates the association between each risk factor and the odds of having HBV/HCV co-infection. The table showed that individuals with a history of blood transfusion have significantly higher odds of HBV/HCV co-infection (AOR: 2.291; 95% CI: 1.322–3.968; P=0.003). Specifically, they have approximately 2.29 times the odds of co-infection compared to those without a history of blood transfusion. Multiple sex partners were not significantly associated with the odds of HBV/HCV co-infection (AOR: 1.111; 95% CI: 0.100–1.211; P=0.868). The association between multiple sex partners and HBV/HCV co-infection was not statistically significant. For example, history of drug injection was not significantly associated with HBV/HCV co-infection (P=0.912). No statistically significant associations were found between the investigated risk factors and HIV/HBV co-infection in this study.

Table 4. Multivariate logistic regression analysis of risk factors for HIV/HBV co-infection among women living with HIV

Variable	Adjusted odds ratio (AOR)	95% confidence interval (CI)	*P*-value
Blood transfusion (vs. no blood transfusion)	2.291	1.322–3.968	0.003
Drug injection (vs. no drug injection)	0.9	0.024–1.027	0.912
Multiple sexual partners (vs. one sexual partner)	1.111	0.100–1.211	0.868

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DISCUSSION

Individuals living with HIV are at increased risk of HBV and HCV co-infection compared to HIV-negative women, primarily due to shared routes of transmission relevant to this population, such as exposure to infected blood through unsafe injection practices or sexual contact. This study did not find statistically significant associations between the investigated sociodemographic factors (age, marital status, education level, and occupation) and HBV/HCV co-infection. While the limited sample size might have reduced the statistical power to detect small or moderate associations, the lack of association might also suggest that these sociodemographic factors have a smaller effect on co-infection risk in this specific group than previously thought, or that other, unmeasured factors could be at play. Blood transfusion was identified as a risk factor for HBV/HCV co-infection. However, drug injection and multiple sexual partners were not significantly associated with co-infection in this study.

Our findings on HBV/HIV co-infection prevalence among HIV-positive women align with previous research in the region. A 2020 study in Yola reported a similar rate of 9.7% among women attending an HIV clinic [11]. This rate closely matches ours at 9.2%, suggesting a stable co-infection scenario in this setting. However, other Nigerian studies have shown variability; one in Abuja found a 7% prevalence [12], and Nnakenyi *et al*. (2020) in Enugu reported 6.6% [13]. Globally, lower rates were seen in Sudan [14], Nepal at 1.5% [15] and in Texas, USA, at 1.5% [16]. Conversely, higher rates were identified in Sokoto, Uganda at 11.7% [17], Nigeria at 14.8% [18], and Ghana at 19.9% [19]. Variations could be attributed to differing social and cultural practices influencing risk behaviors or the sensitivity and specificity of diagnostic tests used [20,21]. Endemic HBV levels in the general population might also affect these rates [16]. To address these disparities, further research should explore specific regional factors influencing these variations and aim to devise region-specific interventions.

Our study identified a 2.2% prevalence of HIV/HCV co-infection among women at the ART clinic in Yola, closely mirroring the 2.3% found by Adewole *et al*. (2009) in Nigeria [22]. However, prevalence varies: Abuja reported 1.2% [12], and Ghana noted 0.7% [19], while Enugu documented 4.6% [13]. These regional disparities emphasize the need for location-specific strategies in managing co-infections. Even lower rates demand attention due to increased morbidity and mortality in HIV/HCV co-infected individuals, highlighting the urgency for integrated care pathways. Our study's HIV/HBV co-infection rate was 9.2%, significantly higher than for HCV, aligning with Nigeria's 2018 National AIDS Indicator and Impact Survey [23]. Triple infection with HIV/HBV/HCV was rare at 0.3%, consistent with Abuja's findings [12] and southeastern Nigeria [13]. The reasons for this low rate are speculative: differences in transmission efficiency or the impact of anti-HBV activity in HIV treatments might play roles [24]. Also, survivorship bias might explain lower triple infection rates as these patients might not survive as long [25]. Further research should explore these phenomena to refine prevention and treatment strategies for these complex infections.

We assessed HBV prevalence across age groups, finding the peak in women aged 39-48, with no cases among those 18-28. This pattern diverges from prior Nigerian studies where HBV peaked in younger cohorts; Olokoba *et al*. (2011) identified the highest prevalence in women aged 25-29 [26], and Nnakenyi *et al*. (2020) in adults 21-30 for HIV/HBV co-infection [13]. Sale *et al*. (2022) in Yola noted the peak in the 26-39 age bracket [11]. Such variations might stem from methodological differences like testing methods (*e.g*., ELISA vs. others), distinct study populations (pregnant women vs. ART attendees), or varying age group definitions. These factors could skew age-related prevalence data. To clarify these trends, further research should explore these discrepancies to better understand age-related HBV dynamics.

In our study, no significant association between age and HCV prevalence among HIV-infected women was found, contrasting with prior research. Studies in Nigeria by Nnakenyi *et al*. (2020) in Enugu [13], Odjimogho *et al*. (2018) in Jos [27], and Mabayoje *et al*. (2013) [28] identified higher HCV prevalence in older groups (41-50, 48-57, and 30-39 years, respectively). Similar trends were noted internationally in Cambodia [29] and Rwanda [30], with peaks at >55 and ≥65 years, respectively, suggesting age as a potential risk factor for HCV. Our findings might differ due to our smaller sample size of 360, which might not capture age-related trends as effectively as larger studies. Further research with broader samples is necessary to elucidate the age-HCV relationship in this demographic.

Our study found no significant association between marital status and HBV or HCV seropositivity, consistent with findings from Sale *et al*. (2022) in Yola among HIV-positive individuals [11]. Although neither our study nor Sale et al.'s identified marital status as an independent risk factor, marital status might still contribute to co-infection risk through interactions with other social or behavioral factors. For instance, specific marital practices or social behaviors within certain cultural contexts might elevate the risk for HBV and HCV transmission through increased exposure to unsafe injection practices or unprotected sexual encounters. Future research should aim to dissect these complex interactions to better understand how marital status influences the risk for HBV and HCV co-infection.

Our study revealed no significant association between educational background and HBV and HCV co-infection prevalence, aligning with findings from Jos by Lar *et al*. (2013) [31] and from Ebonyi by Moses *et al*. (2019) [32].

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Contrarily, Ionita *et al*. (2017) in Nepal found higher HIV/HCV co-infection rates among the more educated [15]. Such disparities might stem from differences in geographical settings, methodologies (like RDT validated with ELISA), or sampling techniques (random vs. targeted), influencing how education impacts healthcare access, prevention awareness, and risk exposure. Despite these varied results, enhancing education on HBV and HCV co-infection remains critical for all educational strata, especially since liver disease from viral hepatitis significantly affects morbidity and mortality in HIV populations [23].

Our study identified no significant association between occupation and the prevalence of HIV/HBV or HIV/HCV co-infection, aligning with findings from Ebonyi by Moses *et al*. (2019) [32]. Contrarily, Lar *et al*. (2013) in Jos discovered higher prevalence among housewives and businesswomen [31], and Mohammadi *et al*. (2009) in Iran also noted increased prevalence among housewives [33]. These differences might stem from how occupations were classified; our study did not list 'housewife' as a distinct category, potentially obscuring related risk factors. Future research should employ refined, contextually appropriate occupational classifications to better understand the link between occupation and co-infection prevalence.

HBV co-infection was significantly higher among those with a history of blood transfusion (AOR: 2.291; 95% CI: 1.322–3.968; *P*=0.03). However, contrary findings from Lagos, Nigeria by Ezechi *et al*. (2014) [34], and from Nepal by Ionita *et al*. (2017) [15] reported no such association. Our smaller sample size (360) compared to Ezechi *et al*. (2391) and Ionita *et al*. (800) might have influenced our findings, potentially due to reduced statistical power. Additionally, differences in HIV prevalence between Nepal (0.2%) and Nigeria (1.4%) might affect the baseline opportunity for HBV co-infection.

No significant association was found between HBV co-infection and having multiple sex partners or engaging in drug injection in our study, aligning with findings from Nepal by Ionita *et al*. (2017) where similar results were observed in an HIV-positive cohort [15]. Both studies suggest these behaviors might not be primary risk factors for HBV among HIV patients in these settings. Further research should delve into why these risk behaviors do not correlate with HBV co-infection in these populations, potentially examining other transmission routes or protective behaviors.

This study underscores the necessity for routine HBV and HCV screening in HIV-positive women at ART clinics in Yola, advocating for the integration of these screenings into existing HIV care protocols to facilitate early co-infection detection and management. The data from this research offer a benchmark for assessing current prevention strategies and can guide the Federal Ministry of Health in Nigeria toward developing more nuanced guidelines for managing co-infections in this demographic.

Physicians providing care to HIV-positive women should screen for HBV infection before initiating ART, based on clinical guidelines. HBV vaccination should be offered to all women who test negative for HBsAg, following the WHO's recommended vaccination schedule. For individuals who do not respond to the primary vaccination series, a booster dose is recommended if there is no seroconversion after the initial series. All HIV-positive women should receive counseling on the risks of bloodborne disease transmission through unscreened blood transfusions and unprotected sex [2].

This study has several limitations. First, the study did not assess occult hepatitis B infection, which might lead to underestimation of HBV prevalence. This omission likely impacts the estimated prevalence of HBV/HCV co-infection and the assessment of associated risk factors. Limited resources prevented the collection of data on additional clinical factors, such as HIV viral load and CD4+ cell counts. These factors may confound the relationship between the studied variables and co-infection risk. Future studies should incorporate these clinical parameters to provide a more comprehensive understanding of the factors influencing HBV and HCV co-infection in this population. Moreover, the next investigations should focus on the impact of HBV and HCV co-infection on HIV viral load and disease progression in this population. Studies with larger sample sizes and longitudinal designs would provide deeper insights into these relationships.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest associated with this manuscript.

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