Science Journal of University of Zakho

DOI: https://doi.org/10.25271/sjuoz

Original Article

MULTIVARIABLE MODELLING OF PREDICTORS OF HEPATITIS C VIRUS SEROPOSITIVITY IN HIV-INFECTED INDIVIDUALS IN NORTH-CENTRAL NIGERIA.

Odebisi-Omokanye, Mutiat Busayo[1,*], Suleiman, Muhammed Mustapha[2], Abdulazeez-Bukoye, Hafsat Damilola[1], Salaudeen, Aminat Omotoke[1],

[1]Medical Microbiology Unit, Department of Microbiology, University of Ilorin, P.M.B. 1515 Ilorin, Nigeria.
[2]Medical Microbiology Unit, Department of Biological Sciences, Al-Hikmah University, Ilorin, Nigeria.

**Corresponding author, E-mail:* odebisi.mb@unilorin.edu.ng (Tel: +234-8034006111)

Received:
10, Nov, 2025

Accepted:
04, Mar, 2026

Published:
12, Apr, 2026

ABSTRACT

This study investigates the co-infection of HCV and its risk factors amongst HIV-positive patients in Ilorin, Kwara State, Nigeria. Consenting HIV-positive individuals (n=188) from the HAART clinic at Sobi Specialist Hospital participated. Data was collected via structured questionnaire while Anti-HCV antibodies were determined via a 3rd-generation ELISA kit (Diagnostic Automation Inc., USA). SPSS version 21 and R-Studio 4.5.1 were used for the data analysis and multivariable logistic regression model analysis after adjusting for confounding variables at p≤ 0.05 and 95%CI for statistical significance. Participants average was 31.47±7.79 years comprising 41.5% and 58.5%. HCV seropositivity was 8.5%. Significant association with HCV infection included age (p < 0.001-AOR:4.28-CI:1.82-10.13) and marital status (p=0.026-AOR:2.65-CI:1.14-6.18). Clinically, history of jaundice (p=0.028- AOR:3.45-CI:1.09-10.84) and recent blood transfusion (p = 0.030) were also significant risk factors; whereas, surgery, tattooing, homosexual practices, and injection drug use were not. HCV-positivity was common among participants with low CD4 counts (<500 cells/mm³) at p=0.94). Similarly, anti-retroviral therapy (ART) duration showed no significant association to HCV status. This study confirms the occurrence of HIV/HCV co-infection in Ilorin, emphasizing the roles of specific sociodemographic and clinical variables. Routine HCV screening within HIV care is recommended to enable early diagnosis, optimize management and improve patient outcomes.

KEYWORDS: Hepatitis C virus; HIV; CD4+; Co-infection, Multivariable

1. INTRODUCTION

Human Immunodeficiency Virus (HIV) and Hepatitis C Virus (HCV) infections pose a global health concern with significant burden in sub-Saharan Africa (Baeke *et al*., 2021). Globally, an estimated 5-20% out of the 37 million HIV positive individuals are concomitantly infected with HCV (WHO, 2019). The immunological burden of HIV can hasten the progression of liver fibrosis and contribute to a more aggressive clinical course of liver disease among infected persons with untreated HCV (Vogel *et al*., 2012). There is a threefold greater risk of progression to cirrhosis in persons with HCV and HIV coinfection compared with those who are infected with HCV only (Graham *et al*., 2001). Due to suppressed immunity, infected individuals undergo lower viral clearance alongside elevated HCV RNA in body fluid which increases the risk of hepatotoxicity (Gedefie *et al.,* 2021). Up to 80-90% of liver-related deaths in persons living with HIV have been attributed to HCV infection (Madhava *et al*., 2002).

The prevalence of HIV/HCV coinfection among people infected with is higher in developing countries and varies disproportionally in different geographical locations within the sub-Saharan Africa from 0% to 22% (Barth *et al*., 2012). Co-infection of one or more of the Hepatitis C with HIV is very much likely as these viruses share similar routes of transmission including unprotected sexual practices, vertical transmission form mother-to-child transmission, transfusion of unscreened blood, sharing of needles by intravenous drug user, injection with contaminated sharps in the healthcare setting, traditional tattooing and scarification among other (Adesegun *et al.,* 2020). Studies in Nigeria have shown HIV-HCV co-infection rates to range between 13.5% and 5% among the HIV seropositive individuals (Okwori *et al*., 2013; Adesegun *et al.,* 2020).

Prompt and proper intervention and monitoring are needed to improve the quality of treatment and increase life expectancy of HIV-infected patients co-infected with HCV (Gedefie *et al*., 2020). It is imperative that there should be proper understanding of the predisposing factors in relation to the prevalence for well-informed strategic preventive measures towards burden reduction. Additionally, all HIV patients should be routinely tested for markers of HCV infection, and emphasis should be given towards the advantage of early detection and therapy to reduce co-infection-related morbidity and mortality. Despite these facts, little attention is given about HCV/HIV co-infections in Nigeria, and HCV is not being routinely screened for among HIV patients. Few studies have been conducted in Nigeria on co-infection of the two viruses but there's sparse information about its burden and related risk factors in North-Central Nigeria. Since HIV individuals are at high risk of HCV infection, this study seeks to evaluate the prevalence of the co-infection alongside regression analysis of the predictors of HCV positivity among

Access this article online

https://doi.org/10.25271/sjuoz.2026.14.2.1632

Printed ISSN 2663-628X;
Electronic ISSN 2663-6298

Science Journal of University of Zakho
Vol. 14, No. 02, pp. 327 –332 January-2026

HIV positive individuals on anti-retroviral therapy (ART) at Sobi Specialist Hospital, Ilorin, Kwara State, Nigeria. This will address hospital practices and related policies to inform routine serological screening of HIV positive individuals.

2. MATERIALS AND METHODS

Study Area:

The study was carried out at Sobi Specialist Hospital, Ilorin, Kwara State, Nigeria. Kwara is a state in the North-Central geopolitical zone of Nigeria, with a land area of about 36,825^{2}km (https://www.nipc.gov.ng/nigeria-states/kwara-state/). The capital is Ilorin. The hospital delivers secondary health-care services and has an anti-retroviral therapy (ART) clinic, providing HIV Voluntary Counselling and Testing (VCT).

Study Design and Population:

The study population were patients who attended the antiretroviral clinic at the Sobi Specialist Hospital, Ilorin, and had been on antiretroviral drugs (HAART), who gave their consent. The study size was determined using the Cochran's formula. This was a purposive study that took place from January to March 2025, and 188 HIV positive individuals were enrolled. A structured questionnaire was used to obtain information on their sociodemographic characteristics, medical history, and any risk factors that predispose the participants' acquisition of HCV such as sociodemographic, clinical, behavioral as well as treatment related factors. Eligible participants included those with confirmed positive HIV status enrolled in the Hospital, above age 15years, on ART and consent to participate while individuals who decline enrollment, had incomplete questionnaire, unable to provide blood sample and did not meet the inclusion criteria were excluded.

Sample Collection:

Five milliliters of blood samples were collected through venipuncture into EDTA bottles to prevent coagulation. The samples were then spun at 3000 rpm for 10 minutes to separate the plasma from the whole blood. Plasma was kept at -20°C until needed for serological assay for HCV antibody.

Anti-HCV Antibody Detection:

The plasma was analyzed for anti-HCV antibody detection using anti-HCV enzyme-linked immunosorbent assay (ELISA) kit *(*DIAGNOSTIC AUTOMATION INC., USA*)* according to the manufacturer's instructions. The assay results were represented quantitatively as the sample-to-cutoff (S/CO) ratio (R), calculated by dividing the optical density (OD) of each sample by the assay's cut-off OD of 0.201. Thus, samples with R greater than 1.0 were regarded as positive while R values less than 1.0 were considered negative to anti-HCV antibody.

Data Processing and Analysis:

Statistical Packages for Social Science (SPSS) version 21 software (IBM, USA) was used for the computation and analysis of data. Descriptive statistics, such as frequencies, percentages, and means, were used when needed to arrange and describe the data. To assess differences between means, the student's t-test was employed, and the Chi-square test was utilized to study discrete variables. Additionally, adjustment of confounders was done in a multivariable logistic regression model using R studio 4.5.1 where Odd Ratio and Confidence Interval (CI) were presented on color coded forest plot. Statistical significance was considered at $p<0.05$ and CI:95%.

3. RESULT

A 100% response rate was recorded in this study, where all the enrolled HIV positive individuals participated (n=188). The mean age of the respondent was 31.47 ±7.79 years, comprising 78 (41.5%) males and 110 (58.5%) females. Analysis of age distribution showed that, the highest number of participants were within the 21–30 year age group (98; 51.1%), followed by the 31–40 and >40 year age groups. Among all participants, 116 (61.7%) were married, and 72 (38.3%) were single. The participants' occupation revealed that 68 (36.2%) were self-employed, 54 (28.7%) were civil servants, 36 (19.1%) were traders, 14 (7.4%) were students, and 16 (8.5%) were unemployed (Table 1).

HCV prevalence of 8.5%, i.e., 16 out of 188 participants, was recorded with the highest proportions among participants of age 21–30 years (8.2% i.e. 8 of 98) and >40 years (28.6% i.e. 8 of 28) at $\chi^2 = 29.20$ and $p < 0.001$. Gender and occupation showed no statistically significant associations with HCV infection ($p = 0.162$ and $p = 0.139$, respectively). Married individuals had a higher rate of seropositivity (14 out of 116; 12.1%) compared to single participants (2 out of 72; 2.8%) at $\chi^2 = 4.93$ and $p = 0.026$). No statistical correlation was recorded for participant's level of education and HCV seropositivity at $\chi^2 = 9.45$ and $p = 0.051$ (Table 1).

In examining clinical and behavioral risk factors, 40 participants indicated that they had recently received a blood transfusion, but none of them tested positive for HCV antibodies (0.0%). In contrast, among participants without a transfusion history, 16 individuals (10.8%) tested positive for HCV. This difference was found to be statistically significant ($\chi^2 = 4.73$; $p = 0.03$). Other factors, such as recent surgery ($p = 0.70$) and a history of liver disease ($p = 0.08$), did not demonstrate significant links to HCV infection. Conversely, a medical history of jaundice demonstrated a statistically significant relationship with HCV seropositivity, with 4 out of 18 participants reporting jaundice (22.2%) testing positive compared with 12 of 170 (7.1%) among those without such history ($\chi^2 = 4.81$; $p = 0.028$). Other behavioral factors such as tattooing, homosexual practices, and drug use injection did not show statistically significant associations with HCV seropositivity (Table 2).

Table 1: Sociodemographic Characteristics of HIV-Infected Participants and Their Association with HCV Seropositivity

Factors		Positive (%)	Negative (%)	X^2 (P value)
Age	≤20	0 (0.0)	10 (100.0)	29.199(0.000) *
	21–30	8 (8.2)	90 (91.8)	
	31–40	0 (0.0)	52 (100.0)	
	>40	8 (28.6)	20 (71.4)	
Gender	Male	4 (25.0)	74 (43.0)	1.959(0.162)
	Female	12 (75.0)	98 (57.0)	
Educational Level	Primary	8 (13.8)	50 (86.2)	9.45(0.051)
	Secondary	0 (0.0)	8 (100.0)	
	Tertiary	6 (5.5)	104 (94.5)	
	Student	2 (33.3)	4 (66.7)	
	No formal education	0 (0.0)	6 (100.0)	
Occupations	Civil Servant	6 (37.5)	48 (27.9)	6.939(0.139)
	Self Employed	4 (25.0)	64 (37.2)	
	Student	0 (0.0)	14 (8.1)	

	Trader	6 (37.5)	30 (17.4)	
	Unemployed	0 (0.0)	16 (9.3)	
Marital Status	Single	2 (12.5)	70 (40.7)	4.925(0.026) *
	Married	14 (87.5)	102 (59.3)	

*p<0.05= Statistical Significance

Table 2: Clinical and Behavioral Risk Factors Associated with HCV Seropositivity among HIV-Infected Individuals

Factors		Positive (%)	Negative (%)	X^2 (P value)
Recent Surgery	Yes	4 (10.0)	36 (90.0)	0.145(0.704)
	No	12 (8.1)	136 (91.9)	
Recent Blood Transfusion	Yes	0 (0.0)	40 (100.0)	4.727(0.030) *
	No	16 (10.8)	132 (89.2)	
Liver Disease	Yes	0 (0.0)	28 (100.0)	3.060(0.080)
	No	16 (10.0)	144 (90.0)	
Medical History of Jaundice	Yes	4 (22.2)	14 (77.8)	4.806(0.028) *
	No	12 (7.1)	158 (92.9)	
Homosexualism	Yes	2 (8.3)	22 (91.7)	0.000(0.960)
	No	14 (8.5)	150 (91.5)	
Tattoo	Yes	2 (6.3)	30 (93.7)	0.250 (0.620)
	No	14 (9.0)	142 (91.0)	
Drug Injection	Yes	6 (10.3)	52 (89.7)	0.350(0.550)
	No	10 (7.7)	120 (92.3)	

*p<0.05= Statistical Significance

Regarding treatment history and immunological status, HCV seropositivity was most common among participants who had been on ART for 6–10 years (8/104; 7.7%), followed by those with treatment durations of ≤5 years (6/78; 7.7%) and >10 years (2/6; 33.3%). Although seropositivity appeared higher among participants on long-term therapy, the association between treatment duration and HCV infection was not statistically significant ($\chi^2 = 4.90$; p = 0.09) (Figure 1). According to WHO immunological staging, most HCV-positive cases in this study occurred among participants with CD4 counts below 500 cells/mm³, indicating mild to moderate immune suppression. Specifically, 6 of 74 participants (8.1%) with CD4 counts between 200–349 cells/mm³ and 6 of 62 participants (9.7%) with CD4 counts between 350–499 cells/mm³ were HCV positive. Among participants with CD4 counts ≥500 cells/mm³, 4 of 52 (7.7%) tested positive for HCV antibodies. Although HCV seropositivity appeared slightly higher among individuals with lower CD4 counts, the association between CD4 count category and HCV infection was not statistically significant ($\chi^2 = 0.13$; p = 0.94) (Figure 1).

Figure 2 presents the multivariable logistic regression model for the strength and direction of the relationship between selected significant variables across the clinical and demographic variables to HCV seropositivity after confounders adjustment. The significant predictors at P<0.05 are represented as green while blue depicts otherwise for HCV infection. The 95% confidence intervals are represented by the horizontal lines and the vertical line is for the AOR =1, where any association crossing that line has no statistical significance. To simply put, the values to the right of 1 indicate increased odds of HCV infection, while those to the left suggest a protective effect (none observed here) or non-significance.

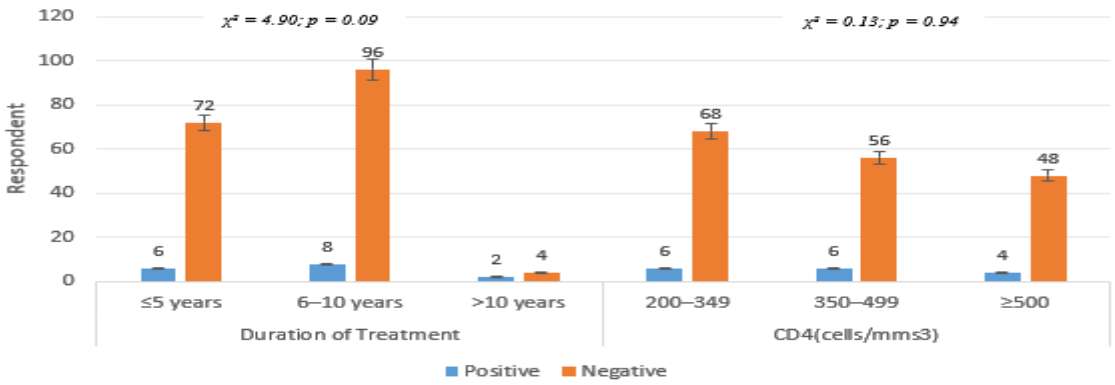

Figure 1: Association between Treatment Duration and CD4 Count Categories in relation HCV Seropositivity among HIV-Infected Participants

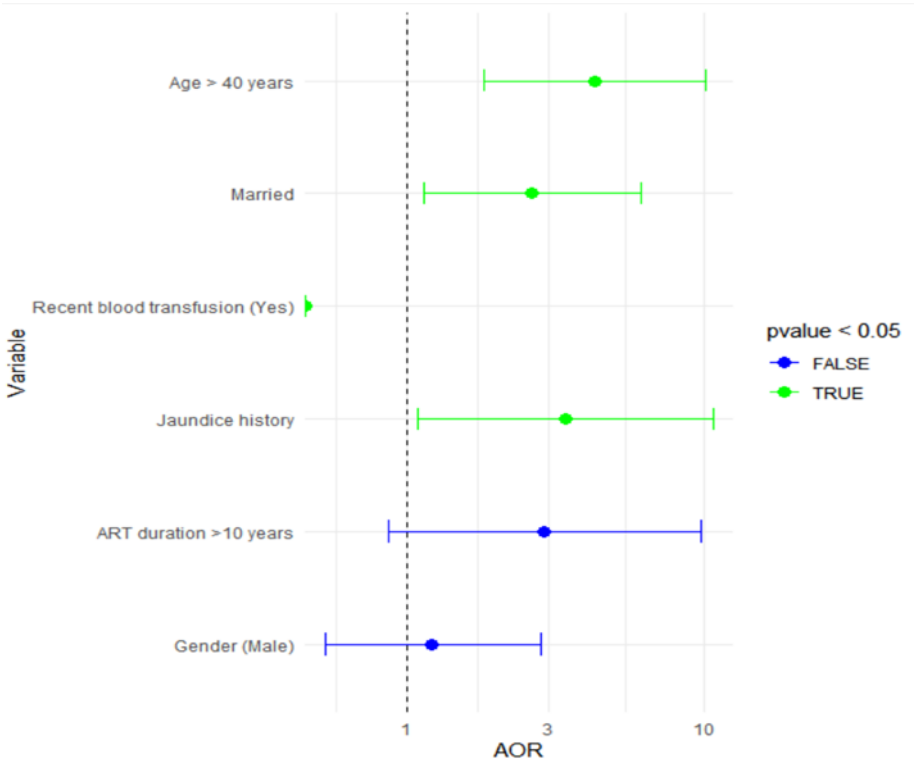

Figure 2: Multivariable Logistic Regression Analysis Showing Predictors of HCV Seropositivity Among HIV-Positive Individuals

4. DISCUSSION

Liver illness is a significant health risk for those living with HIV, and HCV infections are a significant factor in the higher morbidity and death rate among HIV patients, which causes end-stage liver disease, hepatocellular carcinoma, and AIDS to proceed quickly. Therefore, it is important to investigate HCV infection in HIV-positive individuals to shield them from complications and other diseases (Spera *et al.,* 2024).

The observed HCV seroprevalence of 8.5% among HIV-positive participants in this study aligns with global meta-analyses that estimate HIV/HCV co-infection at approximately 6.2%, though it exceeds Nigerian reports of 4.0% in Yenagoa (Okonko & Shaibu, 2023) and 4.3% in Anambra State. This disparity shows the complex epidemiology of HCV in Nigeria, where co-infection rates range from 4.0% in the South-South to as high as 14.6% in rural northern communities (Adesegun *et al.*, 2020) reflecting regional differences in risk exposure, healthcare access, and screening practices.

The HCV positivity among the married individuals ($p = 0.026$) was noticed to be high. This was in contrast with other studies that reported single group participants having higher positivity or marital status having no correlation to the infection (La *et al.,* 2007; Romano *et al*., 2010). This can be adduced to possible region-specific transmission dynamics that differ from one study location to another. The trend could also be related to norms of culture or tradition which includes scarification rituals, or in other cases differences in healthcare-seeking behavior between the groups of married and unmarried (Daw, 2016). The outcome of seroprevalence was further affirmed in this study by the recorded higher odds of HCV seropositivity among the married respondents. This is similar to a study that posited that increased sexual activity among married group could be a contributory factor to increased prevalence (Warssamo 2025). It can also be deduced that household-level transmission pathways may contribute meaningfully to HCV spread in certain Nigerian contexts, as well as the challenging traditional assumptions that primarily link HCV transmission to parenteral exposure (Adesegun *et al.,* 2020; Okonko & Shaibu, 2023).

HCV-positive cases were noticed to be higher within the 20 to 49 years age group at statistical significance of $p < 0.001$ which aligns with a previous report of higher prevalence among the middle-aged adults (Taye & Lakew, 2013). This may be a reflection or interplay of the risk of cumulative exposure and age-related immunologic factors that influence viral persistence. As supported by the model, respondents that are >40 years of age had significantly higher odds of HCV infection than those below indicating increase of exposure risk over time. Age has been suggested as a key factor in the understanding of the spread of HCV in sub-Saharan where higher positivity was reported among the ≥41 years participants (Nnakenyi *et al.*, 2019).

Although, the model outcome posits that the risk of transfusion transmitted HCV still remains a burden as depicted by the highly strong association within participants with recent blood transfusion. It is noteworthy that this study recorded a complete absence of HCV among transfusion recipients contrasting with a 10.8% prevalence among non-transfused individuals ($p = 0.030$). This could be a reflection of success and improvement on the blood safety protocols being used in Nigeria since 2015 (Aneke & Okocha, 2017). This is also consistent with recent findings from Nigerian cohorts showing a decrease in transfusion-related HCV due to improved screening and safer blood handling methods (Okonko & Shaibu, 2023; Abass *et al.,* 2024).

There is a notable link between a history of jaundice and HCV seropositivity ($p = 0.028$), highlighting the liver-targeting nature of HCV and its contribution to worsening liver issues in individuals who are co-infected. The model also affirms that there could be incidence of past undiagnosed HCV infection due to the significant correlation of jaundice history to HCV positivity. This finding is consistent with recent research from Nigeria that points to the significance of liver-related symptoms as early signs of HCV infection in those living with HIV, where jaundice frequently indicates worsening liver damage and fibrosis (Okonko & Shaibu, 2023; Odeghe *et al.,* 2024).

While the distribution of CD4 counts did not show a statistically significant relationship with HCV infection ($p = 0.640$), there was a higher prevalence of HCV-positive cases in

the 250–550 cells/mm³ range, which corresponds to WHO immunological stages II–III. This suggests a level of immune suppression that may help HCV persist. This observation aligns with emerging evidence that immune dysfunction during these stages hinders the body's ability to clear the virus, thereby promoting its persistence (Hernandez & Sherman, 2011; Vlasova *et al.*, 2025). While CD4 count did not show a significant link to HCV infection (p = 0.94), most cases of HCV were found in participants with CD4 counts ranging from 200 to 499 cells/mm³, which aligns with WHO immunological stages II–III. This level indicates moderate immune suppression, potentially hindering the clearance of HCV and allowing the virus to persist. The lack of HCV positivity in individuals with CD4 counts of 550 cells/mm³ or higher suggests that a stronger immune system may offer some protection against acquiring or progressing HCV, emphasizing the relationship between the host's immune response and viral behavior in co-infection situations (Ugwu *et al.,* 2023).

Similarly, the duration of ART exposure showed no statistically significant relationship with HCV seropositivity (p=0.12), although this observed trend could be clinically important. HCV seropositivity was comparable among participants who had received ART for ≤ 5 years and 6–10 years (7.7% each), but notably higher among those on treatment for > 10 years (50.0%). Although ART duration of greater 10 years and gender were non-significant predictors (P>0.05) in the model for HCV infection in this study, increased odds were recorded for the variables. This could have potentially resulted from the categorically small sample size. The positivity trend may indicate a cumulative exposure effect in long-term survivors rather than a direct correlation between treatment duration and infection risk. Similar trends have been noted worldwide, where extended ART can help maintain immune function but does not fully eliminate the risk of infections from hepatotropic viruses. These findings show the importance of longitudinal monitoring and regular HCV screening for patients on long-term ART (Okwuraiwe *et al.,* 2021).

Study Limitations:

This analysis was limited due to a lack of molecular verification such as HCV RNA testing or genotypic determination that would have provided more accurate data on active infection and circulating viral strains. Further investigation that includes molecular test is suggested to support these serological results, and better understand the characteristics of HIV/HCV co-infection in this area.

CONCLUSION

This study presents the continued public health relevance of HIV/HCV co-infection in Ilorin, North-Central Nigeria underscoring the effect of demographic and clinical factors as risk factors among the HIV positive populace. These findings emphasize the need for targeted screening and preventive interventions among high-risk subgroups, especially for HIV positive individuals showing identifiable clinical and demographic vulnerabilities. Strengthening of laboratory capacity for molecular detection and genotyping is also necessary to confirm active infection and guide focused interventions. Further studies using molecular testing with larger multicenter samples would be necessary to improve knowledge of the HCV transmission chain among people living with HIV in Nigeria.

Acknowledgments:

We want to express our sincere appreciation to the Kwara State Ministry of Health, Sobi Specialist Hospital, and participants for their respective roles in this study.

Ethical Statement:

Approval was sought and obtained before the commencement of this study from Kwara State Ministry of Health, Fate-Tanke, Ilorin. Ethical Number: MOH/KS/EU/777/584.

Author Contributions:

O. O. M. B: Conceptualization, methodology, supervision, project administration, and writing – original draft preparation. **. S. M M:** Data curation, formal analysis, investigation, and writing – review and editing. **A. B. H. D.:** Investigation, data collection, and writing – review and editing. **S. A. O:** Investigation, data collection, validation, and writing – review and editing. All agreed to the published version of the manuscript.

Conflict of Interest:

The authors declare no conflict of interest.

Funding:

This study received no external funding.

REFERENCES

Adesegun, O. A., Olaniran, O. H., Bamidele, E., Inyang, J. N., Adegbe, M., Binuyo, T. O., Ehioghae, O., Adeyemi, O., Oyebisi, O., Idowu, A. O., & Ajose, O. (2020). HIV-hepatitis co-infection in a rural community in Northern Nigeria. *Pan African Medical Journal, 36*(352), 1–13. https://doi.org/10.11604/pamj.2020.36.352.23978

Aneke, J.C. & Okocha, C.E. (2017). Blood transfusion safety; current status and challenges in Nigeria. *Asian J Transfus Sci.*11(1):1-5. doi: 10.4103/0973-6247.200781.

Daw, M. A., El-Bouzedi, A. A., Ahmed, M. O., Dau, A. A., Agnan, M. M., & Drah, A. M. (2016). Geographic integration of hepatitis C virus: A global threat. *World Journal of Virology, 5*(4), 170–182. https://doi.org/10.5501/wjv.v5.i4.170

Gamawa, Z. R., Shehu, K., & Moi, I. M. (2024). Prevalence and risk factors of hepatitis B and C co-infection and their correlation with CD4 cells and liver enzymes in HIV patients at a teaching hospital in Nigeria. *SN Comprehensive Clinical Medicine.* https://doi.org/10.1007/s42399-025-01778-7

Gedefie, A., Adamu, A., Alemayehu, E., Kassa, Y., & Belete, M. A. (2021). Hepatitis C virus infection among HIV-infected patients attending Dessie Referral Hospital, Northeastern Ethiopia. *International Journal of Microbiology, 2021,* 6675851. https://doi.org/10.1155/2021/6675851

Graham, C. S., Baden, L. R., Yu, E., Mrus, J. M., Carnie, J., Heeren, T., & Koziel, M. J. (2001). Influence of human immunodeficiency virus infection on the course of hepatitis C virus infection: A meta-analysis. *Clinical Infectious Diseases, 33*(4), 562–569. https://doi.org/10.1086/321909

Hernandez, M. D., & Sherman, K. E. (2011). HIV/hepatitis C coinfection natural history and disease progression. *Current opinion in HIV and AIDS,* 6(6), 478–482. https://doi.org/10.1097/COH.0b013e32834bd365

La, T. P., & Deschênes, M. (2007). Mode of transmission, rather than the hepatitis C virus, as a major determinant of poor interpersonal relationships in patients with chronic hepatitis C. *Canadian Journal of Gastroenterology, 21*(12), 815–819. https://doi.org/10.1155/2007/135414

Nnakenyi, I. D., Uchechukwu, C., & Nto-Ezimah, U. (2020). Prevalence of hepatitis B and C virus co-infection in HIV-positive patients attending a health institution in

Southeast Nigeria. *African Health Sciences, 20*(2), 579–586. https://doi.org/10.4314/ahs.v20i2.5

Odeghe, E., Oyeleke, G., Odofin, M., Duguru, M., Davwar, P., Nyam, D., Lesi, O., Okeke, E., Adelabu, H., Odukoya, O., Akanmu, A., Adeyemo, W., Abdulkareem, F., Imade, G., Joyce, B., Khan, I., Chandler, A., Sagay, A., Murphy, R., & Hawkins, C. (2024). Hepatitis B and C virus co-infection and their association with liver disease in persons with HIV in Nigeria. *Journal of the International Association of Providers of AIDS Care, 23,* 1–8. https://doi.org/10.1177/23259582241292511

Okonko, I., & Shaibu, N. (2023). Evidence of HIV/HCV co-infection among people living with HIV/AIDS attending Federal Medical Centre, Yenagoa, Nigeria. *medRxiv.* https://doi.org/10.1101/2023.03.08.23286986

Okwuraiwe, A. P., Audu, R. A., Ige, F. A., Salu, O. B., Onwuamah, C. K., & Musa, A. Z. (2021). Long-term outcomes of highly active antiretroviral therapy in HIV-infected Nigerians and those co-infected with hepatitis B and C viruses. *African Journal of Clinical and Experimental Microbiology, 22*(1), 67–73. https://doi.org/10.4314/ajcem.v22i1.9

Romano, C. M., de Carvalho-Mello, I. M. V. G., Jamal, L. F., de Melo, F. L., Iamarino, A., Motoki, M., *et al*. (2010). Social networks shape the transmission dynamics of hepatitis C virus. *PLoS ONE, 5*(6), e11170. https://doi.org/10.1371/journal.pone.0011170

Spera, A. M., Pagliano, P., & Conti, V. (2024). Hepatitis C virus eradication in people living with human immunodeficiency virus: Where are we now? *World Journal of Hepatology, 16*(5), 661–666. https://doi.org/10.4254/wjh.v16.i5.661

Taye, S., & Lakew, M. (2013). Impact of hepatitis C virus co-infection on HIV patients before and after highly active antiretroviral therapy: An immunological and clinical chemistry observation, Addis Ababa, Ethiopia. *BMC Immunology, 14,* 23. https://doi.org/10.1186/1471-2172-14-23

Ugwu, C. H., Oketah, E. N., Okerentugba, P. O., & Frank-N. (2023). Co-infection of hepatitis C among HIV-infected patients: A cross-sectional study from a university teaching hospital in Anambra State, Nigeria. *Nigerian Journal of Medical Sciences,* 2–8.

Vlasova, V., Saidakova, E., Korolevskaya, L., Shmagel, N. & Shmagel, K. (2025). Assessment of CD4+ T cell recovery after direct-acting antiviral hepatitis C treatment in HIV/HCV coinfected immunological nonresponders to ART. *Explor Med.* 6,1001323. https://doi.org/10.37349/emed.2025.1001323

Warssamo, B. B. (2025). Generalized linear modeling of HCV infection among medical waste handlers in Sidama Region, Ethiopia. *Frontiers in Epidemiology, 4,* 1485482. https://doi.org/10.3389/fepid.2024.1485482

World Health Organization (WHO). (2019). *Global hepatitis report 2019.* Geneva, Switzerland: World Health Organization. https://www.who.int/publications/i/item/global-hepatitis-report-2019