Prevalence of hepatitis B virus infection and associated risk factors among adult females infected with Human Immunodeficiency Virus in Ogun State, Nigeria

John Cletus Ihongbe¹, Seyi Samson Enitan¹, Michael Olugbamilu Dada¹, Oluchi Ofem¹, Oluchi Gladys Ofem¹, Effiong Joseph Effiong¹, Olalekan Ademola Kemiki², Amarachi Favour Ogbonna¹

¹Department of Medical Laboratory Science, Babcock University, Ilishan-Remo 121103, State, Nigeria. ²Babcock University Teaching Hospital, Molecular and Tissue Culture Laboratory, Ilishan-Remo 121103, Nigeria.

*Corresponding to: Seyi Samson Enitan. Department of Medical Laboratory Science, Babcock University, Ilishan-Remo 121103, Nigeria. E-mail: enitans@babcock.edu.ng.

Abstract

**Background:** Hepatitis B virus (HBV) infection is prevalent in sub-Saharan Africa, including Nigeria, and is frequently observed in individuals co-infected with human immunodeficiency virus (HIV). **Objective:** This study aims to evaluate the prevalence of serological markers for hepatitis B virus and identify the associated risk factors among women with HIV undergoing highly active antiretroviral therapy (HAART) in Ogun State, Nigeria. **Methods:** Ethical approval was obtained from the Babcock University Health Research Ethics Committee (BUHREC) to recruit a total of 110 adult women infected with HIV, receiving treatment at the HIV clinics of Babcock University Teaching Hospital (BUTH) in Ilishan-Remo and General Hospital in Ijebu-Ode, both located in Ogun State, Nigeria. The participants’ HIV status were confirmed using three rapid diagnostic kits: Determine (Abbott Laboratories, Tokyo, Japan), Unigold HIV (Trinity Biotech Plc Bray, Co. Wicklow, Ireland), and 1/2 Stat Pak (Abbott Laboratories, Tokyo, Japan) (Chembio Diagnostic Systems, New York, USA). Additionally, an HBV 5 in 1 Panel manufactured by Innovation Biotechnology Co., Ltd in Beijing, China, was employed to detect HBV markers qualitatively in serum samples. **Results:** Out of the 110 subjects that voluntarily participated in the study, 4 (3.6%) tested positive for HBsAg, 2 (1.8%) tested positive for HBsAb, 81 (73.6%) tested positive for HBeAg, 3 (2.7%) tested positive for HBeAb, and 65 (59.1%) tested positive for HBcAb. There was no significant correlation between the occurrence of HBsAg and the socio-demographic characteristics of the participants (P > 0.05). Various risk factors were identified, including lack of knowledge about HBV, absence of HBV vaccination history, history of blood transfusion, organ transplant, and engaging in unprotected sex, among others. **Conclusion:** The findings highlight the presence of HBV infection among HIV-positive women undergoing HAART in Ogun State, Nigeria, particularly within the age groups of 18–25 years and 26–30 years. These results emphasize the necessity for continuous and targeted public health interventions among this specific population.

**Keywords:** hepatitis B virus; serological markers; HIV; HAART; adult females; South-West Nigeria

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Background

Hepatitis B virus (HBV) is a common cause of liver diseases globally. It primarily infects the liver, leading to acute and chronic hepatitis. Symptoms of acute hepatitis B range from mild to severe, including fatigue, jaundice, abdominal pain, and loss of appetite [1, 2]. While most individuals recover completely within six months, some develop chronic HBV infection, which can last for years and cause liver damage. Chronic hepatitis B can progress to liver cirrhosis, which may require a liver transplant. Additionally, it significantly increases the risk of liver cancer. Factors such as age, viral load, and immune response affect the outcome of HBV infection. Vaccination and proper management are essential in preventing and reducing liver complications [3–5].

HBV and HIV co-infection is a significant global health concern. According to Corcoran & Kim [6], approximately 8% to 10% of individuals living with HIV are suffering from chronic HBV infection. However, the rates of co-infection differ considerably across different regions of the world: Western Pacific region (11.4%), sub-Saharan Africa region (10.0%), Europe (6.7%), and the Americas (5.3%). The co-infection of these two viruses poses challenges in terms of clinical management and epidemiology, leading to increased rates of illness and death. In sub-Saharan Africa, the prevalence of HIV-HBV co-infection ranges from 0% to 28.4% [7]. The overall global prevalence of HBV infection among people with HIV is reported to be 7.4% [8, 9]. In sub-Saharan Africa, particularly in Nigeria, both HBV and HIV infections are significant health challenges. The prevalence of HIV is over 2% in the population, while at least 8% of the population is affected by hepatitis B. Among people living with HIV, the prevalence of chronic hepatitis B is higher, with rates ranging from 15% to 20%, especially in West Africa and Southern African [10].

HBV and HIV share similar routes of transmission and risk factors, increasing the likelihood of co-infection [11, 12]. The interaction between the two viruses is complex. HBV infection impairs immune recovery in individuals with HIV undergoing antiretroviral therapy, leading to decreased CD4 cell restoration, accelerated disease progression, and increased morbidity and mortality rates. On the other hand, HIV alters the natural progression of HBV infection, resulting in a more aggressive course of chronic HBV, higher rates of cirrhosis, hepatocellular carcinoma, and reduced treatment response [13].

In individuals co-infected with HIV and HBV, various patterns of HBV serology can be observed, influenced by immunosuppression and increased susceptibility to HBV exposure. Immune reconstitution following antiretroviral therapy initiation [14–16] or hepatotoxicity associated with HIV treatment can trigger HBV replication flares [17, 18]. Therefore, it is crucial to investigate the prevalence of HBV serological markers in HIV patients receiving antiretroviral therapy.

It is well-documented that gender-based disparities exist in terms of the prevalence and risk factors related to certain diseases. In this regard, the co-infection of HBV and HIV is of increased interest. While the interaction between the two viruses and their effects on people are still far from being fully understood, adult females stand out as the ideal group of research subjects for further exploration into the matter. With their uniquely adaptive biological, behavioral, and socio-cultural characteristics, understanding the risk factors associated with HBV among HIV-positive women can provide crucial insights into developing personalized treatments and advanced patient care. Therefore, more research directed towards female adults is necessary in order to gain greater insight into HBV and HIV co-infection.

In addition, the research on serological markers and associated risk factors of HBV infection among adult women living with HIV is of paramount importance, yet remains largely ununderstood. To fill existing knowledge gaps and provide invaluable data which may lead to targeted prevention interventions, early detection, and treatment strategies, this research will serve as a significant contribution to the scientific field. The focus on female patients is especially necessary given their higher risk status; additionally, it may provide greater insights for public health policies and programs aiming to reduce the transmission of both HBV and HIV. The results of the research study can thus have great implications in clinical practice, with regards to public health, and for future research efforts. Currently, there is a lack of research on the occurrence of HBV serological markers among HIV-positive patients receiving HAART in Ogun State, Nigeria. Specifically, there is a gap in utilizing the HBV 5 in 1 Panel rapid test kit for this purpose. Furthermore, it is crucial to recognize the risk factors associated with the prevalence of HBV infection in this particular context. Due to the limited understanding in this area, conducting a study becomes necessary. Therefore, the aim of this research is to evaluate the prevalence of hepatitis B virus serological markers and identify the associated factors among HIV-positive female patients undergoing HAART in Ogun State, located in the southwestern region of Nigeria. By investigating the prevalence of HBV infection and analyzing the factors that contribute to its occurrence, we aim to fill the existing knowledge gap and enhance our understanding of this specific population.

Methods

Study Design

This study is a prospective epidemiological research project.

Study area

This study was conducted at two healthcare facilities in Ogun State, Nigeria: Babcock University Teaching Hospital (BUTH) located in Ilishan-Remo and General Hospital in Ijebu-Ode. BUTH is a 300 bed capacity private hospital that functions as the primary tertiary care facility for the neighborhood. The Ilishan-Remo community is situated in the Ilene Local Government Area, which is in the tropical part of southwest Nigeria at coordinates 70 29'00”N, 20 55'00”E. On the other hand, General Hospital in Ijebu-Ode, Ogun State, is a government-owned medical facility with a capacity of 1000 beds. It serves as the sole tertiary hospital in the Ijebu Ode Local Government Area (LGA), which is situated at coordinates 6.81310 N, 3.92499 E in the tropical area of southwest Nigeria.

Study Duration

The research lasted for two months (May–July 2021).

Study population

The research took place among female patients who are HIV-positive and receiving healthcare at the HIV clinic of two healthcare facilities: BUTH, Ilishan-Remo, Ogun State, and General Hospital in Ijebu-Ode, Ogun State, Nigeria.

Determination of sample size

The formula described by Aragome [19] was used for sample size calculation.

\[ n = \frac{Z^2\text{PQD}}{d^2} \]

Where:

- \( n \) = sample size
- \( Z = Z \) statistic indicates a level of confidence, which is commonly set at 1.96 at a 95% confidence interval.
- \( P = \text{Prevalence (Proportion in the population having the particular trait).} \)
- \( Q = 1 - P \)
- \( d = \text{precision (in proportion of one; if 5%, d = 0.05).} \)

To determine the required minimum sample size, the calculation employed a 95% confidence interval, a \( P \) value of 0.063, indicating a prevalence rate of 6.3% for HIV-HBV co-infection based on a previous study conducted by Okocha et al. [20]. Additionally, a margin of error (d) of 0.05 was utilized. In order to enhance the study’s robustness and account for potential non-compliance, an additional 20% of the sample size was incorporated to minimize errors.

Therefore:

\[ n = \left( \frac{1.96}{d} \right)^2 \left( \frac{0.063}{1 - 0.063} \right)(0.05)2 \]

\[ n = 90.7 \approx 91 \]

20% of 91: 20/100 X 91 = 18.2 \approx 19

Sample size was therefore: 91 + 19 = 110
A total of 110 HIV positive female patients were used for the research.

**Sampling technique**

The desired sample size of 110 female patients with HIV who provided consent was achieved through random selection. These patients attended the HIV clinic in each hospital and met the inclusion criteria. Once they agreed to participate, individual interviews were conducted, and their blood samples were collected.

**Eligibility of subjects**

**Inclusion Criteria.** The study randomly selected HIV-positive individuals who were undergoing Highly Active Antiretroviral Therapy (HAART) and were visiting Babcock University Teaching Hospital (BUTH) in Ilishan-Remo, Ogun State, as well as General Hospital in Ijebu-Ode, Ogun State. The patients who were included were at least 18 years old and gave their consents to be recruited for the screening.

**Exclusion Criteria.** Patients under the age of 18 and those who tested HIV-negative were not included in the study.

**Informed Consent**

After obtaining a thorough description of the study’s goal, methodologies, and sample collection procedure, each participant gave informed consent. The individuals’ privacy was protected throughout the study.

**Sample Collection and Storage**

Five millitres (5 ml) of venous blood was drawn from the patients’ veins using plain bottles, and the blood was then allowed to coagulate.

After the blood had clotted, the serum was extracted using a Pasteur pipette. To guarantee timely processing, the specimens were quickly examined.

The sera were held at 2 to 8 °C for up to 3 days if a delay was expected. The specimens were kept below −20 °C for long-term storage. In order to prevent the sera from being repeatedly frozen and thawed, frozen specimens were carefully mixed and thoroughly thawed before testing.

**Laboratory investigations**

**HIV detection.** As per standard procedure, the National HIV sero-diagnosis algorithm was used to determine the HIV status of the study participants. Following the manufacturer’s recommendations, three (3) rapid diagnostic kits were used. Determine (Abbott Laboratories, Tokyo, Japan) and Unigold HIV (Trinity Biotech Plc Bray, Co. Wicklow, Ireland) were used to check each patient's serum for the presence of HIV antibodies. The patient was identified as having HIV if both kits produced positive results, and vice versa. The Tie Breaker 1/2 Stat Pak (Chembio Diagnostic Systems, New York, USA) was employed when the test findings did not agree. By choosing one of the first two kits that agreed with the findings of the third kit, the patient’s HIV serostatus was ascertained [21–23].

**HBV detection.** To assess the qualitative detection of HBV markers in serum samples, an HBV 5 in 1 Panel (HBsAb, HBsAg, HBeAg, HBeAb, HBcAb) provided by Innovation Biotechnology Co., Ltd, Beijing, China, was used. The methodology for this assessment was previously described by Enitan et al. [3].

**Data analysis.** Microsoft Excel was used to enter the raw data. Statistical analysis of the data was carried out with the aid of the Statistical package for social sciences – Version 18.0 (SPSS-18). The prevalence of HBV serological markers among the subjects was determined using the Tukey-Kramer Multiple Comparisons test and the Two-Way Analysis of Variance test to identify any differences that were statistically significant. P values under 0.05 were chosen as the threshold for significance. Tables and charts were used to show the results of the statistical analysis.

**Results**

The aim of this study was to investigate the occurrence of HBV serological markers among HIV-infected individuals receiving HAART in Ogun State, a region in the South-west of Nigeria. Table 1 displays the clinical background of HIV infection and the adherence to HAART medication among the study participants. All participants were aware of their HIV status (100%), and the majority of them were diagnosed within the past 1 to 4 years (38.2%). The remaining diagnosis periods were as follows: more than 6 months (20.0%), 5–10 years (18.2%), more than 10 years (15.5%), and less than 6 months (8.2%). Moreover, most participants reported consistent adherence to HAART medication (63.6%). Figure 1 illustrates the HBV serological profile of the research participants. Out of the 110 study participants, 4 (3.6%) tested positive for HbsAg, 2 (1.8%) tested positive for HBcAb, 81 (73.6%) tested positive for HBeAg, 3 (2.7%) tested positive for HBeAb, and 65 (59.1%) tested positive for HBeAc. The occurrence of HbsAg in relation to the socio-demographic characteristics of the research subjects is presented in Table 2. The analysis demonstrated that there was no significant association between the presence of HbsAg and any of the socio-demographic factors of the study participants (P>0.05).

Table 3 shows the risk factors linked to the occurrence of HBV serological markers among the study participants. Out of the 15 (13.6%) respondents who reported having no knowledge of Hepatitis B virus, 8 (7.3%) and 6 (5.5%) tested positive for HBeAg and HBeAc, respectively. Among the 61 (55.5%) respondents who indicated no history of Hepatitis B Virus vaccination, 2 (1.8%), 1 (0.9%), 47 (42.7%), and 33 (30.0%) tested positive for HbsAg, HBsAb, HBeAg, and HBeAb, respectively. Among the 35 (31.8%) respondents with a history of blood transfusion, 2 (1.8%), 1 (0.9%), 26 (23.6%), and 20 (18.2%) tested positive for HbsAg, HBsAb, HBeAg, and HBeAc, respectively. Among the 3 (2.7%) respondents with a history of organ transplant, 3 (2.7%) and 2 (1.8%) tested positive for HBeAg and HBeAc, respectively. Furthermore, out of the 26 (23.6%) respondents who reported having tattoos/ear piercing, 2 (1.8%), 1 (0.9%), 17 (15.5%), 2 (1.8%), and 14 (12.7%) tested positive for HbsAg, HBsAb, HBeAg, HBeAb, and HBeAc, respectively. Additionally, among the 8 (7.3%) respondents who admitted to sharing sharp objects, 7 (6.4%) and 5 (4.5%) tested positive for HBeAg and HBeAc, respectively. Moreover, among the 36 (32.7%) respondents who engaged in unprotected sex, 3 (2.7%), 1 (0.9%), 19 (17.3%), 3 (2.7%), and 19 (17.3%) tested positive for HbsAg, HBsAb, HBeAg, HBeAb, and HBeAc, respectively.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have knowledge of HIV status</td>
<td>Yes</td>
<td>110</td>
<td>100.0</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Time of HIV diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤6 months</td>
<td>9</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>&gt;6 months</td>
<td>22</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>1–4 Years</td>
<td>42</td>
<td>38.2</td>
<td></td>
</tr>
<tr>
<td>5–10 Years</td>
<td>20</td>
<td>18.2</td>
<td></td>
</tr>
<tr>
<td>&gt;10 Years</td>
<td>17</td>
<td>15.5</td>
<td></td>
</tr>
<tr>
<td>Adherence to HAART Medication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>70</td>
<td>63.6</td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>36</td>
<td>32.7</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>4</td>
<td>3.6</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 Clinical History of HIV infection and adherence to HAART medication of the study participants

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**Figure 1** Hepatitis B virus serological profile of the study participants

**Table 2** The frequency of occurrence of HBsAg in relation to the socio-demographic characteristics of the study participants

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>Number examined N (%)</th>
<th>Number negative N (%)</th>
<th>Number positive N (%)</th>
<th>Pearson Chi-Square ($\chi^2$)</th>
<th>P-Value</th>
<th>Likelihood Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age range</strong></td>
<td>18–25 Years</td>
<td>40(36.4)</td>
<td>38(34.5)</td>
<td>2(1.8)</td>
<td>3.269</td>
<td>0.514</td>
<td>4.547</td>
</tr>
<tr>
<td></td>
<td>26–33 Years</td>
<td>25(22.7)</td>
<td>23(20.9)</td>
<td>2(1.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>34–41 Years</td>
<td>23(20.9)</td>
<td>23(20.9)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>42–49 Years</td>
<td>11(10.0)</td>
<td>11(10.0)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;50 Years</td>
<td>11(10.0)</td>
<td>11(10.0)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td>Single</td>
<td>56(50.9)</td>
<td>53(48.2)</td>
<td>3(2.7)</td>
<td>3.606</td>
<td>0.462</td>
<td>4.690</td>
</tr>
<tr>
<td></td>
<td>Married</td>
<td>19(17.3)</td>
<td>19(17.3)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Separated</td>
<td>11(10.0)</td>
<td>11(10.0)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Divorced</td>
<td>15(13.6)</td>
<td>15(13.6)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Widow</td>
<td>9(8.2)</td>
<td>8(7.3)</td>
<td>1(0.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Religion</strong></td>
<td>Christianity</td>
<td>65(59.1)</td>
<td>62(56.4)</td>
<td>3(2.7)</td>
<td>0.616</td>
<td>0.893</td>
<td>0.970</td>
</tr>
<tr>
<td></td>
<td>Islam</td>
<td>35(31.8)</td>
<td>34(30.9)</td>
<td>1(0.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>8(7.3)</td>
<td>8(7.3)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>2(1.8)</td>
<td>2(1.8)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tribe</strong></td>
<td>Hausa</td>
<td>27(24.5)</td>
<td>26(23.6)</td>
<td>1(0.9)</td>
<td>2.201</td>
<td>0.532</td>
<td>3.216</td>
</tr>
<tr>
<td></td>
<td>Igbo</td>
<td>33(30.0)</td>
<td>33(30.0)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yoruba</td>
<td>29(26.4)</td>
<td>27(24.5)</td>
<td>2(1.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>21(19.1)</td>
<td>20(18.2)</td>
<td>1(0.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Educational status</strong></td>
<td>None</td>
<td>16(14.5)</td>
<td>16(14.5)</td>
<td>0(0.0)</td>
<td>1.224</td>
<td>0.747</td>
<td>1.926</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>5(4.5)</td>
<td>5(4.5)</td>
<td>0(0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>35(31.8)</td>
<td>33(30.0)</td>
<td>2(1.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>54(49.1)</td>
<td>52(47.3)</td>
<td>2(1.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NB: There was no significant association between the occurrence of HBsA and all the socio-demographic characteristics of the study participants ($P > 0.05$).
### Table 3 Risk factors linked to the occurrences of HBV serological markers among the study participants.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>No. examined N (%)</th>
<th>No. Positive for HBsAg</th>
<th>No. Positive for HBeAg</th>
<th>No. Positive for HBeAb</th>
<th>No. Positive for HBcAb</th>
<th>No. Positive for HBcAb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you heard of Hepatitis B Virus?</td>
<td>No</td>
<td>15(13.6)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>8(7.3)</td>
<td>0(0.0)</td>
<td>6(5.5)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>95(86.4)</td>
<td>4(3.6)</td>
<td>2(1.8)</td>
<td>73(64.6)</td>
<td>3(2.7)</td>
<td>59(53.6)</td>
</tr>
<tr>
<td>Have you received Hepatitis B vaccine?</td>
<td>No</td>
<td>61(55.5)</td>
<td>2(1.8)</td>
<td>1(0.9)</td>
<td>47(42.7)</td>
<td>0(0.0)</td>
<td>33(30.0)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>49(44.5)</td>
<td>2(1.8)</td>
<td>1(0.9)</td>
<td>34(30.9)</td>
<td>3(2.7)</td>
<td>32(29.1)</td>
</tr>
<tr>
<td>History of Blood Transfusion</td>
<td>No</td>
<td>75(68.2)</td>
<td>2(1.8)</td>
<td>1(0.9)</td>
<td>55(50.0)</td>
<td>3(2.7)</td>
<td>45(40.9)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>35(31.8)</td>
<td>2(1.8)</td>
<td>1(0.9)</td>
<td>26(23.6)</td>
<td>0(0.0)</td>
<td>20(18.2)</td>
</tr>
<tr>
<td>Do you have a history of organ transplant?</td>
<td>No</td>
<td>107(97.3)</td>
<td>4(3.6)</td>
<td>2(1.8)</td>
<td>78(70.9)</td>
<td>3(2.7)</td>
<td>63(57.3)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>3(2.7)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>3(2.7)</td>
<td>0(0.0)</td>
<td>2(1.8)</td>
</tr>
<tr>
<td>Do you have a history of dialysis?</td>
<td>No</td>
<td>101(91.8)</td>
<td>4(3.6)</td>
<td>2(1.8)</td>
<td>74(67.3)</td>
<td>3(2.7)</td>
<td>60(54.5)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>9(8.2)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>7(6.4)</td>
<td>0(0.0)</td>
<td>5(4.5)</td>
</tr>
<tr>
<td>Do you have tattoos/ear piercing?</td>
<td>No</td>
<td>84(76.4)</td>
<td>2(1.8)</td>
<td>1(0.9)</td>
<td>64(58.2)</td>
<td>1(0.9)</td>
<td>51(46.4)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>26(23.6)</td>
<td>2(1.8)</td>
<td>1(0.9)</td>
<td>17(15.5)</td>
<td>2(1.8)</td>
<td>14(12.7)</td>
</tr>
<tr>
<td>Do you share sharp objects?</td>
<td>No</td>
<td>102(92.7)</td>
<td>4(3.6)</td>
<td>2(1.8)</td>
<td>74(67.3)</td>
<td>3(2.7)</td>
<td>60(54.5)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>8(7.3)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>7(6.4)</td>
<td>0(0.0)</td>
<td>5(4.5)</td>
</tr>
<tr>
<td>Do you share tooth brush?</td>
<td>No</td>
<td>110(100.0)</td>
<td>4(3.6)</td>
<td>2(1.8)</td>
<td>81(73.6)</td>
<td>3(2.7)</td>
<td>65(59.1)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>89(80.9)</td>
<td>2(1.8)</td>
<td>2(1.8)</td>
<td>66(60.0)</td>
<td>0(0.0)</td>
<td>53(48.2)</td>
</tr>
<tr>
<td>Smoke</td>
<td>Yes</td>
<td>21(19.1)</td>
<td>2(1.8)</td>
<td>2(1.8)</td>
<td>15(13.6)</td>
<td>3(2.7)</td>
<td>12(10.9)</td>
</tr>
<tr>
<td>Consumption of alcohol</td>
<td>No</td>
<td>81(73.6)</td>
<td>1(0.9)</td>
<td>1(0.9)</td>
<td>56(50.9)</td>
<td>0(0.0)</td>
<td>41(37.3)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>29(26.4)</td>
<td>3(2.7)</td>
<td>1(0.9)</td>
<td>25(22.7)</td>
<td>3(2.7)</td>
<td>24(21.8)</td>
</tr>
<tr>
<td>Involvement in sexual activity without using protection</td>
<td>No</td>
<td>74(67.3)</td>
<td>1(0.9)</td>
<td>1(0.9)</td>
<td>62(56.4)</td>
<td>0(0.0)</td>
<td>46(41.8)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>36(32.7)</td>
<td>3(2.7)</td>
<td>1(0.9)</td>
<td>19(17.3)</td>
<td>3(2.7)</td>
<td>19(17.3)</td>
</tr>
<tr>
<td>1–2 partners</td>
<td>No</td>
<td>71(64.5)</td>
<td>3(2.7)</td>
<td>2(1.8)</td>
<td>51(46.4)</td>
<td>0(0.0)</td>
<td>37(33.6)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>35(31.8)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>26(23.6)</td>
<td>0(0.0)</td>
<td>24(21.8)</td>
</tr>
<tr>
<td>Sex mate count</td>
<td>None</td>
<td>89(80.9)</td>
<td>2(1.8)</td>
<td>1(0.9)</td>
<td>68(61.8)</td>
<td>0(0.0)</td>
<td>55(50.0)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>21(19.1)</td>
<td>2(1.8)</td>
<td>1(0.9)</td>
<td>13(11.8)</td>
<td>3(2.7)</td>
<td>10(9.1)</td>
</tr>
<tr>
<td>Switched sex mates recently</td>
<td>1–2/week</td>
<td>61(55.5)</td>
<td>1(0.9)</td>
<td>1(0.9)</td>
<td>49(44.5)</td>
<td>0(0.0)</td>
<td>34(30.9)</td>
</tr>
<tr>
<td></td>
<td>3–5/week</td>
<td>11(10.0)</td>
<td>3(2.7)</td>
<td>1(0.9)</td>
<td>7(6.4)</td>
<td>3(2.7)</td>
<td>7(6.4)</td>
</tr>
<tr>
<td></td>
<td>Nil</td>
<td>38(34.5)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>25(22.7)</td>
<td>0(0.0)</td>
<td>24(21.8)</td>
</tr>
<tr>
<td></td>
<td>Less often</td>
<td>35(31.8)</td>
<td>2(1.8)</td>
<td>0(0.0)</td>
<td>26(23.6)</td>
<td>3(2.7)</td>
<td>27(24.5)</td>
</tr>
<tr>
<td></td>
<td>Often</td>
<td>56(50.9)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>46(41.8)</td>
<td>0(0.0)</td>
<td>33(30.0)</td>
</tr>
<tr>
<td></td>
<td>Very often</td>
<td>19(17.3)</td>
<td>2(1.8)</td>
<td>2(1.8)</td>
<td>9(8.2)</td>
<td>0(0.0)</td>
<td>5(4.5)</td>
</tr>
</tbody>
</table>

**Discussion**

In this research, we investigated the occurrence of Hepatitis B Virus (HBV) infection among HIV-positive female patients receiving HAART in Ogun State, Nigeria. The study examined the prevalence of HBV serological markers and associated risk factors. The findings revealed the presence of HBV infection in this particular group of patients. The detection of HBV serological markers plays a crucial role in diagnosing HBV infection. The presence of HBsAg indicates the current existence of the infection, whether it is acute or chronic. The detection of HBeAb in the bloodstream suggests a favorable prognosis and lifelong protection after receiving the HBV vaccine [3].

The presence of HBeAb in the bloodstream indicates ongoing viral replication in the liver and increased potential for transmission. On the other hand, the absence of HBeAb suggests lower infectivity. HBeAb is frequently observed during the recovery phase, indicating

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reduced infectivity. HBeAg emerges shortly after the appearance of HBsAg and persists throughout an individual's lifetime. Its presence indicates an infection, whether recent or past, as well as a persistent HBV infection. The coexistence of HBsAg and HBeAg suggests inherent immunity against infection. The presence of HBsAg, HBeAg, and either HBeAb or HBeAg indicates the carrier state of Hepatitis B. Conversely, the absence of all five HBV markers indicates the absence of HBV infection and suggests susceptibility to infection [3, 24–26].

The study observed an overall HBeAg seropositivity rate of 3.6%, which is lower than the rate reported by Okonko et al. [27] among HIV-positive blood donors in Port Harcourt. This indicates a moderate prevalence of HBV infection among HIV-positive patients in the region. However, the 3.6% HBeAg seropositivity rate raises concerns due to the known high risk of mother-to-child transmission and accelerated progression of HIV infection associated with HBV/HIV co-infection. Similar prevalence rates of 3.6% have been reported in other regions of Nigeria [28–32] and in different countries among HIV-positive patients. Earlier studies conducted in Nigeria, Tanzania, Mali, and Iran reported lower prevalence rates (1.13–2.7%) among HIV-positive patients [33–36].

In a study by Okonko et al. [37], a 2.5% prevalence of coinfection between HBV and HIV was observed among seemingly healthy blood donors in Ibadan, Nigeria. However, the seroprevalence rate found in this study is lower than the previously reported range of HBV/HIV coinfection prevalence in Nigeria, which ranged from 10% to 70% [38]. This decline in prevalence is likely attributed to the efforts of public health agencies in the country focusing on HIV/AIDS prevention, which also offers protection against HBV due to similar routes of transmission shared by both viruses.

It is important to emphasize that only 1.8% of the total participants in the study tested positive for HBeAb, indicating a reduced immune response in relation to the prevalence of HBsAg among HIV patients. This finding also suggests that the presence of antibodies against HBV is not influenced by adherence to HAART. Compared to the results reported by Aliyu et al. [39], the rate of HBeAb positivity is higher. When HBsAg is present without detectable antibodies, it indicates an ongoing hepatitis B infection, which can occur before any symptoms manifest. If the HBsAg level remains elevated for more than 6 months, the patient is likely to become a carrier of HBV, meaning they can transmit the virus to others throughout their lifetime.

In addition, 73.7% of the study participants tested positive for HBeAg, while a small percentage (2.7%) had HBeAb. The development of anti-HBe indicates the clearance of the infection as it replaces HBeAg during the resolution of chronic HBV infection [40].

In more than 80% of patients, anti-HBe persists for life and signifies immunity [41]. However, it is concerning that a larger number of HBV-infected individuals lack protective immunity in the form of antibodies.

Moreover, 59.2% of the participants in the study were found to have ALT HBc. This antibody presence indicates an immune response against the virus, which can impact symptom severity and complications, especially when coexisting with HIV. However, it is worth noting that 40.8% of the subjects do not possess the HBc antibody, suggesting an active infection. This finding aligns with the results reported by Aliyu et al. [39].

The study findings also revealed a higher prevalence of Hepatitis B Virus among young adults aged 18–25 years and 26–30 years. This observation is consistent with previous studies conducted in Uyo, Akwa-Ibom State, Nigeria [42], Abuja, Nigeria [43], Tanzania [44] and Cameroon [45]. The increased prevalence among this age group could be attributed to higher levels of sexual activity, particularly among adolescents. Ymele et al. [45] observed a decrease in the prevalence of HBV infection as age increased, whereas Ogundeji [43] identified the age group of 21–40 years as having the highest rates of HIV, HBV, and HCV prevalence in their study.

Regarding marital status, a higher prevalence of HBV was observed among HIV-infected single females (2.7%) compared to married individuals (0%), although this difference was not statistically significant. This finding is consistent with a similar study conducted by Okonko et al. [42]. It suggests that marital status may not directly be a risk factor for HBV infection but could indicate the potential risk for infection in sexual partners. Unmarried individuals may be more likely to engage in multiple sexual partnerships or unprotected sex, contributing to the higher prevalence. Additionally, the presence of HBsAg among married subjects in this study may indicate that the infection was acquired through unprotected heterosexual intercourse or close contact with their infected partners, as the virus can be transmitted through body fluids [43]. This is consistent with the findings of Shedua et al. [44].

Educational level was not found to be a determining factor for the occurrence of HBV infection in this study. Interestingly, the highest prevalence was observed among individuals with secondary and tertiary education (1.8%). This finding contradicts a similar study conducted by Okonko et al. [42], which reported an association between educational level and HIV-HBV co-infections. In their study, a higher prevalence was observed among individuals with primary education (8.3%) compared to those with tertiary (6.9%). However, our findings are in line with a study conducted by Katamba et al. [46], which revealed a correlation between individuals with primary education, particularly at lower levels, and the occurrence of HBV and hepatitis B co-infections.

In this study, a significant proportion of the study subjects (86.4%) demonstrated knowledge about HBV. This percentage is considerably higher compared to the 57.4% reported in a similar study conducted by Omotola et al. [29]. The disparity in awareness levels can be attributed to differences in sample sizes between the two studies. The high level of HBV awareness observed in this study can be attributed to the educational background of the participants, as approximately 70% of them had either secondary or tertiary education. This suggests that higher education levels contribute to better access to health-related information and risk factors, leading to improved adherence to HIV clinical care. This is evident in the higher rate of HAART adherence among the patients attending HIV clinics.

Addressing the potential presence of occult hepatitis B virus infection (OBI) among the study participants is crucial. Among the 110 HIV-positive subjects examined, 65 of them (59.1%) tested positive for HBeAb, while only 2 and 4 individuals were positive for HBsAb and HBsAg, respectively. Furthermore, 61 individuals had HBeAb alone without HBsAg. The presence of HBeAb alone is noteworthy and can serve as a significant indicator for seropositive OBI. Numerous studies have reported the existence of OBI among HIV-positive individuals, which holds clinical and epidemiological importance. It is essential to note that individuals with OBI, lacking detectable HBsAg, are at risk of viral reactivation during immunosuppression and can unknowingly transmit the virus to others [47, 48].

OBI is particularly common among individuals at high risk of infection, including those who are HIV-positive, with a prevalence of at least 8% in areas where hepatitis B is endemic. Many individuals remain unaware of their HBV-positive status and often receive a diagnosis at an advanced stage of the disease. Studies conducted in Africa have reported OBI frequencies ranging from 3.7% to 30% in HIV-infected populations [49–51]. Amplification and analysis of the HBV surface gene using techniques like polymerase chain reaction (PCR) and restriction fragment length polymorphism (RFLP) play a crucial role in this regard. However, it is unfortunate that HBV genotyping, which aids in predicting disease progression and severity, is rarely conducted in resource-limited countries due to cost constraints.

Lastly, it is important to highlight the significance of uninterrupted antiretroviral therapy in controlling HIV replication, which reduces the risk of liver cirrhosis and hepatocellular carcinoma development in individuals chronically infected with HBV. This is particularly relevant in regions like Nigeria in sub-Saharan Africa, where non-adherence to antiretroviral therapy is common and possibly a serious concern. Therefore, there is a need to consider implementing structured treatment interruptions (STIs), as suggested by Palmisano et al. [52].
Conclusion

The findings of this study provide evidence of moderate endemcity of HBV infection among HIV-positive females in Ogun State, South-west Nigeria, particularly among young adults aged 18–25 years and 26–30 years. Among the participants, 3.6% tested positive for HBsAg, indicating current infection, while 1.8% showed the presence of HBeAg, suggesting previous exposure or immunization. The majority exhibited HBeAg (73.6%), indicating active viral replication, while HBeAb serum levels (2.7%) were relatively low, suggesting successful management of the infection. Furthermore, 59.1% had HBcAb, indicating either current or past exposure to the virus. Interestingly, no significant correlations were found between the occurrence of HBsAg or HBeAb and the socio-demographic characteristics of the participants, including age, education, employment, or marital status. However, the study identified several risk factors associated with HBV infection, such as lack of knowledge about HBV, absence of HBV vaccination history, history of blood transfusion or organ transplant, and unprotected sex. Based on these findings, it is recommended to implement measures aimed at increasing awareness of HBV, promoting immunization programs, advocating for safe blood transfusion and organ transplant practices, and promoting safe sexual behavior to prevent HBV transmission. This study highlights the prevalence of HBV infection and associated risk factors among HIV-positive adult females in Ogun State, Nigeria. The findings underscore the need for comprehensive public health interventions, including educational initiatives, immunization campaigns, and preventive strategies, to reduce the burden of HBV and improve overall health outcomes in this population.

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