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Assessment of Plasma Interferon Gamma among Adult Patients with Hepatitis B Infection in Kebbi State, Nigeria

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Abstract

Hepatitis B virus (HBV) infection remains a major global public health concern, particularly in Nigeria. Interferon gamma (IFN-γ), a critical cytokine in antiviral immunity, may influence disease progression and immune regulation. This study assessed plasma IFN-γ levels among adults with HBV infection and examined their associations with sociodemographic characteristics. A hospital-based cross-sectional study was conducted at Sir Yahaya Memorial Hospital in Birnin Kebbi, involving 400 adults screened for hepatitis B surface antigen (HBsAg). Plasma IFN-γ concentrations in HBsAg-positive participants were quantified using an enzyme-linked immunosorbent assay (ELISA), while sociodemographic data were analyzed using SPSS version 23, with statistical significance set at $p \leq 0.05$. Of the 400 participants, 170 (42.5%) tested positive for HBsAg. The highest prevalence was observed among participants aged 20–29 years (52.9%) and males (64.8%), while students (26.5%) and civil servants (24.8%) recorded the highest occupational prevalence. Mean plasma IFN-γ levels were slightly higher

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in females (8.02 ± 2.46 pg/mL) than in males (7.89 ± 2.49 pg/mL), although the difference was not statistically significant ($p \geq 0.05$). No significant correlations were found between IFN-γ levels and age or occupation. The findings demonstrate a high prevalence of HBV infection among young adults, particularly males, while plasma IFN-γ concentrations did not vary significantly across the examined sociodemographic groups. This study provides context-specific evidence on HBV prevalence and cytokine profiles in Kebbi State and underscores the need for youth-focused HBV education and vaccination programs.

Keywords: HBsAg; Hepatitis B Virus; Interferon Gamma; Nigeria; Plasma Cytokines

INTRODUCTION

Hepatitis B virus (HBV) is a partially double-stranded DNA virus belonging to the *Hepadnaviridae* family and is a major contributor to serious liver conditions, including cirrhosis and hepatocellular carcinoma (HCC)(Abdelhamed & El-Kassas, 2024; H. Li et al., 2020). It is the most widespread form of viral hepatitis (VH) in humans and ranks as the second leading cause of death among transmissible diseases worldwide (MacLachlan & Cowie, 2015). Globally, HBV affects approximately 300 million people, with about 1.5 million new infections each year. It is estimated that one-third of the global population has been infected at some point in their lives (Foundation, 2025). The African region, with a prevalence rate of 6.1%, is considered a high-burden area for HBV, where one death due to the infection occurs every 2.5 minutes (Alberts et al., 2022).

Nigeria is considered hyper-endemic for hepatitis B virus (HBV) infection, with a prevalence rate exceeding 8% (Ajuwon et al., 2021). Alarmingly, around 90% of Nigerians living with chronic HBV are unaware of their infection status, largely due to inadequate healthcare resources, limited public awareness, and insufficient political commitment to address the crisis (Adewuyi et al., 2025). Nigeria is also among the five countries accounting for over half of the global HBV burden. The prevalence of HBV in Nigeria is significantly higher than that of HIV in the 15–64-year age group, at 8.1% compared to 1.5%. Despite its major public health impact, viral hepatitis continues to receive minimal attention in terms of funding, education, and treatment efforts (Olayinka et al., 2016). A systematic review by Ajuwon et al. (2021), analysing data from 2010 to 2019, reported a pooled national HBV

prevalence of 9.5%, categorizing the burden as high by WHO standards. The North West geopolitical zone recorded the highest prevalence at 12.1%, with rural areas more affected (10.7%) than urban settings.

Several recent studies have documented a high prevalence of hepatitis B virus (HBV) infection in Kebbi State. A study by Bashar et al. (2020) found an overall prevalence of 19.6%, with 16.3% of patients presenting acute infection. Among prospective blood donors and pregnant women, Yakubu et al. (2016) reported a prevalence of 16.6%. In a more targeted population, Tajudeen et al. (2025) observed a 10.5% prevalence in a general screening conducted in Birnin Kebbi. Meanwhile, Wang et al. (2025) found a 7.0% prevalence among adolescents receiving healthcare in a teaching hospital. These findings collectively confirm a persistent high burden of HBV in Birnin Kebbi. Interferon gamma (IFN-γ) is a key proinflammatory cytokine predominantly produced by type 1 helper T cells (Th1), as well as CD4+ and CD8+ T lymphocytes, natural killer (NK) cells, and macrophages(Jorgovanovic et al., 2020). It plays a central role in the immune defence against intracellular pathogens, including hepatitis B virus (HBV)(Alspach et al., 2019). IFN-γ exerts antiviral, antiproliferative, and antitumor effects by enhancing cellular immunity, particularly through the activation of cytotoxic CD8+ T cells(Castro et al., 2018). In HBV-infected individuals, elevated IFN-γ levels are associated with viral clearance, while lower levels are typically observed in inactive carriers, suggesting its crucial role in controlling HBV replication and disease progression (Busca & Kumar, 2014). Evidence indicates that IFN-γ contributes to reducing viral load by suppressing HBV replication and promoting cytotoxic immune responses (Georgi et al., 2025). Evidence from both in vitro and in vivo studies using HBV-infected animal models shows that IFN-γ possesses direct antiviral effects.(Q. Li et al., 2022)

Hepatitis B virus (HBV) infection remains a critical public health concern in Nigeria, with high prevalence rates and serious health consequences including cirrhosis and hepatocellular carcinoma (Egbe et al., 2023; Sebastião, 2025). Despite the widespread impact, the immunological mechanisms that influence HBV persistence or clearance particularly the role of cytokines such as interferon-gamma (IFN-γ)—are poorly understood. This study provides novel data on plasma levels of interferon-gamma among HBV-infected adults in Kebbi State, Northwestern Nigeria, and a region where such immunological studies are scarce. This contributes to the limited pool of local evidence on cytokine profiles in viral hepatitis. Understanding the distribution of IFN-γ among infected individuals may offer

insight into disease progression and host immune response, potentially guiding future diagnostic or therapeutic approaches that integrate immune profiling.

MATERIALS AND METHODS

Study Area and Design

This study employed a cross-sectional design and was conducted over a six-month period (October 2022 to March 2023) in two phases at Sir Yahaya Memorial Hospital, Birnin Kebbi a tertiary healthcare institution located in Kebbi State, Nigeria. Phase I focused on screening and identifying individuals positive for HBV. In Phase II, the activity levels of interferon-gamma (IFN-γ) were measured among randomly selected participants who tested positive for hepatitis B.

Ethical Consideration

Ethical clearance for the research was obtained from the Kebbi State Ministry of Health and the Ethics Review Committee of Sir Yahaya Memorial Hospital, Birnin Kebbi. All participants provided written informed consent prior to their inclusion in the study, and this was properly documented.

Inclusion and Exclusion Criteria

Male and female patients between the ages of 19 and 49 years who appeared to be in good health and attended Sir Yahaya Memorial Hospital were randomly chosen for the study. Individuals younger than 18 years or older than 50 years were excluded from participation.

Sociodemographic Data Collection

The questionnaire used for data collection was adapted from previous research (Bashar et al., 2020) and modified to align with the local context. Data were gathered using structured, pre-tested questionnaires. Sociodemographic information obtained from participants included sex/gender, age group (in years), marital status, occupation, type of settlement, and vaccination history.

Sample size determination

The sample size for this study was determined using the Cochran formula for cross-sectional studies:

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

Where:

n = required sample size

Z = Z-score corresponding to the desired confidence level (typically 1.96 for 95% confidence)

p = prevalence from previous study (Aishetu et al., 2017 = 27.6% or 0.276)

d = margin of error (commonly 5% or 0.05)

Substituting the values:

$$n = (1.96^2 \times 0.276 \times (1 - 0.276)) \div (0.05^2)$$

Calculations:

n = (3.8416 × 0.276× 0.724) ÷ 0.0025

n = 0.7676 ÷ 0.0025

n = 307.06

To the nearest whole number, the sample size is 307. However, 400 samples were ultimately collected for improved statistical power.

Sample Collection

A total of 5 millilitres of venous blood was drawn from each participant using a sterile syringe and transferred into plain specimen bottles. The samples were left to clot at room temperature for 30 minutes, after which they were centrifuged at 2500 revolutions per minute (rpm) for 5 minutes. The resulting serum was carefully separated and stored for further analysis.

Sample Analysis

Screening for hepatitis B surface antigen (HBsAg) was performed using a rapid diagnostic test. The ACON rapid test kit, a chromatographic immunoassay, was employed for the qualitative detection of HBV antibodies in serum or plasma. Plasma levels of interferon-gamma (IFN-γ) were quantified in HBsAg-positive samples using a commercially available enzyme-linked immunosorbent assay (ELISA) kit, following the manufacturer's instructions.

Data Analysis

Data analysis was conducted using SPSS version 23. Categorical variables were described using frequencies and percentages. IFN-γ concentrations were expressed as mean ± standard deviation. Group comparisons were performed using independent t-tests and analysis of variance (ANOVA), while Pearson's correlation coefficient was applied to evaluate the relationships between variables.

RESULTS

HBsAg Prevalence

Figure 1 illustrates the distribution of hepatitis B surface antigen (HBsAg) test results among a total of 400 participants. Out of the total sample, 170 individuals (42.5%) tested positive for HBsAg, indicating active hepatitis B infection, while 230 individuals (57.5%) tested negative

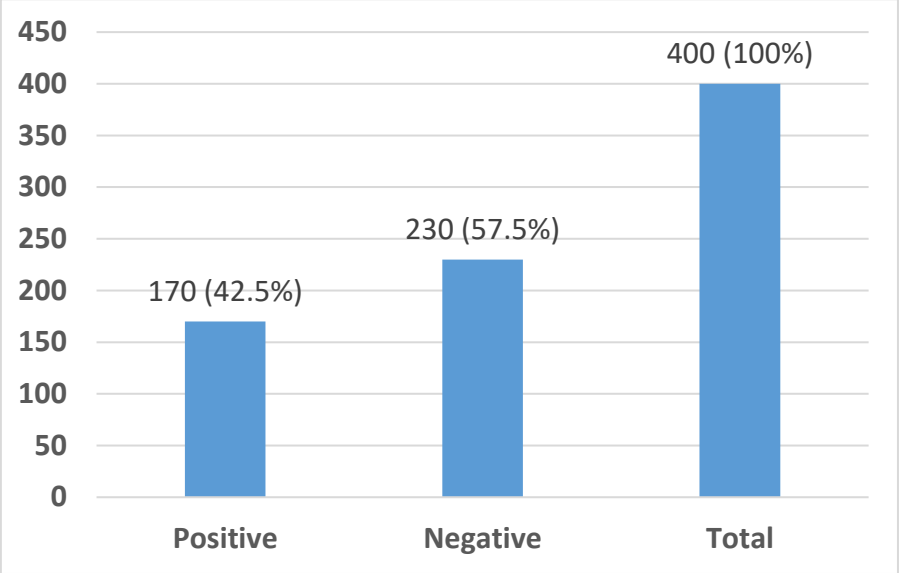


Figure 1: HBsAg Prevalence among study participants

HBsAg prevalence by age

Figure 2 shows the distribution of hepatitis B surface antigen (HBsAg) positive cases across different age groups. The highest number of positive cases was recorded in the 20 to 29 age group, with over 50 individuals affected. This is followed by the 30 to 39 age group, which had slightly more than 30 cases. The 40 to 49 age group had a much lower count, with around 10 cases, while the 10 to 19 age group had the fewest, with only 1 case.

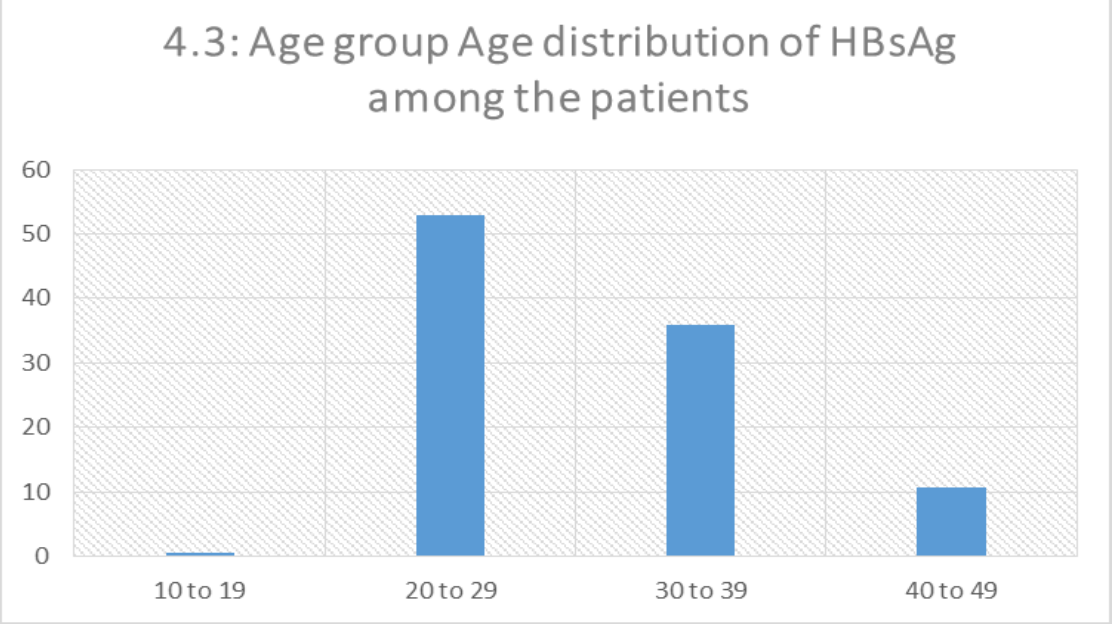


Figure 2: Age group Age prevalence of HBsAg among the patients"

HBsAg Prevalence by Sex

Figure 3 illustrates the gender distribution of hepatitis B surface antigen (HBsAg) positive cases among the study population. A greater proportion of HBsAg-positive individuals were males. Specifically, males made up 107(60%) of the HBsAg-positive cases, while females comprised around 68(40%).

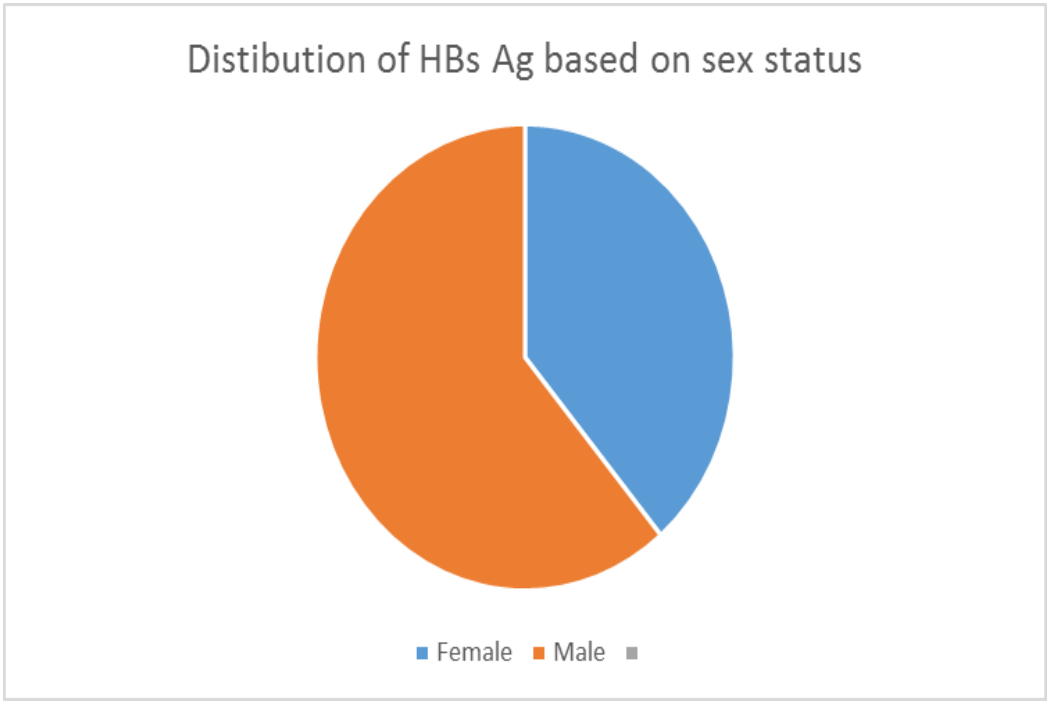


Figure 3: Prevalence of HBsAg based on sex status

HBsAg Prevalence by Occupational Status

Figure 4 presents the distribution of hepatitis B surface antigen (HBsAg) positivity among different occupational groups. The highest prevalence was observed among students, who accounted for 49 cases (28.8%) of the total HBsAg-positive individuals. This was followed by civil servants with 35 cases (20.6%), housewives with 33 cases (19.4%), farmers with 26 cases (15.3%), and individuals engaged in business with 25 cases (14.7%). Footballers had the lowest prevalence, contributing only 2 cases (1.2%) to the total. The table highlights that students and civil servants were the most affected occupational groups, while footballers had the least number of positive cases.

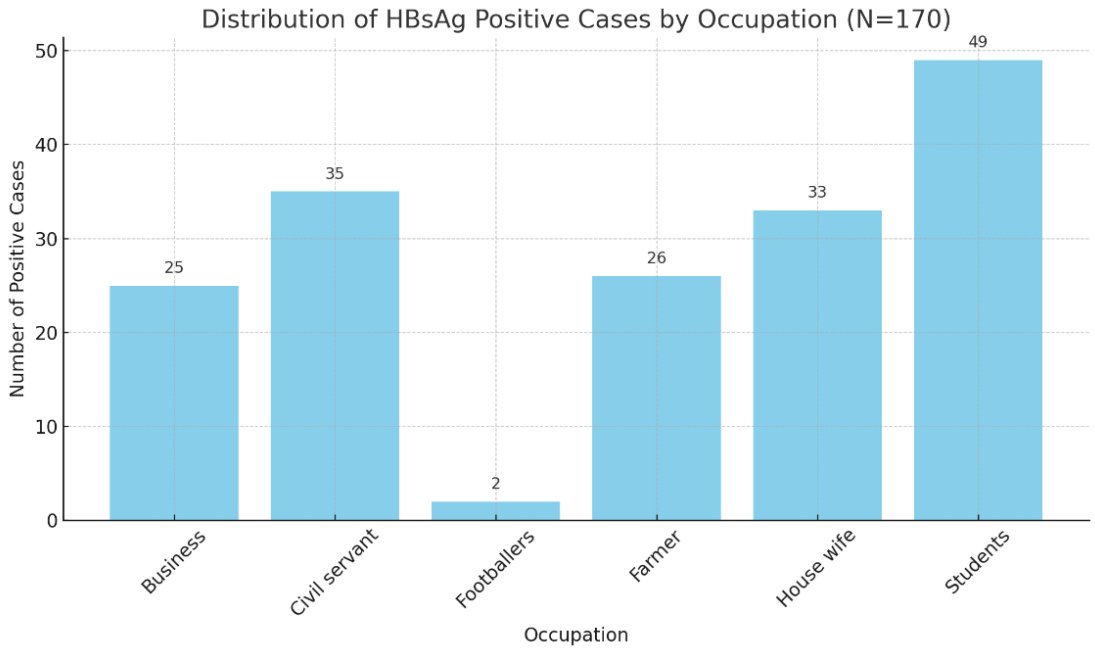


Figure 4: prevalence of HBsAg among different occupational groups.

IFN-γ Levels

Figure 5 presents the plasma levels of interferon gamma (INF-γ) among male and female participants who tested positive for hepatitis B surface antigen (HBsAg). The mean plasma INF-γ concentration among males was 7.89 ± 2.49 units, while that of females was slightly higher at 8.02 ± 2.46 units. Statistical analysis indicating that the difference in INF-γ levels between male and female HBsAg-positive participants was not statistically significant.

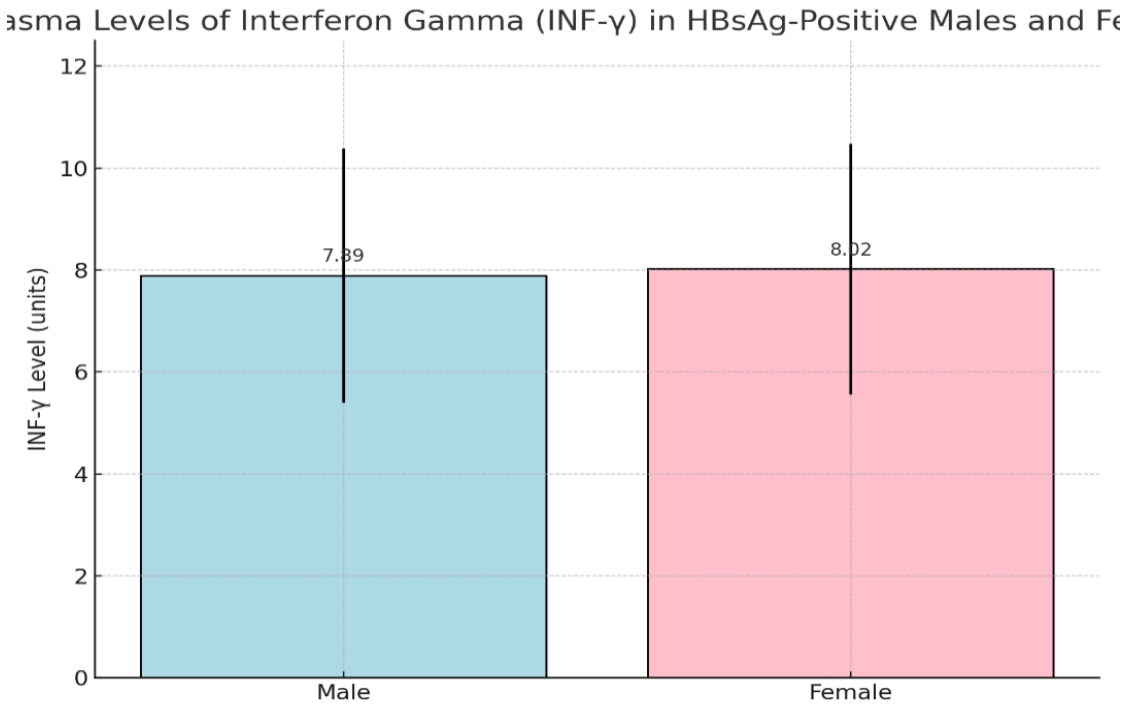


Figure 5: plasma levels of interferon gamma (INF-γ) among male and female participant

Figure 6 shows the plasma levels of interferon gamma (INF-γ) among hepatitis B surface antigen (HBsAg) positive individuals across different occupational groups. The mean INF-γ levels (± standard deviation) were as follows: Business – 7.18 ± 1.37**,** Civil Servants – 7.78 ± 1.68, Farmers – 8.56 ± 3.71, Housewives **–** 8.71 ± 2.39, and Students **–** 7.61 ± 2.52**.**

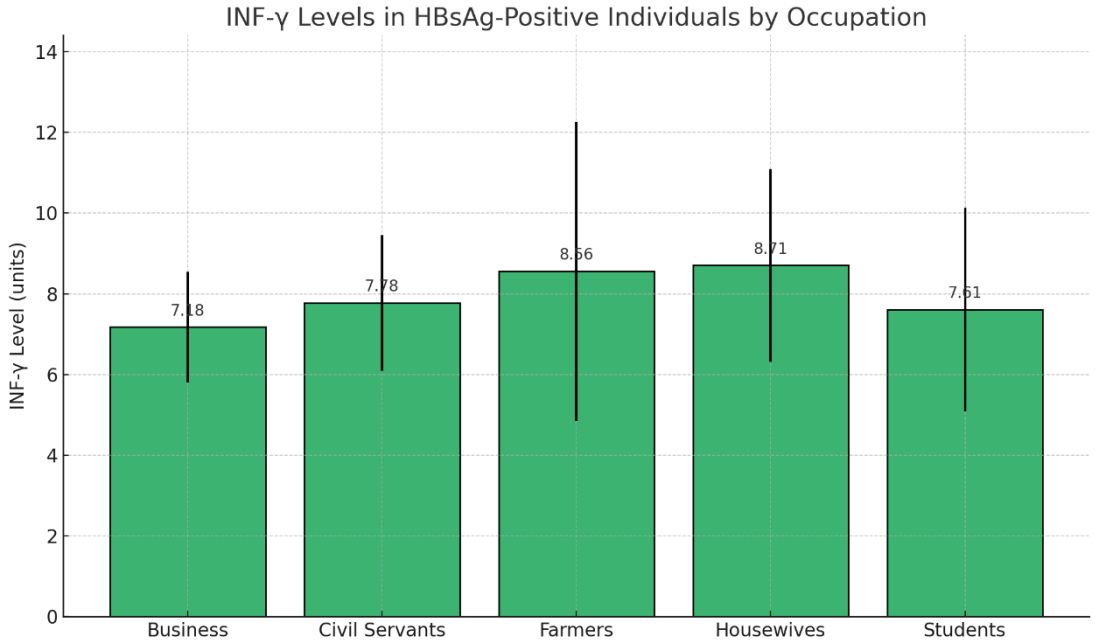


Figure 6: Plasma levels of interferon gamma (INF-γ) across different occupational groups

Figure 6 presents the correlation analysis between plasma levels of interferon gamma (INF-γ) and age among individuals infected with hepatitis B surface antigen (HBsAg). The correlation analysis revealed no significant association between age and interferon gamma (INF-γ) levels among HBsAg-positive individuals (rho = +0.023, p = 0.763), indicating that age had no meaningful influence on INF-γ expression in the study population."

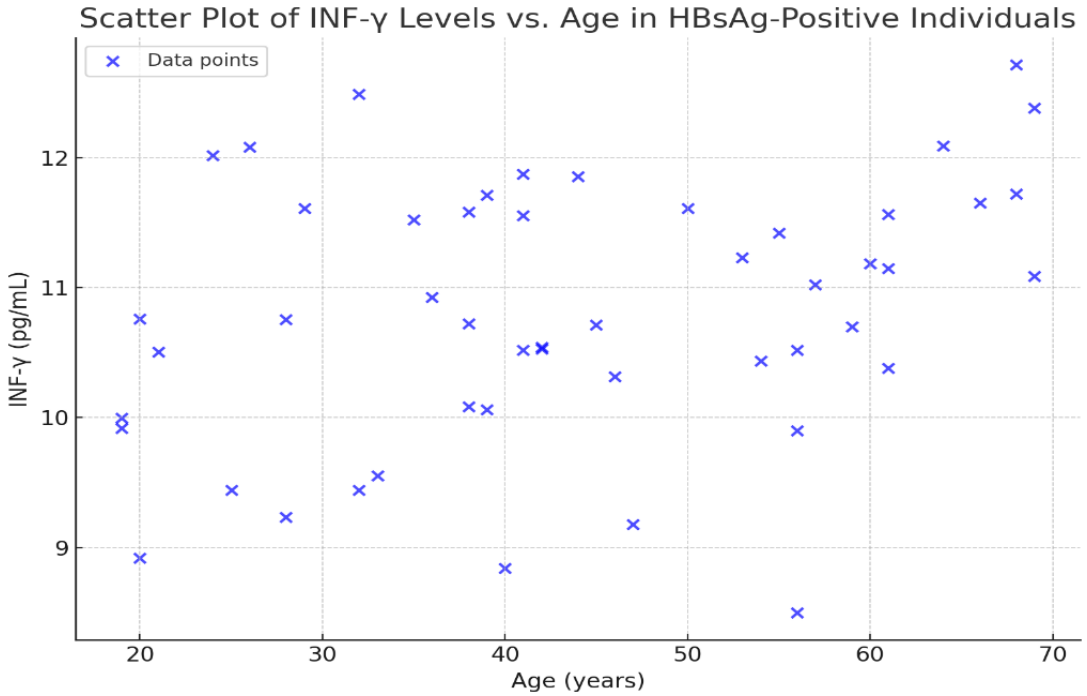


Figure 7: Relationship between age and INF-γ levels among HBsAg-positive individuals

DISCUSSION

The prevalence of hepatitis B virus (HBV) infection observed in this study (42.5%) is significantly higher than rates reported in previous studies conducted within Birnin Kebbi and other parts of Kebbi State. For instance, Bashar et al. (2020) reported a prevalence of 19.6% among outpatients, while Yakubu et al. (2016) and Tajudeen et al. (2025) recorded prevalence rates of 16.6% and 10.5%, respectively, among blood donors, pregnant women, and the general population. Similarly, Wang et al. (2025) documented a 7.0% prevalence among adolescents, and Maganda et al. (2024) reported HBV rates of 15.2% and 11.0% among students of Waziri Umaru Polytechnic and Federal University Birnin Kebbi, respectively. The higher prevalence recorded in this study may be attributed to its hospital-based setting, which likely included symptomatic individuals or those at higher risk of

infection. Recent studies across Nigeria have reported HBV prevalence rates ranging from 3.8% to 14.3%, significantly lower than the 42.5% observed in this study. These include 14.3% in Plateau State (Tyem et al., 2023), 10.9% in Port Harcourt (Cookey et al., 2022), 10.1% in Bayelsa (Nwodo et al., 2023), and 3.8% in Abuja (Abioye et al., 2022). Most studies identified young adults as the most affected group.

The predominance of HBV among males (64.8%) and young adults aged 20–29 years (52.9%) aligns with previous findings (Tyem et al., 2023; Wang et al., 2025), suggesting that these groups are particularly vulnerable. This may be attributed to several factors. Males are more likely to engage in high-risk behaviours such as unprotected sex, sharing sharp objects, and receiving tattoos or haircuts with unsterilized instruments. Young adults, particularly those aged 20–29, are typically more sexually active and socially mobile, increasing their risk of exposure.(Olayinka et al., 2016; Omeje et al., 2017).

The findings indicate that although the mean interferon gamma (IFN-γ) levels were slightly higher in females than in males, the difference was not statistically significant ($p \geq 0.05$), indicating that sex had no statistically significant influence on IFN-γ expression among HBV-infected individuals in this study. Additionally, the absence of significant correlations between IFN-γ levels and age or occupation implies that IFN-γ response to HBV infection is relatively consistent across different demographic groups. These results suggest that factors other than age, sex, or occupation such as individual immune variability, viral load, or HBV genotype may more substantially influence IFN-γ modulation.

CONCLUSION

This study revealed a high prevalence (42.5%) of hepatitis B surface antigen (HBsAg) among adults attending Sir Yahaya Memorial Hospital, Birnin Kebbi, with the highest infection rates observed among young adults aged 20–29 years and male participants. Students and civil servants were the most affected occupational groups. Although interferon gamma (IFN-γ) levels were marginally higher in females, no significant association was found between IFN-γ levels and sex, age, or occupation. These findings highlight the ongoing public health burden of HBV in Northwestern Nigeria and the need for focused attention on vulnerable demographic groups. The immunological data suggest that IFN-γ plays a role in HBV infection control, but its expression appears independent of socio-demographic factors in this population. Based on these findings, it is recommended that routine HBV

screening and awareness campaigns, especially targeting young adults and males should be initiated. Integrating interferon gamma (IFN-γ) monitoring into HBV management may support personalized care.

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