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Liver biomarkers and Hepatitis B virus infection outcome in southwestern Nigeria

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Abstract

Background: Chronic hepatitis B virus (HBV) infection remains a major public health problem in Nigeria and other parts of sub-Saharan Africa, contributing significantly to liver cirrhosis and hepatocellular carcinoma (HCC). Liver biochemical markers are routinely used to assess hepatic injury and function, but their predictive value for HBV disease progression remains incompletely understood.

Methods: This cross-sectional study involved 114 patients with chronic HBV infection recruited from tertiary hospitals in Southwestern Nigeria. Participants were categorized into asymptomatic inactive carriers (n=17), active symptomatic carriers (n=69), clearance group (n=10), and patients with cirrhosis/HCC (n=18). Liver biochemical markers including alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), albumin, total protein, total bilirubin, and conjugated bilirubin were measured using standard enzymatic methods. Associations between biomarkers and disease outcomes were assessed using independent t-tests, one-way ANOVA, and multivariable logistic regression analysis.

Results: The mean age of participants was 38.78 ± 13.76 years, and 53.5% were male. Among the liver biomarkers evaluated, only albumin showed significant variation across HBV disease stages ($p < 0.001$), with the lowest levels observed in patients with cirrhosis/HCC (28.34 ± 17.29 g/L). Cirrhotic patients had significantly higher ALT ($p = 0.034$) and ALP ($p = 0.021$) levels and significantly lower albumin concentrations ($p < 0.001$) than non-cirrhotic patients. Patients with HCC also demonstrated significantly higher ALT ($p = 0.050$) and lower albumin levels ($p < 0.001$) compared with non-cirrhotic patients. Multivariable logistic regression identified serum albumin as the only independent predictor of HBV outcome (OR = 0.902, 95% CI: 0.841–0.967, $p = 0.004$), while AST, ALT, AST/ALT ratio, bilirubin levels, total protein, age, and gender were not significant predictors.

Conclusion: Serum albumin was significantly associated with HBV disease severity and emerged as the only independent predictor of disease outcome. These findings suggest that albumin may serve as a simple, inexpensive, and readily available biomarker for risk stratification and monitoring of disease progression among patients with chronic HBV infection in Southwestern Nigeria.

Keywords: Chronic Hepatitis B; Albumin; Liver Biomarkers; Cirrhosis; Hepatocellular Carcinoma; Disease Progression; Nigeria.

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1. Introduction

Chronic Hepatitis B infection continues to be major worldwide public health concern, especially in sub-Saharan Africa (1), where the disease burden is disproportionately elevated (2). Nigeria is designated as a hyperendemic area for hepatitis B virus (HBV) infection, with millions of individuals afflicted by chronic HBV and its related consequences, such as liver cirrhosis and hepatocellular cancer (3). In Southwestern Nigeria, the ongoing prevalence of HBV infection remains a significant health, social, and economic challenge, despite heightened awareness and vaccine initiatives (4).

The clinical outcomes of HBV infection differ significantly among affected persons. While some individuals effectively eliminate the virus and acquire immunity, others advance to chronic infection, liver fibrosis, cirrhosis, or liver cancer (5). The variations in disease outcomes are shaped by a complex interplay of viral, host, and environmental variables. Complications of Chronic Hepatitis B (CHB) infection are liver cirrhosis and Hepatocellular Carcinoma (HCC).

Liver function markers are crucial indicators for evaluating the severity and progression of HBV-related liver disease. Biomarkers include alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), bilirubin, and albumin are frequently utilized to assess hepatic damage and liver function in patients infected with HBV. Changes in these indicators frequently indicate active hepatic inflammation, hepatocellular injury, or compromised liver function. Examining the correlation between liver indicators across different stages of HBV infection may not be limited to diagnostic markers only, but could it be used as predictors, thereby enhancing comprehension of liver state and illness prognosis in chronic HBV infection?

This study seeks to assess liver indicators, and ascertain their correlation with HBV outcomes in patients from Southwestern Nigeria. This research may enhance illness prediction, facilitate early intervention, and refine focused management options for HBV infection among the Nigerian population.

2. Materials and methods

2.1. Study setting, design and population

The research adhered to the Declaration of Helsinki for Biomedical Research involving human Subjects. Approval for the study was received from the Ethics Committees of the Uniosun Teaching Hospital, Bowen University Teaching Hospital and Ladoke Akintola University of Technology Teaching Hospital. Informed written consent was obtained from each participant included in the study.

This was a cross-sectional study involving 114 patients with chronic HBV infection in southwestern Nigeria. Liver biochemical markers and clinical characteristics were assessed at the time of enrollment, and associations between these markers and disease status were evaluated. The participants for the study were characterized by the presence of HBsAg positivity more than six (6) months. Participants were enrolled at the Gastroenterology Clinics of Bowen University Teaching Hospital, Ogbomoso; Ladoke Akintola University of Technology (LAUTECH) Teaching Hospital, Ogbomoso, Oyo State; and Uniosun Teaching Hospital, Osogbo, Osun State, Nigeria. All patients were of Nigerian ethnicity. Patients included inactive asymptomatic carriers (IAC), active symptomatic carriers (ASC), Clearance group (CG) liver cirrhosis, and hepatocellular cancer (CH) from CHB according to current guideline definitions (6). A data collection tool was used to document demographic details, general medical history, and some laboratory results.

2.2. Sample Collection and processing

All individuals who were diagnosed seropositive for HBsAg were included for the study. Five ml of blood was drawn by venipuncture under aseptic precaution in the EDTA tube, plasma was separated for assessment of ALT, AST, ALP, Albumin, total protein as well as the total bilirubin, and conjugated bilirubin levels using standardized enzymatic colorimetric assay reagents obtained from Randox Laboratories Ltd., Crumlin, United Kingdom, according to the manufacturer's instructions. Samples were processed for hematological parameters at the chemical pathology laboratory unit of Ladoke Akintola University of Technology Teaching Hospital. The liver function enzymes, Albumin level and total protein were quantified using colorimetry method. Within the confines of this study as applicable to HBV infection, several liver function parameters were assayed as markers of liver function; they include Alanine Transaminase (ALT), Aspartate Transaminase (AST), Alkaline Phosphatase (ALP), total protein, Bilirubin (total and conjugated) and albumin level; these assays were selected because of they are used to measure liver injury, inflammation and disease progression. However, this study did not lose sight of the fact that the liver performs several roles including synthetic, storage, metabolic, excretory and detoxification functions(7), and that it also stands out clearly as one organ whose true functional assessment involves the assemblage of a battery of general body functional markers

including blood glucose, plasma proteins, plasma lipids and some haematological markers. This was kept in mind when interpreting the results.

Values of AST >40 IU/L, ALT >36 IU/L, ALP >120 IU/L, Total Bilirubin (TB) >17 µmol/L, Conjugated bilirubin (CB) > 5.1 µmol/L, albumin >50g/L and total protein (TP) >80g/L were considered as abnormal values.

Liver cirrhosis was diagnosed mainly through imaging studies, which was charactered by medial segment atrophy of the left lobe, caudate lobe hypertrophy, or liver nodularity for early-stage disease, and images of portal hypertension such as varices, splenomegaly, patent paraumbilical vein, or ascites in advanced stage disease. Other evidences were adopted to support imaging results, consisting of clinical presentations (such as ascites, encephalopathy, and gastrointestinal bleeding), laboratory examination (such as thrombocytopenia, serum albumin, and prolonged prothrombin time), and liver biopsy.

2.3. Statistical analysis

Statistical analysis was performed using SPSS version 27.0 (SPSS Inc., Chicago, IL, USA). Descriptive analysis and One-way Analysis of variance were used to compare data. Pearson's correlation coefficient (r) was used to determine the association between variables. Odds ratio (OR) and 95 % confidence interval were computed. Univariate and multivariate analysis were done to access disease outcome predictors. A p-value ≤0.05 was considered to be statistically significant.

3. Results

This study was carried out among 114 HBV patients. The mean age of the study participants is (38.78±13.76) and 53.5% of the participants were male while 46.5% were females (table 1).

The mean values of liver biomarkers across genders were not significantly different except for conjugated bilirubin 5.00 ± 3.16 and 8.76 ± 11.71 (p=0.017).

The mean estimation of liver biochemical parameters, including AST, ALT, ALP, AAR, total bilirubin, conjugated bilirubin, total protein, and albumin levels across various stages of Hepatitis B disease did not show significant difference except for albumin which exhibited a significant difference across HBV disease stages (p<0.001), with the CH group displaying markedly lower mean albumin levels (28.34±17.29) compared to other groups. (Table 3).

Comparison of biochemical parameters were done between non-cirrhotic and cirrhotic patients using independent sample *t*-tests to assess differences between the Cirrhotic and non-cirrhotic group. The average AST level was elevated in cirrhotic patients (24.89 ± 22.35) relative to non-cirrhotic patients (21.50 ± 26.65); still, the difference lacked statistical significance (p =0.613). Conversely, ALT levels exhibited a notable elevation in cirrhotic patients (23.78 ± 19.11) relative to non-cirrhotic patients (15.58 ± 13.95) (p = 0.034). ALP levels were markedly higher in cirrhotic patients (83.50 ± 90.41) compared to non-cirrhotic patients (53.67 ± 38.0) (p = 0.021). Albumin levels exhibited a considerable decrease in cirrhotic patients (28.34 ± 17.29) compared to non-cirrhotic patients (41.02 ± 9.10), with this difference being highly statistically significant (p < .001). No statistically significant variations were detected in AAR, total bilirubin, conjugated bilirubin, or total protein levels between the two groups (p > .05). While conjugated bilirubin levels were lower in cirrhotic individuals compared to non-cirrhotic patients, the difference was not statistically significant (p = .117). These findings reveal that cirrhosis is highly correlated with increased ALT and ALP levels and decreased albumin concentration, suggesting growing hepatic dysfunction in cirrhotic patients (Table 2).

Table 1 Age and gender distribution of study participants

Variables	Value
Age (Mean ± SD)	38.78±13.76
Gender n (%)	
Males	61 (53.5%)
Females	53 (46.5%)

Table 2 Independents t-test assessment of liver parameters and cirrhosis among the study participants

Variable	Non-C Stage (Mean± SD)	C-Stage (Mean± SD)	p-value
AST Level	21.50±26.65	24.89±22.35	0.613
ALT Level	15.58±13.95	23.78±19.11	0.034*
ALP Level	53.67±38.0	83.50±90.41	0.021*
AAR	1.46±0.91	1.18±0.67	0.214
Total Bil.	17.29±16.07	16.74±8.56	0.888
Conj. Bil.	7.21±9.13	4.26±2.21	0.117
Total Protein	68.92±11.13	71.83±9.26	0.298
Albumin	41.02±9.10	28.34±17.29	<0.001*

AAR AST/ALT Ratio; Total Bil. (total bilirubin); Conj. Bil. (Conjugated Bilirubin) * Significant

Table 3 Mean difference (One Way ANOVA) in ALT levels across HBV disease stages

Variable	AIC (Mean± SD)	ASC (Mean± SD)	CG (Mean± SD)	CH (Mean± SD)	p-value
AST Level	13.88±9.40	23.81±30.39	18.50±14.18	24.89±22.35	0.498
ALT Level	15.18±12.57	16.05±14.97	13.00±8.35	23.78±19.12	0.183
ALP Level	43.00±38.2	56.56±35.03	52.20±55.47	83.50±90.41	0.100
AAR	1.13±0.47	1.55±1.02	1.40±0.46	1.18±0.66	0.194
Total Bil.	12.15±7.05	19.60±18.11	10.10±3.61	16.74±8.56	0.117
Conj. Bil.	5.13±5.46	8.17±10.29	4.14±1.10	4.26±2.21	0.168
Total Protein	66.94±12.02	68.28±11.20	76.70±4.90	71.83±9.26	0.069
Albumin	42.47±13.37	40.20±8.28	44.20±4.21	28.34±17.29	<0.001*

AIC: Asymptomatic Inactive Carriers; ASC: Active Symptomatic Carriers; CG: Clearance Group; CH: Cirrhosis and HCC; AAR AST/ALT Ratio * Significant

Table 4 The differences between AST, ALT, and albumin in CHB patients without Cirrhosis versus HCC complication

Variable	Non-C Stage (Mean± SD)	HCC-Stage (Mean± SD)	p-value
AST Level	21.85±27.77	24.89±22.35	0.664
ALT Level	15.88±14.46	23.78±19.11	0.050*
Albumin Level	40.65±9.45	28.34±17.29	<0.001*

Table 5 The differences between AST, ALT, and albumin in CHB patients without Cirrhosis versus Cirrhosis complication

Variable	Non-C Stage (Mean± SD)	Cirrhosis-Stage (Mean± SD)	p-value
AST Level	21.85±27.77	18.50±14.18	0.709
ALT Level	15.88±14.46	13.00±8.35	0. 539
Albumin Level	40.65±9.45	44.20±4.21	0.245

Table 6 The differences between AST, ALT, and albumin in CHB patients with Cirrhosis versus HCC complication

Variable	C Stage (Mean± SD)	HCC (Mean± SD)	p-value
AST Level	18.50±14.18	24.89±22.35	0.423
ALT Level	13.00±8.35	23.78±19.11	0. 539
Albumin Level	44.20±4.21	28.33±17.29	0.104

Table 7 Multivariate logistic regression of Liver biomarkers and outcomes of HBV

Predictors	β	S.E.	Wald	p-value	OR	95% C.I.	
						Lower	Upper
AST	-0.018	0.036	0.243	0.622	0.982	0.914	1.055
ALT	0.072	0.046	2.408	0.121	1.074	0.981	1.176
AST/ALT	-0.430	0.826	0.271	0.603	0.651	0.129	3.284
Total Bil	-0.015	0.057	0.071	0.791	0.985	0.881	1.101
ConjBil	-0.149	0.114	1.688	0.194	0.862	0.689	1.078
Albumin	-0.103	0.036	8.348	0.004	0.902	0.841	0.967
T P	0.044	0.042	1.052	0.305	1.045	0.961	1.135
Age			2.668	0.849			
Gender	0.427	0.718	0.354	0.552	1.532	0.375	6.254

Multivariate logistic regression was performed to assess the association between liver biomarkers and HBV outcome inoder determine independent factors that predict HBV disease progression and cirrhosis. Upon adjustment for liver enzymes, bilirubin levels, age group, and gender, serum albumin was found as the only significant predictor (OR = 0.902, 95% CI: 0.841–0.967, p = 0.004). The variables AST (p = 0.622), ALT (p = 0.121), AST/ALT ratio (p = 0.603), total bilirubin (p = 0.791), conjugated bilirubin (p = 0.194), total protein (p = 0.305), age group (p = 0.849), and gender (p = 0.552) were not independently correlated with the outcome (Table 7).

4. Discussion

In this study male (53.5%) constitute a higher proportion of the participants than the females, this could be related to the mechanism of sex hormones of androgen and estrogen. The liver is regarded as a sexually dimorphic organ that expresses androgen receptors and oestrogen receptors α (8). The liver exhibits sensitivity to sex hormones, resulting in variations in gene expression patterns, immunological responses, and xenobiotic metabolism between males and females (9). The HBV X protein (HBx) enhances hepatic androgen receptor activity through androgen-dependent pathways, hence amplifying sexual dimorphism in liver tissue in male patients infected with HBV. Androgen receptors (AR) enhance HBV transcription, encompassing all viral mRNA. Two Androgen-Responsive Elements (ARE) that are closely associated with the androgen receptor (AR) are located in enhancer I of the HBV genomic nucleotide. These two factors induce an elevation in HBV mRNA levels mediated by androgen receptors. Consequently, AR enhances the transcription of HBx. Elevated HBx levels are directly correlated with the increase of ARE in the HBV genome. Consequently, the ARE inside the HBV genome establishes a cycle of reciprocal interactions between androgen receptors and HBx. ARE is responsible for the enhancement of HBV transcription regulation. Consequently, in male HBV patients, viral replication is more vigorous, and the carcinogenic potential is elevated (9).

The mean estimation of liver biochemical parameters across various stages of Hepatitis B disease did not show significant difference except for albumin which exhibited a significant difference across HBV disease stages ($p<0.001$), with the CH group displaying markedly lower mean albumin levels (28.34±17.29) compared to other groups, indicating progressive deterioration of liver synthetic function in cirrhosis and HCC patients,

The assessment of liver biomarkers across patients in cirrhosis stage and those not in cirrhosis stage of HBV did not show significant differences for AST, AAR, conjugated, total bilirubin and total protein but was significant for ALT, ALP and albumin. These findings reveal that cirrhosis stage of HBV is highly correlated with increased ALT and ALP levels and decreased albumin concentration, suggesting growing hepatic dysfunction in cirrhotic patients this is consistent with the report of Maulidia et al (10) and also with other studies in China who also reported a $p<0.001$(11). ALT alongside with AST are enzymes that catalyze the transfer of α-amino groups from aspartic and alanine to the α-keto ketoglutaric acid groups to produce oxalic and pyruvic acids, which are important contributors to the citric acid cycle (12). Both enzymes necessitate pyridoxal-5'-phosphate (vitamin B6) to facilitate this reaction; however, the impact of pyridoxal-5'-phosphate shortage is more pronounced on ALT activity than on AST. Both enzymes have large concentrations in the liver. AST is widely distributed in the heart, skeletal muscles, kidneys, brain, and red blood cells, while ALT is present at modest amounts in skeletal and renal muscles. Consequently, an elevation in ALT levels is more indicative of hepatic injury (7). In the liver, ALT is only found in the cytoplasmic compartment, while AST is present in both the cytosol and mitochondria. The third zone of liver acini exhibits elevated AST concentrations, and injury to this zone can result in more pronounced alterations in AST levels (13). Patients with advanced liver cirrhosis invariably exhibit hypoalbuminemia due to diminished albumin production by hepatocytes. Water and sodium retention influence the albumin concentration in the extracellular space. Additional factors are likely to contribute to hypoalbuminemia, including an elevation in the transcapillary rate.

AST and albumin levels in CHB patients without cirrhosis were significantly different from those in CHB patients with HCC complications, with p-values of 0.050 and <0.001, respectively (Table 4). This finding aligns with recent research indicating significant variations in ALT and albumin levels between CHB patients without difficulties and those experiencing HCC issues. (14,15). However varies with others that reported significant differences in AST and albumin differences instead of ALT and albumin (10)

Hepatocellular carcinoma usually results from cirrhosis or chronic hepatitis. In these conditions, inflammation and hepatocyte regeneration occur consistently. Cellular proliferation compensates for irreversible hepatocyte damage from chronic liver injury. This process leads to the development of fibrosis and cirrhosis during the ongoing remodeling of the liver (16). In hepatocellular carcinoma, elevated ALT levels signify hepatocyte damage either from tumour development or further liver cell harm due to impaired blood supply or venous drainage. This may also result from persistent liver cell necrosis in individuals with concurrent active cirrhosis or chronic active hepatitis (17). The size of the tumour influenced albumin levels. In patients with HCC, an increase in tumour diameter correlates with a decrease in albumin levels. Decreased albumin levels indicate hepatic parenchymal damage resulting from tumour proliferation. Reduced albumin levels correlate with an unfavourable outcome for hepatocellular cancer (18).

Liver cirrhosis is categorized into two stages: compensated cirrhosis and decompensated cirrhosis. During the asymptomatic stage of HBV, people may experience a favourable quality of life and remain undiagnosed for several years. Decompensated liver cirrhosis is marked by clinical manifestations such as ascites, hemorrhage, encephalopathy, and jaundice (19). This stage of the disease is associated with morbidity. Once decompensated liver cirrhosis stage is assumed, cirrhosis evolves into a systemic disease characterized by multi-organ or organ system failure (20). In compensated liver cirrhosis, AST and ALT values typically remain within acceptable ranges. In decompensated liver cirrhosis, blood levels of AST and ALT typically rise.

This study found no variations in AST and ALT levels between study participants without cirrhosis and those with cirrhosis complications, which may be attributed to various factors, including the phase of CHB and illness prognosis this report is consistent with that of Lai et al., (21); and Chen et al., (22).

In the present study, multivariable logistic regression analysis identified serum albumin as the only independent predictor of HBV disease outcome after adjustment for liver enzymes, bilirubin levels, age, and gender. Specifically, higher albumin levels were associated with lower odds of adverse HBV outcomes (OR = 0.902, 95% CI: 0.841–0.967, $p = 0.004$). This finding highlights the importance of hepatic synthetic function in the progression of chronic HBV infection and supports the utility of albumin as a clinically relevant prognostic biomarker.

The observed correlation aligns with prior research indicating the predictive importance of albumin in HBV-related liver damage. Albumin is produced solely by hepatocytes and acts as a critical marker of liver synthesis capacity. Decreased serum albumin levels typically indicate advancing hepatic impairment, systemic inflammation, and malnutrition, all of which exacerbate disease development and lead to unfavourable clinical consequences. Studies on HBV-related cirrhosis has consistently demonstrated that albumin-based indices have significant predictive significance. The Albumin–Bilirubin (ALBI) score, which integrates blood albumin and bilirubin concentrations, has been recognised as an independent predictor of liver-related mortality in individuals with chronic hepatitis B-

associated cirrhosis. Patients with reduced albumin levels and elevated ALBI grades demonstrated markedly inferior long-term survival outcomes. (23).

Additional evidence supporting the prognostic role of albumin has been reported in patients with HBV-associated decompensated cirrhosis. Several investigators have demonstrated that albumin-related biomarkers, including the blood urea nitrogen-to-albumin ratio, prothrombin time-to-albumin ratio, and neutrophil-to-albumin ratio, independently predict mortality and adverse clinical outcomes in HBV-related cirrhosis. These studies emphasize that albumin is not merely a marker of nutritional status but also reflects hepatic functional capacity and systemic inflammatory burden(24–26).

Furthermore, recent studies examining progression from chronic hepatitis B to cirrhosis and hepatocellular carcinoma have identified serum albumin as a protective factor against disease progression. Lower albumin concentrations were associated with an increased likelihood of developing advanced liver disease, reinforcing the concept that declining albumin levels accompany worsening hepatic injury and fibrosis (27).

The biological plausibility of our findings is supported by the multifunctional role of albumin in maintaining oncotic pressure, transporting endogenous and exogenous substances, modulating oxidative stress, and regulating inflammatory responses. As liver function deteriorates during chronic HBV infection, albumin synthesis decreases, resulting in hypoalbuminemia that reflects impaired hepatic reserve and increased disease severity. Therefore, serum albumin may serve as a simple, inexpensive, and readily available biomarker for identifying patients at increased risk of HBV progression. Taken together, our findings corroborate previous reports demonstrating the prognostic importance of albumin in HBV-related liver disease and suggest that serum albumin should be considered an important component of risk stratification models aimed at predicting disease progression and clinical outcomes among patients with chronic HBV infection.

5. Conclusion

This study highlights the importance of liver biochemical markers in the progression of chronic hepatitis B infection. Among all the biomarkers evaluated, serum albumin showed a significant decline with advancing disease severity and was identified as the only independent predictor of HBV outcome. Higher albumin levels were associated with reduced odds of adverse disease progression, emphasizing its value as a marker of hepatic synthetic function and disease prognosis. Given its simplicity, affordability, and availability, serum albumin may serve as a useful biomarker for risk stratification and monitoring of patients with chronic HBV infection.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this report.

Statement of Ethical approval

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (2024). Ethical approval was obtained from UNIOSUN Teaching Hospital, Osogbo, Nigeria (UTH/REC/2025/01/1094); Bowen University Teaching Hospital, Ogbomoso Nigeria (NHREC/12/04/2012) and Ladoke Akintola University of Technology Teaching Hospital, Ogbomoso, Nigeria (LTH/OGB/EC/2024/478).

Statement of informed consent

Informed consent was obtained from all participants or their legal guardians before data collection. Participation was entirely voluntary, and confidentiality was ensured through the use of coded identifiers.

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