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Original Article

Liver Biochemical Abnormalities and Their Association with Systemic Inflammatory and Severity Markers in Hospitalized COVID-19 Patients.

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Abstract

Background:
Coronavirus disease 2019 (COVID-19) is a multisystem disorder frequently associated with hepatic biochemical abnormalities. However, data from sub-Saharan Africa remains limited. This study aimed to evaluate liver enzyme abnormalities and identify factors associated with hepatic cytolysis among hospitalized COVID-19 patients at the University Clinics of Kinshasa.

Methodology:
A retrospective, cross-sectional, analytical study was conducted among 273 patients with PCR-confirmed COVID-19 between 2020 and 2022. Patients with pre-existing liver disease, viral hepatitis, alcohol consumption, or incomplete records were excluded. Hepatic cytolysis was defined as AST and/or ALT levels greater than twice the upper limit of normal. Sociodemographic, clinical, and biological data were analyzed using univariate and multivariate logistic regression models to identify independent associations.

Results:
The mean age of patients was 58.6 ± 14.9 years, with a predominance of males (75.4%). Hepatic cytolysis was observed in 65.9% of patients, predominantly characterized by elevated AST levels. Significant correlations were identified between liver enzymes and markers of inflammation and disease severity, including CRP, LDH, and oxygen saturation. Multivariate analysis demonstrated that elevated CRP, LDH, triglycerides, uric acid, and troponin levels were independently associated with hepatic cytolysis.

Conclusion:
Liver biochemical abnormalities are common in hospitalized COVID-19 patients and are strongly associated with systemic inflammation, metabolic disturbances, and multiorgan involvement. These findings suggest that hepatic cytolysis reflects systemic disease severity rather than isolated liver injury. Routine liver function assessment at admission may support risk stratification and clinical monitoring.

Keywords:
COVID-19, Hepatic Cytolysis, Liver Enzymes, Inflammation, Kinshasa, SARS-Cov-2

Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), continues to represent a major global public health challenge, with significant morbidity and mortality across diverse populations [1]. Although the African continent has reported comparatively lower infection and mortality rates than other regions, the pandemic has exerted substantial pressure on healthcare systems, particularly in resource-limited settings such as the Democratic Republic of the Congo [2,3]. These contextual differences highlight the importance of region-specific clinical and epidemiological data to better understand disease patterns and outcomes.

COVID-19 is now well established as a multisystem disorder with a wide clinical spectrum, ranging from asymptomatic infection to severe and critical illness [4]. While respiratory involvement remains the dominant clinical feature, increasing evidence has demonstrated the involvement of multiple organ systems, including the cardiovascular, renal, neurological, and hepatic systems [5]. Among these, hepatic involvement has emerged as a frequent yet complex manifestation, particularly in hospitalized patients with moderate to severe disease.

Abnormalities in liver biochemical parameters, especially elevations in aspartate aminotransferase (AST) and alanine aminotransferase (ALT), have been widely reported in patients with COVID-19 [6]. These alterations are thought to arise from a combination of mechanisms, including systemic inflammatory responses, hypoxic injury, drug-induced hepatotoxicity, and indirect viral effects mediated through immune and endothelial dysfunction [7]. Consequently, liver enzyme abnormalities are increasingly recognized not only as indicators of hepatic involvement but also as potential markers of overall disease severity and systemic stress.

However, the interpretation of liver enzyme abnormalities in COVID-19 remains challenging. AST, in particular, is not liver-specific and may reflect injury to extrahepatic tissues such as skeletal muscle and cardiac muscle. Therefore, elevations in liver enzymes may represent a broader pattern of multiorgan involvement rather than isolated hepatic dysfunction. This distinction is clinically important, as it influences both the interpretation of laboratory findings and the management of patients.

Despite a growing body of international literature, data on hepatic biochemical abnormalities in COVID-19 from sub-Saharan Africa remain limited [8]. Differences in demographic characteristics, prevalence of comorbidities, healthcare infrastructure, and disease severity profiles necessitate context-specific investigations. In the Democratic Republic of the Congo, there is a paucity of studies exploring the extent and clinical significance of liver enzyme abnormalities in hospitalized COVID-19 patients.

In this context, the present study aimed to assess liver biochemical abnormalities and identify factors associated with hepatic cytolysis among hospitalized patients with COVID-19 at the University Clinics of Kinshasa between 2020 and 2022. Specifically, this study focuses on biochemical markers of liver injury (AST, ALT, and bilirubin) and their relationship with inflammatory, metabolic, and severity-related parameters. By examining these associations, the study seeks to clarify whether hepatic cytolysis reflects primary liver involvement or serves as a surrogate marker of systemic disease severity in COVID-19.

Methodology

Study Design

This study was designed as a retrospective, cross-sectional, descriptive, and analytical hospital-based investigation conducted to evaluate liver biochemical abnormalities and their associated factors among patients with COVID-19. The retrospective nature allowed for the analysis of routinely collected clinical and laboratory data, while the analytical component enabled the identification of independent associations with hepatic cytolysis. The study design was consistently applied across the manuscript to ensure clarity and methodological coherence.

Ethics

Ethical approval for the study was obtained from the Research Ethics Committee of the School of Public Health, University of Kinshasa (UNIKIN), under approval number 040/2026. The study strictly adhered to ethical principles, including respect for patient confidentiality, anonymity, and data protection. As this was a retrospective analysis of anonymized medical records, no direct patient contact or intervention was involved, and all procedures complied with institutional and international ethical standards.

Setting

The study was conducted at the University Clinics of Kinshasa, a tertiary-level referral hospital in the Democratic Republic of the Congo, which served as a major COVID-19 treatment center during the pandemic. The study period extended from 2020 to 2022, encompassing multiple waves of COVID-19 and allowing for the inclusion of patients with varying degrees of disease severity.

Participants

The study included all hospitalized patients with laboratory-confirmed COVID-19, diagnosed by polymerase chain reaction (PCR), during the study period. A consecutive sampling approach was employed to minimize selection bias, whereby all eligible patients meeting inclusion criteria were included. Patients were excluded if they had pre-existing liver disease, viral hepatitis, a history of alcohol consumption, or incomplete medical records. This approach ensured a relatively homogeneous cohort for assessing COVID-19-related liver involvement.

Variables

The primary outcome variable was hepatic cytolysis, defined as elevation of aspartate aminotransferase (AST) and/or alanine aminotransferase (ALT) levels greater than twice the upper limit of normal (2×ULN), based on laboratory reference standards. Independent variables included sociodemographic characteristics (age, sex), clinical parameters (symptoms, comorbidities, vital signs, oxygen saturation), and biological markers such as liver enzymes (AST, ALT, total bilirubin), inflammatory markers (C-reactive protein [CRP]), and tissue injury markers (lactate dehydrogenase [LDH], troponin, triglycerides, and uric acid). These variables were selected based on their biological relevance to COVID-19 severity and systemic involvement.

Data Sources / Measurement

Data were extracted from hospital medical records using a structured data collection approach. All data were anonymized prior to analysis. Laboratory measurements were obtained at the time of hospital admission, ensuring consistency in timing across participants. Standardized laboratory methods were used for biochemical analysis, and values were interpreted according to institutional reference

ranges. Clinical variables, including comorbidities and symptoms, were recorded based on physician documentation in patient files.

Bias

Several potential sources of bias were considered. Selection bias was minimized through consecutive inclusion of all eligible patients during the study period. However, the hospital-based design may introduce severity bias, as only hospitalized patients were included. Information bias was possible due to reliance on retrospective record data, although standardized hospital documentation reduced this risk. Confounding factors such as disease severity, hypoxia, comorbid conditions (e.g., hypertension, diabetes, obesity), and treatment-related effects were acknowledged; however, not all could be fully controlled due to limitations inherent to retrospective data.

Study Size

A total of 273 patients were included in the study. This sample size was determined by the number of eligible patients meeting inclusion criteria during the study period. The sample was considered adequate to perform both descriptive and multivariate analyses, particularly for identifying associations with hepatic cytolysis.

Statistical Methods

Data analysis was performed using Microsoft Excel and SPSS software. Descriptive statistics were used to summarize baseline characteristics. Comparisons between groups (with and without hepatic cytolysis) were conducted using the Chi-square test for categorical variables and Student's t-test or Mann–Whitney U test for continuous variables, depending on data distribution.

Univariate logistic regression analysis was initially performed to identify variables associated with hepatic cytolysis. Variables with a p-value < 0.20 in univariate analysis were subsequently included in a multivariate logistic regression model to determine independent associations. Multicollinearity among variables was assessed using the variance inflation factor (VIF). Results were expressed as odds ratios (OR) with 95% confidence intervals (CI). A p-value < 0.05 was considered statistically significant. Complete-case analysis was applied, and no imputation was performed due to minimal missing data (<5% for most variables)

Results

Participants

A total of 273 patients with PCR-confirmed COVID-19 were included in the final analysis. All participants met the inclusion criteria and were consecutively recruited from hospitalized cases at the University Clinics of Kinshasa between 2020 and 2022. Patients with pre-existing liver disease, viral hepatitis, alcohol consumption, or incomplete medical records were excluded to ensure a more specific assessment of COVID-19-related hepatic involvement. The final sample therefore represents a well-defined cohort of hospitalized COVID-19 patients, as detailed in Table 1.

Descriptive Data

The study population had a mean age of 58.6 ± 14.9 years, with a predominance of male patients (75.4%). A substantial proportion of participants were aged ≥65 years (38.5%), reflecting a population at higher risk for severe disease. Hypertension (47.3%) and diabetes mellitus (19.0%) were the most common comorbidities, while obesity was present in 13.6% of cases. Clinically, the most frequently reported symptoms included fever (53.8%), cough (49.8%), asthenia (46.2%), and dyspnea (31.5%). A high proportion of patients (76.9%) developed acute respiratory distress syndrome (ARDS), and the majority presented with moderate to severe forms of COVID-19 according to WHO classification. The mean oxygen saturation (SpO_2) was 90.4 ± 10.2%, indicating significant respiratory compromise in a subset of patients. These baseline sociodemographic and clinical characteristics are comprehensively presented in Table 1 .

Biologically, patients demonstrated elevated inflammatory and tissue injury markers. Median CRP and LDH levels were notably increased, reflecting systemic inflammation and cellular damage. Liver enzymes showed variability, with median AST levels higher than ALT, suggesting a predominance of AST elevation. Additional biomarkers, including troponin, triglycerides, and uric acid, also demonstrated variations consistent with systemic involvement. These findings are summarized in Table 2.

It should be noted that oxygen saturation values differed between clinical and biological datasets, as Table 1 presents pulse oximetry measurements at admission, whereas Table 2 includes oxygenation parameters derived from arterial blood gas analysis, resulting in lower mean values.

Outcome Data

Hepatic cytolysis was observed in 65.9% of patients, while 34.1% had normal liver enzyme levels. The pattern of liver enzyme abnormalities revealed that isolated AST elevation was more frequent (26.4%) compared to isolated ALT elevation (4.8%), whereas combined AST and ALT elevation was observed in 34.8% of cases. This distribution highlights the predominance of AST-driven biochemical abnormalities in this cohort. The detailed cytolysis profile is illustrated in Figure 1.

Correlation analyses further demonstrated significant associations between liver enzymes and clinical and biochemical parameters. A statistically significant negative correlation was observed between AST levels and oxygen saturation (SpO_2), indicating that worsening hypoxia was associated with higher AST levels (Figure 2). Conversely, AST showed a strong positive correlation with CRP levels ($r = 0.586$; $R^2 = 0.57$), suggesting a close relationship between liver enzyme elevation and systemic inflammation (Figure 3).

Additionally, AST levels were negatively associated with bicarbonate (HCO_3^-), while positive associations were observed between ALT and diastolic blood pressure, and between AST and LDH levels. These findings collectively indicate that liver enzyme abnormalities are closely linked with metabolic, inflammatory, and hemodynamic disturbances. These associations are presented in Figures 2–6.

Main Results

In univariate logistic regression analysis, several variables were significantly associated with hepatic cytolysis, including male sex, elevated CRP, LDH, triglycerides, creatine kinase (CK), uric acid, and troponin levels. However, after adjustment in multivariate logistic regression analysis, only CRP, LDH, triglycerides, uric acid, and troponin remained independently associated with hepatic cytolysis. Specifically, elevated CRP and LDH levels were strongly associated with increased odds of hepatic cytolysis, reflecting the contribution of systemic inflammation and tissue injury. Similarly, abnormal triglyceride and uric acid levels indicated metabolic dysregulation, while elevated troponin suggested concurrent cardiac involvement. In contrast, male sex and CK lost statistical significance after adjustment, indicating that their initial associations were likely confounded by other variables. These independent associations are summarized in Table 3, which presents both univariate and multivariate analyses with corresponding odds ratios and confidence intervals.

Table 1: General and Clinical Characteristics of the Study Population (n = 273).

Variables	Total (n = 273)	Male (n = 206)	Female (n = 67)	p-value
Age (years), Mean ± SD	58.6 ± 14.9	60.2 ± 14.8	59.0 ± 14.8	0.460
Age group, n (%)				
≥65 years	105 (38.5)	77 (37.4)	28 (41.8)	0.307
<65 years	168 (61.5)	129 (62.6)	39 (58.2)	
Race, n (%)				
Black	232 (85.0)	170 (82.5)	62 (92.5)	0.031*
Comorbidities (Antecedents), n (%)				
Hypertension	129 (47.3)	97 (47.1)	32 (47.8)	0.517
Diabetes mellitus	52 (19.0)	39 (18.9)	13 (19.4)	0.530
Heart disease	12 (4.4)	10 (4.9)	2 (3.0)	0.401
HIV infection	4 (1.5)	2 (1.0)	2 (3.0)	0.253
Obesity	37 (13.6)	23 (11.2)	14 (20.9)	0.038*
Clinical signs, n (%)				
Headache	28 (10.3)	21 (10.2)	7 (10.4)	0.556
Coma	20 (7.3)	15 (7.3)	5 (7.5)	0.572
Asthenia	126 (46.2)	96 (46.6)	30 (44.8)	0.453
Fever	147 (53.8)	121 (58.7)	26 (38.8)	0.003*
Vomiting	4 (1.5)	3 (1.5)	1 (1.5)	0.678
Nausea	4 (1.5)	3 (1.5)	1 (1.5)	0.678
Diarrhea	14 (5.1)	8 (3.9)	6 (9.0)	0.098
Abdominal pain	3 (1.1)	2 (1.0)	1 (1.5)	0.572
Anorexia	35 (12.8)	21 (10.2)	14 (20.9)	0.023*
Cough	136 (49.8)	108 (52.4)	28 (41.8)	0.085
Dyspnea	86 (31.5)	63 (30.6)	23 (34.3)	0.334
Chest pain	4 (1.5)	2 (1.0)	2 (3.0)	0.253
ARDS	210 (76.9)	158 (76.7)	52 (77.6)	0.511
COVID-19 severity (WHO), n (%)				
Mild	35 (12.8)	26 (12.6)	9 (13.4)	
Moderate	153 (56.0)	113 (54.9)	40 (59.7)	0.687
Severe & critical	85 (31.1)	67 (32.5)	18 (26.9)	
Vital signs, mean ± SD				
Temperature (°C)	37.2 ± 0.9	37.0 ± 0.9	37.1 ± 0.9	0.127
SpO_2 (%)	90.4 ± 10.2	88.7 ± 11.6	90.0 ± 10.6	0.245
Respiratory rate (breaths/min)	27.5 ± 6.3	28.4 ± 7.6	27.7 ± 6.6	0.394
Systolic BP (mmHg)	139.2 ± 20.6	136.3 ± 18.6	138.5 ± 20.1	0.356
Diastolic BP (mmHg)	83.2 ± 13.2	82.1 ± 12.6	83.0 ± 13.1	0.585
Mean arterial pressure (mmHg)	101.3 ± 16.2	100.2 ± 11.8	101.0 ± 15.3	0.630
Heart rate (beats/min)	88.7 ± 14.4	82.5 ± 15.3	87.3 ± 14.8	0.007*

*p<0.05 is considered statistically significant

Table 2: Biological Characteristics of the Study Population (n = 273).

Variables	Total (n = 273)	Male (n = 206)	Female (n = 67)	p-value
Respiratory & Blood Gas Parameters				
SpO_2 (%)	72.2 ± 29.2	72.5 ± 28.8	71.2 ± 30.7	0.777
pCO_2 (mmHg)	36.5 ± 9.0	36.1 ± 8.0	37.7 ± 11.7	0.260
HCO_3^- (mmol/L)	24.5 ± 5.2	24.4 ± 4.7	25.0 ± 6.6	0.410
Hematological Parameters				
White blood cells (×10⁹/L)	6.6 (5.9–7.0)	6.6 (5.7–7.1)	6.2 (5.6–7.1)	0.205
Neutrophils (×10⁹/L)	4.5 (4.1–5.2)	4.6 (4.2–5.3)	4.2 (3.2–5.2)	0.496
Lymphocytes (×10⁹/L)	1.2 (1.1–1.3)	1.2 (1.1–1.3)	1.4 (1.2–1.6)	0.130
Hemoglobin (g/dL)	13.3 ± 2.2	13.6 ± 2.1	12.2 ± 2.2	<0.001*
Hematocrit (%)	38.7 ± 6.6	39.4 ± 6.4	36.8 ± 7.0	0.006*

Platelets (×10⁹/L)	187.0 (162.0–221.0)	189.0 (161.0–221.0)	165.0 (141.0–351.0)	0.594
Inflammatory & Tissue Injury Markers				
CRP (mg/L)	121.5 (107.0–139.0)	127.0 (107.0–142.0)	108.0 (65.0–204.0)	0.430
Procalcitonin (ng/mL)	0.23 (0.17–0.34)	0.26 (0.17–0.35)	0.18 (0.08–0.43)	0.944
LDH (U/L)	407.0 (358.0–459.0)	406.0 (289.0–479.0)	407.0 (236.5–513.0)	0.223
CK (U/L)	173.0 (103.0–237.0)	199.0 (158.0–285.0)	91.0 (62.0–175.0)	0.262
Troponin (ng/L)	16.2 (7.7–35.6)	16.9 (10.6–45.1)	7.4 (2.0–37.5)	0.020*
BNP (pg/mL)	173.0 (118.0–580.6)	193.6 (117.9–620.0)	173.0 (117.0–3038.0)	0.150
D-dimers (µg/L)	1581.6 (1021.4–2476.3)	1475.7 (921.6–2429.7)	1923.2 (600.9–7148.9)	0.299
Liver Function Parameters				
AST (U/L)	52.0 (42.0–90.0)	50.0 (42.0–90.0)	52.0 (25.0–119.0)	0.027*
ALT (U/L)	45.0 (29.0–63.0)	46.0 (33.0–63.0)	38.0 (23.0–88.0)	0.092
Total bilirubin (mg/dL)	9.4 (6.2–11.7)	10.6 (6.4–14.3)	7.6 (4.4–10.8)	0.342
Direct bilirubin (mg/dL)	3.6 (3.0–6.8)	5.6 (3.0–7.8)	2.9 (2.3–6.0)	0.493
Albumin (g/L)	30.3 ± 8.0	30.9 ± 8.4	28.8 ± 7.1	0.375
Total proteins (g/L)	77.5 ± 17.1	78.4 ± 16.3	74.5 ± 19.2	0.218
Metabolic & Electrolyte Parameters				
Calcium (mmol/L)	1.1 ± 0.2	1.1 ± 0.2	1.1 ± 0.1	0.816
Sodium (mmol/L)	137.4 ± 5.7	137.2 ± 6.1	137.9 ± 4.4	0.362
Potassium (mmol/L)	3.9 ± 0.6	3.9 ± 0.6	3.8 ± 0.6	0.105
Total cholesterol (mmol/L)	4.6 ± 1.3	4.5 ± 1.4	4.9 ± 1.0	0.201
LDL-C (mmol/L)	3.0 ± 1.2	3.0 ± 1.2	3.0 ± 1.1	0.931
HDL-C (mmol/L)	1.1 ± 0.5	1.0 ± 0.4	1.3 ± 0.6	0.007*
Triglycerides (mmol/L)	1.6 ± 0.9	1.7 ± 0.9	1.4 ± 0.8	0.149
Urea (mg/dL)	26.4 (19.8–33.0)	32.1 (24.0–46.2)	15.6 (10.8–20.4)	0.155
Creatinine (mg/dL)	1.02 (0.84–1.19)	1.18 (1.01–1.46)	0.77 (0.72–0.84)	0.074
Uric acid (µmol/L)	333.0 (283.0–392.0)	328.5 (274.0–449.0)	333.0 (239.0–392.0)	0.720

*p<0.05 is considered statistically significant

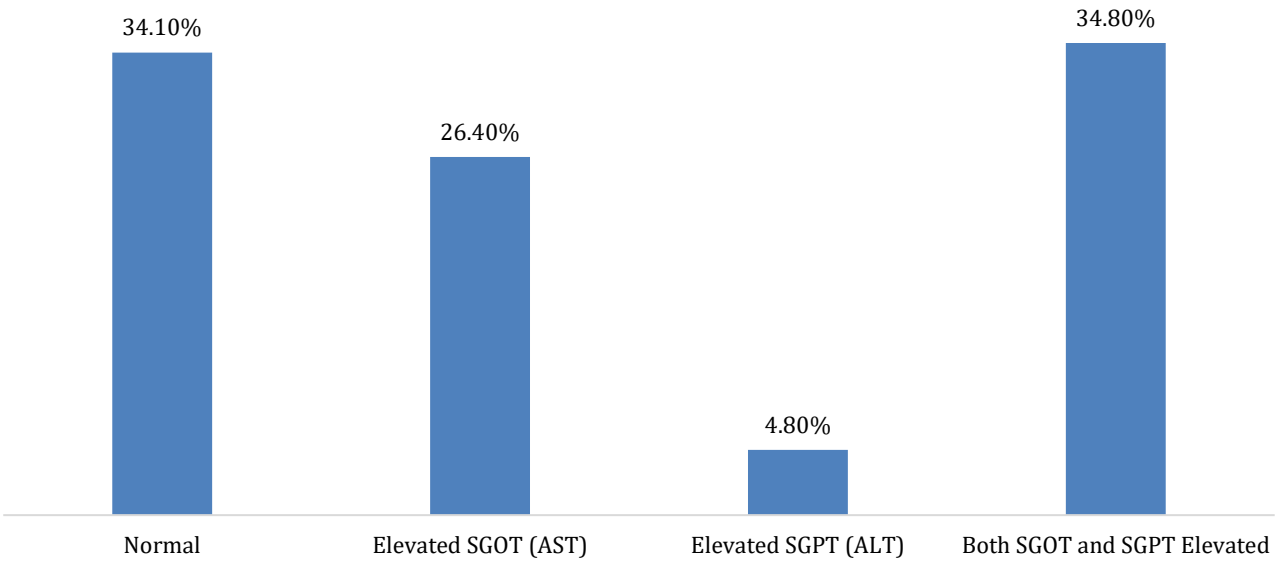

Figure 1 : Distribution of hepatic cytolysis patterns among hospitalized COVID-19 patients (n = 273).

This figure illustrates the distribution of liver biochemical profiles among the study population. Hepatic cytolysis was defined as AST and/or ALT levels greater than twice the upper limit of normal. Overall, 65.9% of patients exhibited hepatic cytolysis, while 34.1% had normal liver enzyme levels. Among those with abnormalities, isolated AST elevation was the most frequent pattern (26.4%), followed by combined AST and ALT elevation (34.8%), whereas isolated ALT elevation was relatively uncommon (4.8%). These findings indicate a predominance of AST-driven biochemical alterations in this cohort.

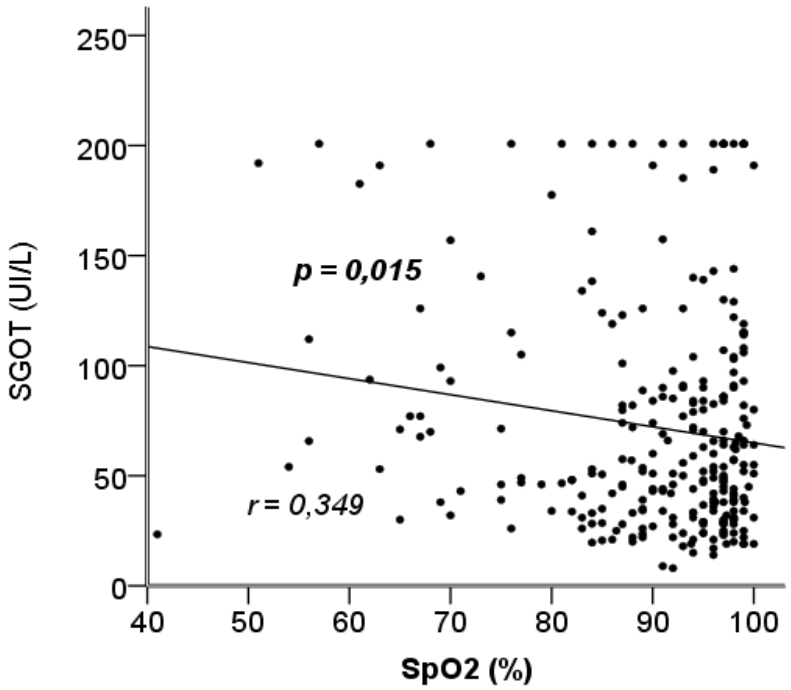

Figure 2. Association between AST levels and oxygen saturation (SpO_2) in COVID-19 patients.

Scatter plot with linear regression showing the relationship between AST levels and oxygen saturation (SpO_2) at admission. A statistically significant negative correlation was observed ($p < 0.001$), indicating that lower oxygen saturation was associated with higher AST levels. This suggests that hypoxia may contribute to hepatocellular injury or reflect systemic disease severity. The regression line represents the best linear fit, with shaded areas indicating the 95% confidence interval.

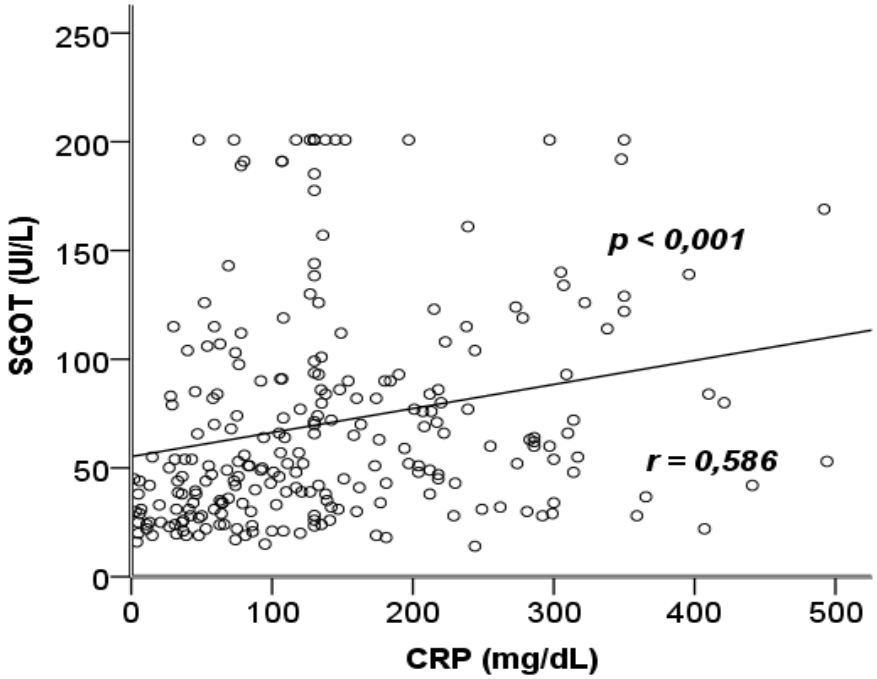

Figure 3. Correlation between AST levels and C-reactive protein (CRP) in COVID-19 patients.

Scatter plot with linear regression demonstrating the association between AST levels and CRP concentrations. A statistically significant positive correlation was observed ($r = 0.586$; $p < 0.001$), with approximately 57% of the variation in AST levels explained by CRP ($R^2 = 0.57$). This finding highlights the strong relationship between hepatic enzyme elevation and systemic inflammatory response in COVID-19.

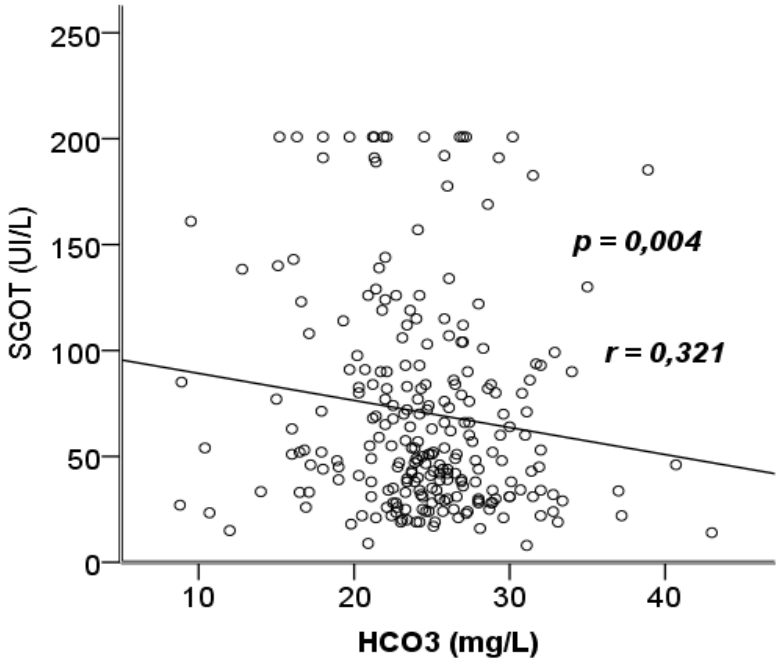

Figure 4. Relationship between AST levels and bicarbonate (HCO_3^-) concentration

Linear regression analysis showing the association between AST levels and serum bicarbonate (HCO_3^-). A statistically significant negative relationship was observed ($p < 0.001$), indicating that lower bicarbonate levels were associated with higher AST concentrations. This may reflect metabolic disturbances and acid–base imbalance associated with disease severity.

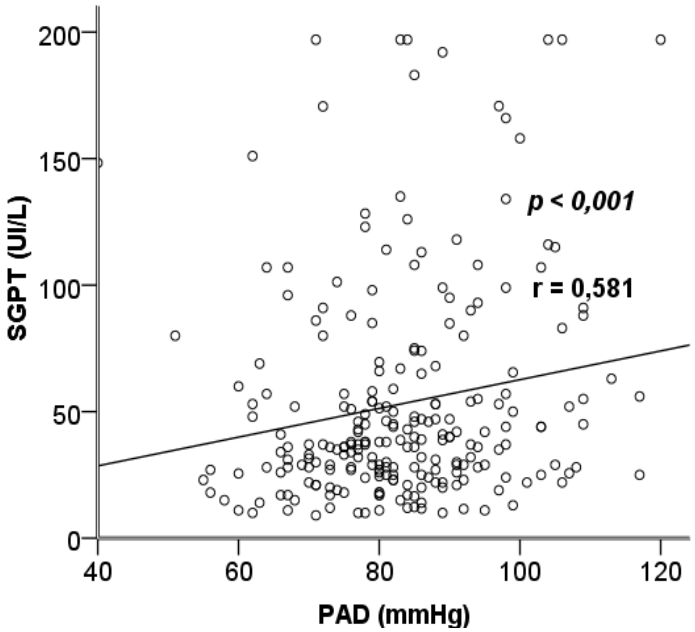

Figure 5. Association between ALT levels and diastolic blood pressure (DBP)

Scatter plot with linear regression illustrating the relationship between ALT levels and diastolic blood pressure (DBP). A statistically significant positive association was observed ($p < 0.001$), suggesting that increased DBP is associated with higher ALT levels. This may indicate a link between hemodynamic factors and liver enzyme alterations in COVID-19.

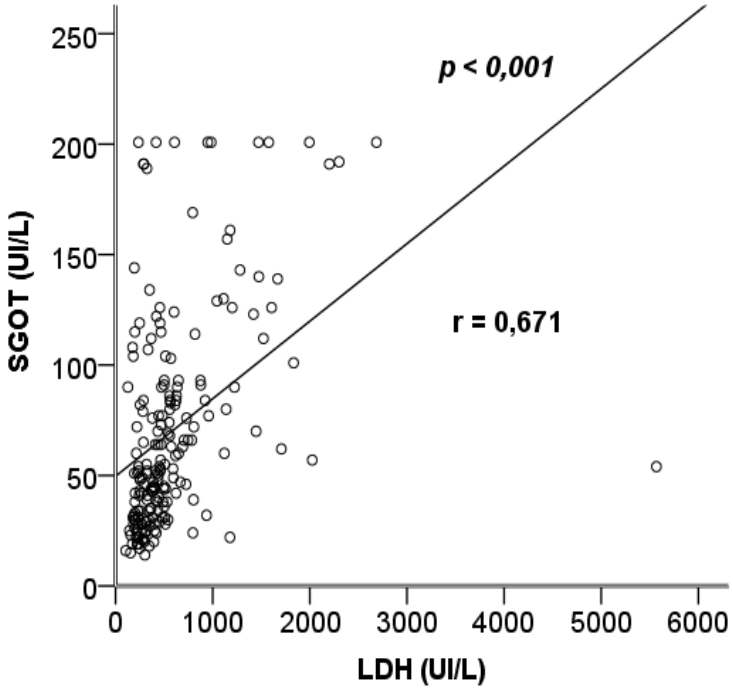

Figure 6. Correlation between AST levels and lactate dehydrogenase (LDH).

Linear regression analysis demonstrating the association between AST levels and LDH concentrations. A statistically significant positive correlation was observed ($r = 0.671$; $p < 0.001$), indicating that increased LDH levels are strongly associated with elevated AST. Approximately 67% of the variation in AST levels was explained by LDH ($R^2 = 0.67$), suggesting that liver enzyme abnormalities are closely linked to systemic tissue injury.

Table 3: Independent Associations with Hepatic Cytolysis in Patients with COVID-19.

Variables		Univariate Analysis		Multivariate Analysis	
		p-value	OR (95% CI)	p-value	Adjusted OR (95% CI)
Gender	Female	—	1 (reference)	—	1 (reference)
	Male	0.012	1.56 (1.13–2.75)	0.951	1.09 (0.08–1.48)
CRP	Normal	—	1 (reference)	—	1 (reference)
	Abnormal	0.004	2.79 (1.89–3.61)	0.009	2.13 (1.23–3.01)
LDH	Normal	—	1 (reference)	—	1 (reference)
	Abnormal	0.010	2.57 (1.25–5.29)	0.017	2.10 (1.78–3.11)
Triglycerides (TG)	Normal	—	1 (reference)	—	1 (reference)
	Abnormal	0.022	2.97 (1.17–7.55)	0.019	1.56 (1.14–3.11)
Creatine Kinase (CK)	Normal	—	1 (reference)	—	1 (reference)
	Abnormal	0.049	1.96 (1.03–3.83)	0.750	1.38 (0.19–2.98)
Uric Acid	Normal	—	1 (reference)	—	1 (reference)
	Abnormal	0.015	2.61 (1.94–7.25)	0.034	2.48 (1.26–4.01)
Troponin	Normal	—	1 (reference)	—	1 (reference)
	Abnormal	0.012	2.79 (1.25–6.20)	0.005	3.32 (1.15–5.05)

*p<0.05 is considered statistically significant

Discussion

The present study provides important insights into liver biochemical abnormalities among hospitalized patients with COVID-19 at the University Clinics of Kinshasa. The findings demonstrate a high prevalence of hepatic cytolysis (65.9%), with a predominance of AST elevation, supporting the growing body of evidence that liver enzyme abnormalities are frequent in patients with moderate to severe COVID-19 [19–23]. These results are consistent with previously reported studies, where liver enzyme alterations have been observed in 60–80% of hospitalized patients, particularly in severe disease [10,11].

The demographic profile of the study population, characterized by a predominance of males and a mean age of approximately 58 years, aligns with earlier reports suggesting that older age and male sex are associated with increased vulnerability to severe COVID-19 [9,34–36]. Although male sex was associated with hepatic cytolysis in univariate analysis, this association did not persist after multivariate adjustment, indicating that the observed effect may be mediated by other clinical or biological factors.

A key finding of this study is the strong association between liver enzyme abnormalities and markers of systemic inflammation and

disease severity. The significant positive correlation between AST and CRP ($r = 0.586$; $R^2 = 0.57$) highlights the central role of inflammation in the pathophysiology of hepatic involvement in COVID-19 [28–31]. Elevated CRP levels reflect a hyperinflammatory state driven by cytokine release, particularly interleukin-6 (IL-6), which has been implicated in multiorgan dysfunction [37,38]. Similarly, the independent association between LDH and hepatic cytolysis underscores the contribution of tissue injury and cellular damage, which are hallmarks of severe COVID-19 [32,33].

The observed negative association between AST levels and oxygen saturation further supports the hypothesis that hypoxia plays a significant role in liver injury. Reduced oxygen delivery in severe respiratory disease can lead to hypoxic hepatitis and contribute to hepatocellular damage [24–26]. However, the relationship between oxygen saturation and systemic parameters may vary across populations, as reported in previous studies [27].

Importantly, the predominance of AST elevation over ALT suggests that liver enzyme abnormalities in COVID-19 may not be exclusively hepatic in origin. AST is present in multiple tissues, including skeletal muscle and cardiac muscle, and its elevation may reflect systemic injury rather than isolated liver damage. This interpretation is further supported by the significant associations observed with LDH and troponin, indicating concurrent muscle and cardiac involvement [19–23]. Therefore, hepatic cytolysis in COVID-19 should be considered a marker of systemic disease severity rather than a specific indicator of liver dysfunction.

Metabolic factors also appear to play a significant role in the observed biochemical alterations. The independent associations of triglycerides and uric acid with hepatic cytolysis suggest the involvement of metabolic dysregulation and oxidative stress in COVID-19 pathophysiology [39–47]. These findings are consistent with emerging evidence linking metabolic syndrome components to worse clinical outcomes in COVID-19 patients.

In multivariate analysis, CRP, LDH, triglycerides, uric acid, and troponin remained independently associated with hepatic cytolysis. This combination of inflammatory, metabolic, and cardiac markers reinforces the concept that COVID-19 is a multisystem disease with complex interactions between different physiological pathways. The liver, therefore, acts as both a target and a marker of systemic involvement.

The findings of this study contribute to the understanding of liver involvement in COVID-19, particularly in the context of sub-Saharan Africa, where data remain limited. The results highlight the importance of interpreting liver enzyme abnormalities within a broader clinical and biological framework rather than as isolated findings.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the retrospective and hospital-based design introduces potential selection bias, as only hospitalized patients who are more likely to have moderate to severe disease were included. Consequently, the findings may not be generalizable to patients with mild or asymptomatic COVID-19. Second, the use of medical records as the primary data source may introduce information bias due to incomplete or inconsistently recorded data. Although efforts were made to include only patients with complete records, some variables may still be subject to measurement variability. Third, the timing of laboratory measurements was limited to values obtained at hospital admission and did not account for dynamic changes over the course of the disease. Longitudinal assessment of liver function could provide a more comprehensive understanding of disease progression. Fourth, residual confounding cannot be excluded. Important factors such as disease severity, hypoxia, comorbidities (e.g., hypertension, diabetes, obesity), and treatment-related hepatotoxicity were not fully controlled due to limitations inherent to retrospective data. These factors may have influenced the observed associations. Fifth, hepatic cytolysis was defined based on AST and ALT levels without incorporating more comprehensive markers of liver function, such as coagulation parameters or imaging findings. In addition, AST is not liver-specific and may reflect extrahepatic injury, including muscle and cardiac damage. Finally, missing data handling was based on complete-case analysis, and no imputation methods were applied. Although the proportion of missing data was low, this approach may still introduce bias in certain analyses.

Conclusion

Liver biochemical abnormalities are highly prevalent among hospitalized patients with COVID-19 and are strongly associated with markers of systemic inflammation, metabolic dysregulation, and multiorgan injury. The predominance of AST elevation and its association with CRP, LDH, and troponin suggest that hepatic cytolysis reflects systemic disease severity rather than isolated liver dysfunction. These findings emphasize the importance of routine liver function assessment in hospitalized COVID-19 patients, particularly at admission, as part of a comprehensive clinical evaluation. Liver enzyme abnormalities may serve as useful adjunct markers for risk stratification and monitoring disease progression.

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