

Biochemical Assessment of Alanine Aminotransferase (ALT), Aspartate Aminotransferase (AST) and Albumin (ALB) Levels among blood donors infected with viral hepatitis and malaria in Ife East local government area, Ile Ife, Osun state, Nigeria.

Abstract

Background: Liver function markers are critical indicators of hepatic health, influenced by a complex interplay of lifestyle, genetics, and infectious agents. This study evaluated the prevalence and sociodemographic determinants of elevated Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), and Albumin (ALB) levels within a diverse cohort.

Methods: A cross-sectional study was conducted to analyze liver biomarkers in relation to age, sex, occupation, education, blood group, and co-infections (Malaria, HBV, and HCV). Statistical significance was determined using p-value analysis to identify clinical correlations.

Results: The overall prevalence of elevated biomarkers was recorded as AST (6.3%), ALT (4.8%), and ALB (7.5%). Age-specific analysis revealed the highest enzyme elevations in the 27–35 aged group (AST: 8.7%; ALT: 8.1%), while the highest ALB elevation (13.6%) occurred in those aged 18–26 years. Males exhibited higher elevation rates compared to females. Occupationally, students demonstrated the highest vulnerability, with elevated AST at 12.7% and ALB at 14.5%. Educational background influenced results, with secondary school leavers showing higher enzyme elevations than tertiary graduates. Analysis of blood groups indicated that B-negative (20.0%) and O-negative (14.6%) individuals were most susceptible to AST/ALT fluctuations. While no significant association was found between liver enzymes and Malaria or HBV ($p > 0.05$), a highly significant correlation was observed between HCV and Albumin ($p=0.001$), as well as general hepatitis infection and Albumin ($p=0.016$).

Conclusion: The results suggest that liver stress in this population is largely driven by sociodemographic and lifestyle factors, particularly among younger adults and students. While viral infections like HCV do not significantly impact transaminase leakage in this cohort, they significantly impair the liver's synthetic capacity (Albumin). These results underscore the need for targeted metabolic screening in young adults and the inclusion of protein panels in viral hepatitis management.

Keywords: AST, ALT, albumin, hepatitis B and C viruses, blood group, malaria

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Introduction

The safety of the global blood supply remains a critical public health priority, particularly in sub-Saharan Africa and other developing regions where the prevalence of transfusion-transmissible infections (TTIs) remains high. Blood transfusion is a life-saving intervention, yet it serves as a potential vehicle for the transmission of devastating pathogens, most notably the Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and *Plasmodium species* (Malaria). While screening protocols have improved, the physiological impact of these infections on the donor's hepatic function often asymptomatic at the time of donation remains a subject of significant clinical interest.¹

The liver is the primary metabolic hub of the body, responsible for detoxification, protein synthesis, and the regulation of biochemical pathways. When hepatocytes are damaged by viral infiltration or parasitic sequestration, intracellular enzymes leak into the systemic circulation.² Alanine Aminotransferase (ALT) and Aspartate

Aminotransferase (AST) are the most sensitive indicators of hepatocyte integrity. ALT is primarily localized in the liver, making it a specific marker for hepatic parenchymal injury. AST, while present in the liver, is also found in cardiac and skeletal muscle. Albumin (Alb), as the primary protein synthesized by the liver, serum albumin levels serve as a crucial marker of the liver's synthetic capacity. A decline in albumin often reflects chronic hepatic distress or significant systemic inflammation.³ HBV and HCV are non-cytopathic viruses; the liver damage they cause is largely mediated by the host's immune response against infected hepatocytes. In chronic states, this leads to persistent elevations of ALT and AST and a gradual decline in Albumin as functional liver tissue is replaced by fibrous scars.⁴

Conversely, Malaria introduces a different dynamic. The intra-erythrocytic cycle of *Plasmodium* leads to hemolysis, but the pre-erythrocytic stage involves significant multiplication within hepatocytes. This exo-erythrocytic phase, combined with the inflammatory cytokine storm and potential malarial hepatopathy,

can cause acute fluctuations in liver enzymes, even in semi-immune adult donors who may appear healthy during physical examination. In many settings, blood donors are only screened for the presence of antigens or antibodies. However, the biochemical profile of these donors provides a deeper look into the “silent” burden of disease. Co-infections such as a donor carrying both HBV and Malaria can synergistically accelerate liver damage, leading to marked biochemical derangements that might not be captured by rapid diagnostic tests (RDTs) alone. Monitoring ALT, AST, and Albumin in infected donors is not only essential for understanding the epidemiology of liver disease in the donor population but also serves as a surrogate marker for the quality of the donated unit. High levels of circulating enzymes or low protein content can affect the storage lesions and therapeutic efficacy of the blood components.⁵ This study aim at assessing Alanine Aminotransferase, Aspartate Aminotransferase and Albumin among Blood Donors infected with Hepatitis B and C Virus and Malaria in Ife East Local Government Area, Ile Ife, Osun State, Nigeria.

Materials and methods

Ethical consideration

Ethical clearance was obtained from the Health Research Ethics Committee (HREC) of the Osun State Ministry of Health Nigeria (OSHREC/PRS/569T/437). Informed written consent was obtained from all participants, and confidentiality of results was strictly maintained.

Study area

The study was conducted in Ife East Local Government Area (LGA), headquartered in the ancient city of Ile-Ife, Osun State, Nigeria. This region is a major educational and commercial hub, primarily served by the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC) and various comprehensive health centers. The area is characterized by a tropical climate with distinct rainy and dry seasons, providing an endemic environment for *Plasmodium* transmission. Majority of the inhabitants are skilled workers, e.g. civil servants and artisans while others are unskilled workers, e.g. peasant farmers, traders and transport workers (Figure 1).

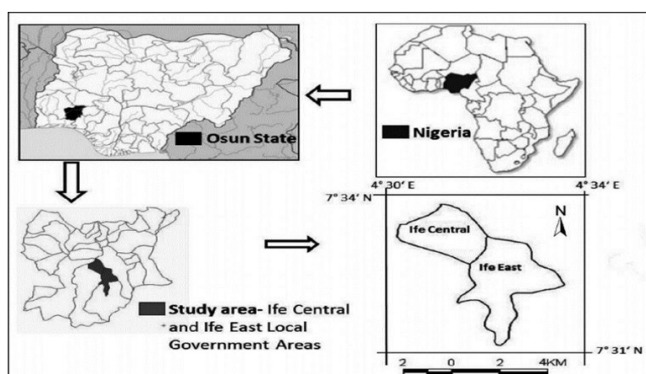


Figure 1 Map showing Ife East Local Government Areas, Osun State of Ife, Nigeria.¹

Study design

A total of 400 blood samples were collected and prior to the collection of the blood samples structured questionnaire designed to collect basic demographic information including age, residential location, occupation and educational level and other information as regards the study.

Study population

The study populations comprise of voluntary and replacement blood donors who came to donate blood at the government approved blood donor’s centers within the local government area. They were approached and the purpose of the study was discussed with them. Thereafter, the procedure to be taken was explained to them. The donors were informed that only those that signed the consent form will be allowed to participate in the study. They were also informed that participation is voluntary.

Sample size determination

$$N = \frac{P(1-P)d^2}{S^2}$$

Where:

- Z = 1.96 (95% confidence interval).
- P = Estimated prevalence of TTIs (HBV, HCV, or Malaria) in Osun State based on previous literature.
- Sd = 0.05 (desired margin of error).

$$P = 40.67\%, D = 1.96, S = 0.05$$

$$40.67(1-40.67) 1.96^2$$

$$N = \frac{(0.05)^2 \cdot 0.92695929457}{0.0025}$$

$$N = 370.784 \text{ (Wang and Ji, 2020).}^6$$

Sample collection and preparation

Approximately 5mL of venous blood was collected from each participant through venipuncture using sterile needles and syringes.

- 2mL was dispensed into an Ethylenediaminetetraacetic acid (EDTA) container for malaria parasite screening and hematological parameters.
- 3mL was dispensed into a plain (serum) separator tube.

The plain tubes was allowed to clot at room temperature and then centrifuged at 3,000 rpm for 5 minutes to obtain clear serum. The serum will be aliquoted and stored at -20°C until biochemical analysis.

Laboratory analysis

Screening for viral pathogens (HBV and HCV)

Donors were screened for Hepatitis B Surface Antigen (HBsAg) and Hepatitis C Virus (HCV) antibodies using third-generation Enzyme-Linked Immunosorbent Assay (ELISA) kits, following the manufacturer’s instructions. Positive results was re-tested for confirmation.

Biochemical assays (ALT, AST and Albumin)

Forty-four (44) Hepatitis (b and c) positive sera from 400 blood donors were used in the estimation of AST and ALT as follows:

A. Method

Three or more tubes (depending on the number of tests) were taken and label as follows: B – Reagent blank, S – Standard (pyruvate 57

ALT IU/l), 1, 2, etc – Animals' tests B. The Reagents are: Reagent 1= Substrate PH 7.4,

Reagent 2= DNPH Colour reagent,

Reagent 3 = Sodium hydroxide (4mol/L),

Reagent 4 = working pyruvate standard 0.25l of Reagent 1 was pipetted into samples' tubes (1, 2, etc). The tubes were transferred into water bath set at 37°C, 0.05 ml (50 µl) of animal's serum was added after 5 minutes, Mixed and incubate at 37°C for exactly 30 minutes.

The timing started after adding serum to the first tube. Just before 30 minutes was due, the followings were pipetted into the blank and standard tubes:

B. .0.1 ml distilled water,

0.5 ml Reagent 1,

0.1 ml distilled water,

0.4 ml Reagent 1, S 0.1 ml Reagent 4.

At exactly 30 minutes, tubes 1, 2, etc. were removed from the water bath and placed in the rack with tubes B and S., 0.25 ml Reagent 2 was immediately added to each tube and mix well and left at room temperature (20–28°C) for 20 minutes., 2.5 ml of Solution 1 was added to each tube and mix well and also left at room temperature for 10 minutes., The absorbance of the standard, and test samples were read in a spectrophotometer set at wavelength 505 nm. The instrument was zero with the reagent blank solution in tube B. The colours of the solutions are stable for up to 1 hour. The ALT activity in IU/l in the test samples was read from the calibration graph, making sure that the reading of the standard which corresponds to ALT 57 IU/l agrees with the calibration curve.⁷

Measurement of albumin (Alb)

The technique used for serum albumin was the Bromocresol Green (BCG) Method, which was a dye-binding colorimetric assay. Albumin is unique because it possesses a strong positive charge at a slightly acidic pH. The anionic dye Bromocresol Green was added to serum in a buffered solution (usually at pH 4.2), it binds specifically to albumin. The binding causes a shift in the absorption maximum of the dye. The colour changes from yellow-green to a blue-green complex. The intensity of the blue-green color was measured using spectrophotometer at 620–630 nm. The color intensity is directly

proportional to the concentration of albumin in the sample, which is then compared against a known standard.

Determination of blood group of the donors

Determination of the blood groups of the donors was done using Anti sera A, B, AB and anti D that determine the Rhesus factor as follows:

A glass slide was marked as follows Anti-A, Anti-B, Anti D and each division was pipette into as follows:

Anti-A: 1 volume anti-A serum, 1 volume donor's capillary blood,

Anti-B: 1 volume anti-B serum, 1 volume donor's capillary blood,

Anti-AB: 1 volume anti-AB serum, 1 volume donor's capillary blood,

Anti-D: 1 volume anti-D serum, 1 volume donor's capillary blood.

The contents of each division were mixed using a clean piece of stick for each. The slide was tilted from side to side, looking for agglutination and the results recorded after 2 minutes.

Data Analysis

Analysis of the data was analyzed using appropriate Statistical Package for the Social Sciences (SPSS) tool version 21.0. The prevalence was calculated as the number of serologically positive samples divided by the total number of samples tested. The Chi-square test was used to determine associations between positivity and socio demographic factors. The strength of the associations was assessed by odds ratios and 95% confidence intervals (CI) were calculated. A p-value < 0.05 will be considered statistically significant.

Results

In Table 1, the total percentage of elevated AST was 25 (6.3%), ALT 19(4.8%) and ALB 30 (7.5%), while the non-elevated AST 19 (4.8%), ALT 25 (6.3%) and ALB 14 (3.5%) was recorded in the study. The percentage elevated AST 15(8.7%) was recorded in aged 27-35 years, followed by 8(5.2%) in aged 36-44 years and the least 2(4.5%) in aged 45-53 years, while that of ALT was 14(8.1%) in aged 27-35 years followed by 4(2.6%) in aged 36-44 years and the least 1(2.3%) in aged 45-53 years. The percentage elevated ALB 3(13.6%) was recorded in aged 18-26 years followed by 15(8.7%) in aged 27-35 years and the least (4.5%) in aged 45-53 years.

Table 1 The Age distribution of AST,ALT and ALB of the positive blood donors according to socio-demographic factors in Ife East L.G.A. in Osun State. (N=400).

Age (years)	Number examined	Number infected	AST (%)		ALT (%)		ALB (%)	
			0-12	> 12	0-12	> 12	< 35	>35
18-26	22	3	3 (13.6)	0 (0.0)	3(13.6)	0(0.0)	0 (0.0)	3 (13.6)
27- 35	172	24	9 (5.2)	15(8.7)	10(5.8)	14(8.1)	9(5.2)	15(8.7)
36-44	153	14	6(3.9)	8 (5.2)	10 (6.5)	4 (2.6)	4(2.6)	10 (6.5)
45-53	44	3	1 (2.3)	2 (4.5)	2 (4.5)	1 (2.3)	1(2.3)	2 (4.5)
54-62	9	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	400	44	19 (4.8)	25 (6.3)	25 (6.3)	19(4.8)	14 (3.5)	30 (7.5)

Normal range: Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST) = (0-12u/L),

Albumin (ALB) = (35-50g/L).

In sex (Table 2), the percentage elevated AST 24 (6.3%), ALT 19 (5.0%) and ALB 29 (7.7%) was recorded in male.

Table 2 The Sex distribution of AST,ALT and ALB of the positive blood donors according to socio-demographic factors in Ife East L.G.A. in Osun State. (N=400).

Sex	Number examined	Number infected	AST (%)		ALT (%)		ALB (%)	
			0-12	> 12	0-12	> 12	< 35	>35
Male	379	43	19(5.0)	24(6.3)	24(6.3)	19(5.0)	14(3.7)	29 (7.7)
Female	21	1	0(0.0)	1(4.8)	1(4.8)	0(0.0)	0 (0.0)	1(4.8)
Total	400	44	19 (4.8)	25 (6.3)	25 (6.3)	19(4.8)	14 (3.5)	30 (7.5)

Normal range:Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST) = (0-12u/L),Albumin (ALB) = (35-50g/L).

In marital status, the percentage elevated AST 11(7.0%), ALT 9(5.7%) and ALB 16(10.1%) was recorded among single (Table 3).

Table 3 The marital Status distribution,AST,ALT and ALB of the positive blood donors according to socio-demographic factors in Ife East L.G.A. in Osun State. (N=400).

Marital Status	Number examined	Number infected	AST (%)		ALT (%)		ALB (%)	
			0-12	> 12	0-12	> 12	< 35	>35
Married	242	25	11(4.8)	14(5.8)	15(6.2)	10(4.1)	11(4.5)	14(5.8)
Single	158	19	8(5.1)	11(7.0)	10(6.3)	9(5.7)	3(1.9)	16(10.1)
Total	400	44	19 (4.8)	25 (6.3)	25 (6.3)	19(4.8)	14 (3.5)	30 (7.5)

Normal range:Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST) =

(0-12u/L),Albumin (ALB) = (35-50g/L).

In occupation, the percentage elevated AST 7(12.7%) was recorded in student followed by 4(6.8%) in driver and the least 3(4.6%) in trader while that of ALT was 6(10.9%) in student followed by 1(6.3%) in farmer and the least 1(1.5%) in trader. The percentage elevated ALB 8(14.5%) was recorded in student followed by (9.7%) in civil servant and the least 3(4.6%) in trader (Table 4).

Table 4 The Occupation distribution of AST,ALT and ALB of the positive blood donors according to socio-demographic factors in Ife East L.G.A. in Osun State. (N=400).

Occupation	Number examined	Number infected	AST (%)		ALT (%)		ALB (%)	
			0-12	> 12	0-12	> 12	< 35	>35
Artisan	143	14	6(4.2)	8(5.6)	7(4.9)	7(4.9)	6 (4.2)	8 (5.6)
Civil servant	62	7	4(6.5)	3(4.8)	4(6.5)	3(4.8)	1 (1.6)	6(9.7)
Trader	65	4	1(1.5)	3(4.6)	3(4.6)	1(1.5)	1(1.5)	3 (4.6)
Driver	59	6	2(3.4)	4(6.8)	5(8.5)	1(1.7)	2(3.4)	4 (6.8)
Student	55	11	4(7.3)	7(12.7)	5(9.1)	6(10.9)	3 (5.5)	8(14.5)
Farmer	16	2	2(12.5)	0(0.0)	1(6.3)	1 (6.3)	1(6.3)	1(6.3)
Total	400	44	19 (4.8)	25 (6.3)	25 (6.3)	19(4.8)	14 (3.5)	30 (7.5)

Normal range:Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST) = (0-12u/L),Albumin (ALB) = (35-50g/L).

In education, the percentage elevated AST 18(6.7%) was recorded in secondary followed by 1(6.3%) in primary and the least 6 (5.2%) in tertiary while that of ALT was 15(5.6%) in secondary and the least 1(6.3%) in primary (Table 5).

Table 5 The Education distribution of AST,ALT and ALB of the positive blood donors according to socio-demographic factors in Ife East L.G.A. in Osun State. (N=400).

Education	Number examined	Number infected	AST (%)		ALT (%)		ALB (%)	
			0-12	> 12	0-12	> 12	< 35	>35
Primary	16	2	1 (6.3)	1 (6.3)	2(12.5)	0(0.0)	1 (6.3)	1 (6.3)
Secondary	268	30	12(4.5)	18(6.7)	15(5.6)	15(5.6)	10(3.7)	20(7.5)
Tertiary	116	12	6(5.2)	6(5.2)	8(6.9)	4(3.4)	3(2.6)	9(7.8)
Total	400	44	19 (4.8)	25 (6.3)	25 (6.3)	19(4.8)	14 (3.5)	30 (7.5)

Normal range:Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST) = (0-12u/L),Albumin (ALB) = (35-50g/L).

(Table 6), In blood group, the percentage elevated AST (20.0%) was recorded in B-ve followed by 14.6% in O-ve and the least 3.5% in O+ve while that of ALT was 20.0% in B-ve followed by 7.3% in O-ve and the least 2.7% in A+ve. The percentage elevated ALB (12.2%) was recorded in O-ve followed by (9.3%) in B+ve and the least (5.5%) in O-ve.

Table 6 The Age distribution,AST,ALT and ALB of the positive blood donors according to blood group in Ife East L.G.A, Osun State. (N=400).

Blood Group	Number Examined	Number Infected	AST (%)		ALT (%)		ALB (%)	
			0-12	> 12	0-12	> 12	< 35	>35
Ab +ve	5	0	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0 (0.0)
A -ve	2	0	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0 (0.0)	0(0.0)
A +ve	73	7	2(2.7)	5(6.8)	5(6.8)	2 (2.7)	3(1.4)	4 (5.5)
B -ve	5	1	0(0.0)	1(20.0)	0(0.0)	1(20.0)	1(20.0)	0 (0.0)
B +ve	75	10	4(5.3)	6(8.0)	6(8.0)	4 (5.3)	3 (4.0)	7(9.3)
O -ve	41	7	1(2.4)	6(14.6)	4(9.8)	3 (7.3)	2(4.9)	5(12.2)
O +ve	199	19	12(6.0)	7(3.5)	10(5.0)	9(4.5)	5(2.5)	14(7.0)
Total	400	44	19 (4.8)	25 (6.3)	25 (6.3)	19(4.8)	14 (3.5)	30 (7.5)

Normal ranges:WBC = 4000-10,000/mm³, Neutrophil = 40-70% Lymphocyte = 20-45%, Eosinophil= 1-6%, Packed cell volume (PCV) Women = (36-46%), Men = (40-54%).

Table 7, There was no significant difference between malaria and AST (p= 0.757), ALT (p= 0.319) and ALB (p= 0.233) also, there was no significant difference between HCV and AST (p=0.257), ALT (p=0.450), but with ALB (p=0.001). There was no significant

difference between HBV and AST (p=0.617), ALT (p=1.000) and ALB (p=0.617), the general hepatitis virus infection had no significant difference with AST (p=0.366), ALT (p=0.366), but with ALB (p= 0.016) (Tables 7,7a–7c).

Table 7 Relationship between malaria parasite count and AST,ALT ALB ANOVA.

	Sum of Squares	df	Mean square	F	sig
Malaria count*AST Between Groups (combined)	685359.832	1	685359.8	0.097	0.757
Within Groups	2.97E+08	42	7058537		
Total	2.97E+08	43			
Malaria count*ALT Between Groups(combined)	7022461.293	1	7022461	1.017	0.319
Within Groups	2.90E+08	42	6907654		
Total	2.97E+08	43			
Malaria count*ALB Between Groups	1.00E+07	1	1.00E+07	1.464	0.233
Within Groups	2.87E+08	42	6836505		
Total	2.97E+08	43			

Table 7a Relationship between HCV and AST,ALT,ALB.

	AST		ALT		ALB	
	0-12	> 12	0-12	>12	< 35	>35
Observed N	12	16	17	11	5	23
Expected N	14.0	14.0	14.0	14.0	14.0	14.0
Residual	-2.0	2.0	3.0	-3.0	-9.0	9.0

AST (X²) = 1.286, p=0.257,ALT (X²) = 0.571, p=0.450,ALB (X²) = 11.571, p= 0.000

Table 7b Relationship between HBV and AST,ALT,ALB.

	AST		ALT		ALB	
	0-12	> 12	0-12	>12	< 35	>35
Observed N	7	9	8	8	9	7
Expected N	8.0	8.0	8.0	8.0	8.0	8.0
Residual	-1.0	1.0	0.0	0.0	1.0	-1.0

AST (X²) = 0.250, p=0.617,ALT (X²) = 0.000, p=1.000,ALB (X²) = 0.250, p= 0.617

Table 7c Relationship between General Hepatitis infection and AST,ALT,ALB.

	AST		ALT		ALB	
	0-12	> 12	0-12	>12	< 35	>35
Observed N	19	25	25	19	14	30
Expected N	22.0	22.0	22.0	22.0	22.0	22.0
Residual	-3.0	3.0	3.0	-3.0	-8.0	8.0

AST X² = 0.818, p=0.366,ALT X² = 0.366,ALB (X²) = 5.818, p= 0.016

Discussion

The study recorded an overall prevalence of elevated Aspartate Aminotransferase (AST) at 6.3% and Alanine Aminotransferase (ALT) at 4.8%. In clinical diagnostics, ALT is traditionally viewed as a more specific indicator of liver parenchyma injury, whereas AST is found in the heart, skeletal muscle, and kidneys. The slightly higher prevalence of AST elevation relative to ALT suggests that a subset of the population may be experiencing systemic metabolic stress or mild muscular exertion rather than acute, localized hepatic necrosis. Interestingly, the prevalence of elevated Albumin (ALB) at 7.5% higher than both enzymes is a notable finding. While hypoalbuminemia is a classic sign of chronic liver disease, hyperalbuminemia (elevated ALB) is almost exclusively associated with hemoconcentration due to dehydration.⁸ This may reflect environmental heat stress or high physical activity levels in the study cohort.

A significant trend is the peak of elevated enzymes in the 27–35 age group (AST 8.7%; ALT 8.1%). This aligns with 2025 longitudinal data indicating a Metabolic Shift in young adults. Recent studies on Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD) suggest that this age group is increasingly susceptible due to the westernization of diets and high consumption of fructose-sweetened beverages.⁹

Conversely, the lowest rates were seen in the 45–53 age group (ALT 2.3%). This inverse age gradient suggests that older participants may have more stable dietary habits or represent a healthy survivor cohort, while the younger demographic is currently facing the brunt of lifestyle-induced hepatic stress.¹⁰ The study recorded higher elevations in males (AST 6.3%; ALT 5.0%; ALB 7.7%). Clinically, males often exhibit higher baseline transaminase levels due to higher body mass index (BMI) and muscle mass. Current 2025 research also highlights that males are statistically more likely to engage in binge alcohol consumption and have higher rates of visceral adiposity, both of which trigger transient enzyme elevations.¹¹

Occupationally, students showed the highest rates of elevation across all markers (AST 12.7%; ALT 10.9%; ALB 14.5%). This is a critical finding. AST/ALT in Students is likely linked to Academic Stress-Induced Hepatic Flux. Sleep deprivation and excessive intake of energy drinks (high in taurine and caffeine) can cause mild, reversible elevations in liver enzymes.¹² The high ALB (14.5%) likely points to dehydration, a common issue in student populations who prioritize caffeine over water intake.

There was higher AST/ALT elevations in those with secondary education compared to tertiary education. This inverse relationship is often attributed to Health Literacy. Public health reports suggest that higher educational attainment correlates with better nutritional choices and a higher likelihood of seeking preventive care, thereby mitigating the risk factors for liver stress.¹³

The highest elevations in B-negative (AST/ALT 20.0%) and O-negative individuals (AST 14.6%) are striking. While the link between ABO blood groups and liver health is an emerging field, some 2026 genomic studies suggest that Rh-negative individuals may have different inflammatory responses to subclinical oxidative stress. However, because Rh-negative groups represent a small percentage of the general population, these high percentages must be interpreted as a potential genetic vulnerability that requires a larger sample size for definitive correlation.¹⁴

The most statistically significant finding is the relationship between HCV and Albumin ($p=0.001$) and General Hepatitis and Albumin ($p=0.016$). The lack of significance with AST/ALT ($p > 0.05$) indicates

that the viral infections were likely not in an acute, inflammatory phase at the time of testing. However, the high significance with Albumin suggests that these viruses are affecting the liver's synthetic function. This indicates a chronic state where the liver's ability to produce or regulate proteins is compromised, even if the cells are not currently "leaking" enzymes into the blood.^{15,16}

The non-significant relationship between Malaria and liver markers ($p=0.757$ for AST) suggests that the malaria cases in this cohort were likely uncomplicated. Similarly, for HBV, the lack of transaminase elevation suggests a state of inactive carrier status or low viral replication within the studied population.^{17,18}

Conclusion

The study identifies a clear intersection between lifestyle (young, single students) and chronic viral markers (HCV). While the metabolic markers (AST/ALT) are driven by the younger demographic's lifestyle, the synthetic capacity (ALB) is significantly impacted by viral hepatitis.

Recommendations

Targeted hydration and nutritional counseling for university students to address the 12.7% AST elevation rate. Since HCV significantly impacts Albumin levels without spiking enzymes, screening should not rely solely on AST/ALT; protein panels are essential. Further investigation into the B-negative blood group's apparent susceptibility to enzyme spikes is warranted.

Acknowledgments

None.

Conflicts of interests

The authors declare that there are no conflicts of interest.

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