

**Original Article****Open Access****Biochemical evaluation of liver function enzymes in Lassa fever patients**<sup>1</sup>Anjorin, A. A., \*<sup>1</sup>Salami, W. O., <sup>2</sup>Omojola, T. E., <sup>1</sup>Ajoseh, S. O., <sup>3</sup>Gbenga-Ayeni, B. O.,  
<sup>3</sup>Etafo, J., <sup>1</sup>Lawal-Sanni, A. O., and <sup>2,3</sup>Hassan, A. O.<sup>1</sup>Department of Microbiology, Faculty of Science, Lagos State University, P. O. Box 0001, LASU Post Office, Ojo, Lagos, Nigeria<sup>2</sup>Department of Medical Microbiology and Parasitology, Faculty of Medical Laboratory Science, Achievers University, Owo, Nigeria<sup>3</sup>Infection Control and Research Laboratory, Federal Medical Centre, Owo, Nigeria\*Correspondence to: [wasiu.salami@lasu.edu.ng](mailto:wasiu.salami@lasu.edu.ng); +2348032582702**Abstract:****Background:** Lassa fever (LF) is a zoonotic acute viral hemorrhagic disease caused by the Lassa virus (LV). It has a high case fatality rate of about 5,000 deaths in humans from 300,000-500,000 cases each year globally. The high mortality rate from Lassa fever has been associated with abnormal liver enzyme production due to LV infiltration of the liver. However, data are sparse on the different enzymes and their proportions associated with LF. This study aims to evaluate the effect of LF on the levels of selected liver enzymes.**Methodology:** This was a case-control epidemiological study of 100 participants comprising 70 participants with LF attending Federal Medical Centre, Owo between May and September 2023, and 30 healthy controls randomly selected within the hospital environs. Demographic information (age and gender) was collected from the participants with data collection form. Venous blood samples were collected from the participants into appropriate sample bottles and centrifuged to separate plasma for laboratory analyses. Lassa fever was confirmed by amplification of LV RNA using reverse transcriptase-polymerase chain reaction (RT-PCR) technique. Specific liver enzymes, including alanine transaminase (ALT), aspartate transaminase (AST), and alkaline phosphatase (ALP), were assayed from the plasma using Mindray chemistry system with Architect c8000 and Roche Cobas c501 chemistry analyzers. Data were analysed using SPSS version 20.0. software. Mean values were compared using the *t*-test while categorical variables were compared using the Chi-square test. Statistical significance was set at  $p < 0.05$  with 95% confidence interval.**Results:** The results showed that among the study participants, the age group 20-39 years had the highest frequency of LF (37.1%, 26/70), with a slightly higher frequency in the females (51.4%, 36/70), compared to the males (48.6%, 34/70). The mean plasma ALP level of  $263.84 \pm 50.73$  U/L in LF patients was significantly higher than  $46.80 \pm 1.85$  U/L in the controls ( $t = 35.740$ ,  $p < 0.0001$ ). Similarly, the mean plasma ALT level of  $158.96 \pm 11.46$  U/L in LF patients was significantly higher than  $10.67 \pm 8.55$  U/L in the control ( $t = 71.405$ ,  $p < 0.0001$ ), and the mean plasma AST level of  $283.0 \pm 15.71$  U/L in LF patients was significantly higher than  $19.26 \pm 9.02$  U/L in the control ( $t = 105.60$ ,  $p < 0.0001$ ). Elevated plasma levels of ALP, ALT and AST were recorded in 45.7%, 70.0% and 85.7% of LF patients, compared to 0%, 6.7% and 6.7% in the controls respectively ( $p < 0.0001$ ).**Conclusion:** The study found significantly elevated liver enzymes in LF patients, providing insights into the pathological effects of the LV virus on the liver.**Keywords:** Lassa fever, Liver, Enzymes, Biochemical, Evaluation.

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Copyright 2025 AJCEM Open Access. This article is licensed and distributed under the terms of the Creative Commons Attribution 4.0 International License [<a rel="license" href="http://creativecommons.org/licenses/by/4.0/">](http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided credit is given to the original author(s) and the source. Editor-in-Chief: Prof. S. S. Taiwo**Évaluation biochimique des enzymes de la fonction hépatique chez les patients atteints de fièvre de Lassa**<sup>1</sup>Anjorin, A. A., \*<sup>1</sup>Salami, W. O., <sup>2</sup>Omojola, T. E., <sup>1</sup>Ajoseh, S. O., <sup>3</sup>Gbenga-Ayeni, B. O.,  
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## Résumé:

**Contexte:** La fièvre de Lassa (FL) est une maladie hémorragique virale aiguë zoonotique causée par le virus de Lassa (VL). Son taux de mortalité est élevé, avec environ 5000 décès chez l'homme, sur 300 000 à 500 000 cas chaque année dans le monde. Ce taux élevé de mortalité a été associé à une production anormale d'enzymes hépatiques due à une infiltration hépatique par le VL. Cependant, les données sur les différentes enzymes et leurs proportions associées à la FL sont rares. Cette étude vise à évaluer l'effet de la FL sur les taux de certaines enzymes hépatiques.

**Méthodologie:** Il s'agissait d'une étude épidémiologique cas-témoins portant sur 100 participants, dont 70 atteints de FL et admis au Centre Médical Fédéral d'Owo entre mai et septembre 2023, et 30 témoins sains sélectionnés aléatoirement dans l'environnement hospitalier. Les informations démographiques (âge et sexe) ont été recueillies auprès des participants à l'aide d'un formulaire de collecte de données. Des échantillons de sang veineux ont été prélevés auprès des participants dans des flacons appropriés, puis centrifugés afin de séparer le plasma en vue d'analyses en laboratoire. La fièvre de Lassa a été confirmée par amplification de l'ARN du VG par RT-PCR. Des enzymes hépatiques spécifiques, dont l'alanine transaminase (ALAT), l'aspartate transaminase (ASAT) et la phosphatase alcaline (PAL), ont été dosées à partir du plasma à l'aide du système de chimie Mindray équipé des analyseurs Architect c8000 et Roche Cobas c501. Les données ont été analysées à l'aide du logiciel SPSS version 20.0. Les valeurs moyennes ont été comparées à l'aide du test t, tandis que les variables catégorielles ont été comparées à l'aide du test du Khi carré. La signification statistique a été fixée à  $p < 0,05$  avec un intervalle de confiance à 95%.

**Résultats:** Les résultats ont montré que parmi les participants à l'étude, le groupe d'âge 20-39 ans avait la fréquence la plus élevée de FL (37,1%, 26/70), avec une fréquence légèrement plus élevée chez les femmes (51,4%, 36/70), par rapport aux hommes (48,6%, 34/70). Le taux plasmatique moyen de PAL de  $263,84 \pm 50,73$  U/L chez les patients atteints de FL était significativement plus élevé que celui de  $46,80 \pm 1,85$  U/L chez les témoins ( $t=35,740$ ,  $p < 0,0001$ ). De même, le taux plasmatique moyen d'ALAT de  $158,96 \pm 11,46$  U/L chez les patients atteints de FL était significativement plus élevé que  $10,67 \pm 8,55$  U/L chez le témoin ( $t=71,405$ ,  $p < 0,0001$ ), et le taux plasmatique moyen d'ASAT de  $283,0 \pm 15,71$  U/L chez les patients atteints de FL était significativement plus élevé que  $19,26 \pm 9,02$  U/L chez le témoin ( $t=105,60$ ,  $p < 0,0001$ ). Des taux plasmatiques élevés d'ALP, d'ALAT et d'ASAT ont été enregistrés chez 45,7%, 70,0% et 85,7% des patients atteints de FL, contre 0%, 6,7% et 6,7% chez les témoins respectivement ( $p < 0,0001$ ).

**Conclusion:** L'étude a révélé une élévation significative des enzymes hépatiques chez les patients atteints de FL, ce qui permet de mieux comprendre les effets pathologiques du virus LV sur le foie.

**Mots-clés:** Fièvre de Lassa, Foie, Enzymes, Biochimie, Évaluation

## Introduction:

Lassa fever (LF) presents as an acute viral hemorrhagic illness and was first identified in 1969 in the town of Lassa, located in Borno State, Nigeria, specifically within the Yedseram River valley at the southern end of Lake Chad (1). The disease is widespread in West African nations, with 300,000 - 500,000 cases each year, resulting in approximately 5,000 fatalities (2). Outbreaks of Lassa fever are endemic to West Africa, specifically occurring in Nigeria, Liberia, Sierra Leone, Guinea, and the Central African Republic (3). Emerging evidence suggests that human infections occur in the Democratic Republic of Congo, Mali, and Senegal. Additionally, cases have been exported to other countries by infected travelers (3).

The causative agent is the Lassa virus (LV), an RNA virus belonging to the Arenaviridae family. The African soft-furred rat (*Mastomys natalensis*) serves as the natural reservoir for Lassa fever. Widely distributed across West Africa, this rodent species closely interacts with humans. The virus is excreted in the urine of *Mastomys* spp and contamination of human food represents a probable route of transmis-

sion (4). Human-to-human transmission of the virus can occur through contact with bodily fluids in healthcare settings, leading to nosocomial epidemics with case fatality rates (CFR) as high as 65% (5).

Illness in humans develops within 3 weeks after infection with LV (4). The early features of LF are general and might include fever, fatigue, headache, throat discomfort, muscle pain, cough, chest pain, abdominal pain, nausea, vomiting, and diarrhoea (6). In most cases, symptoms are mild, however, severe illness complicated by abnormal bleeding, generalized edema, respiratory distress, hypotension, proteinuria, transaminitis, deafness, encephalopathy, and/or hypotension develops in approximately 20% of cases (1).

Although the overall mortality rate for LF is minimal, it reaches 15 to 20% for hospitalized patients (7). Higher fatality rates have been reported during outbreaks and among pregnant women, particularly in the third trimester of pregnancy (8). Furthermore, the liver is adversely affected by the LV and this may lead to a rise in the production of liver enzymes. Lassa fever on the other hand has a prevalence of 5% in Nigeria and up to 15% in

the study area, as it has been endemic to the region in previous years (9). It is seen that LF which adversely affects the functionality of the liver may lead to an abnormal production of liver enzymes, leading to increased mortality.

Diagnostic procedures are crucial in managing LF outbreak as they enable early identification, facilitating prompt antiviral treatment and minimizing illness and death. They also aid in tracing community contacts and providing an accurate assessment of the epidemic (10). Based on the classification of the virus, the National Institute of Allergy and Infectious Diseases has designated the LV as a 'Category A' pathogen, highlighting its significant potential for public health impact. To establish a diagnosis, laboratory testing is crucial because clinical symptoms alone are inadequate for distinguishing LF from other febrile illnesses (11).

A suspect case must be promptly excluded or confirmed to enable suitable case management, which may involve treatment, isolation protocols or contact tracing. LF is most often diagnosed by serology using enzyme-linked immunosorbent assay (ELISA), which detect IgM and IgG antibodies as well as LV antigen. During the initial days of illness, only a subset of patients exhibits detectable IgM and IgG antibodies. Interestingly, patients with fatal LF may not produce antibodies at all (12). Therefore, reverse transcription-polymerase chain reaction (RT-PCR) serves as a valuable and prompt diagnostic method for LF, and RT-

PCR is applicable during the initial phase of the disease.

Nevertheless, in response to the recommendation of the World Health Organization (WHO) for early diagnostic tests for LF (6) and recognizing LV as a high-priority pathogen with epidemic potential within the WHO Research and Development framework (6), this study was necessary. Furthermore, the recent high prevalence of LF in Nigeria according to the 2024 data from the Nigeria Center for Disease Control (NCDC), has resulted in its increased unpredictable clinical manifestations especially in asymptomatic patients thus justifying the need to study the potential effect of the virus on vital organs of the body such as the liver (13). The present study aims to evaluate the effects of LF on the functionality of the liver by assay of selected liver enzymes in the blood.

## Materials and method:

### Study area:

The study was conducted at the Molecular Laboratory of the Federal Medical Center, Owo, Ondo State, Nigeria, a city located on the southern edge of the Yoruba Hills that serves as a crossroads for routes from nearby towns (Fig 1). Owo had a population of over 220,000 as of the 2006 census, primarily inhabited by the Yoruba ethnic group with influences from urbanization and industrialization.



Fig 1 : Map of Ondo State, Nigeria showing the location of the study area (<https://soluap.com/ondo-map-showing-local-governmen-areas/>)

**Ethical consideration:**

Ethical clearance for this study was obtained from the Ethical Review Board of Federal Medical Center, Owo after a successful review and consideration with identification number FMC/OW/380/VOLCLXX XVII/169. In addition, informed consent and/or assent were obtained from the study participants as applicable. The study adhered to the principles outlined in the 1964 Helsinki Declaration and its current amendments, or equivalent ethical standards.

**Study design:**

This study was a case-control design with LF patients as the case group and healthy persons as the control group.

**Sampling technique:**

A randomized sampling technique was used to select 70 LF patients, who were matched with 30 controls by age and gender. The clinical characteristics of the controls were assessed, including their health status and presence of other diseases.

**Sample size determination:**

The sample size formula proposed by Pourhoseingholi et al., (14) was used to calculate the sample size for the LF patients (case) for the study, given as  $N = t^2 p(1-p)/m^2$ , where  $N$  = sample size,  $p$  = prevalence rate (5% = 0.05),  $m$  = margin of error (=0.05), and  $t$  = level confidence at 95% (=1.96).

Applying the formula, a sample size of 73 was calculated using a prevalence rate of 5% ( $p=0.05$ ) for LF in Ondo State, Nigeria (9). However, only 70 LF patients were recruited as case and 30 healthy persons as control.

**Inclusion and exclusion criteria:**

The inclusion criteria for the case are patients with symptoms associated with LF such as fever, malaise, bleeding, and other systemic symptoms, with laboratory confirmation of LF by RT-PCR or serological evidence of recent infection. Individuals with existing comorbidities that could influence the outcomes or clinical manifestations of LF were excluded.

**Data collection:**

Primary data were collected using structured questionnaire and other data were collected from the LF surveillance register in the study area, with some participants completing the questionnaire independently and for some, face-to-face interviews were conducted while adhering to safety guidelines.

**Sample Collection and processing:**

About 4 ml of venous blood was collected from each participant into lithium heparin bottle for enzyme analysis. With the sample being highly infectious, personal protective equipment (PPE) and triple packaging were

used for prevention and containment. The blood samples were centrifuged and plasma separated. The plasma was initially stored at  $-20^{\circ}\text{C}$  before being transferred to  $-80^{\circ}\text{C}$  for long-term storage. For LV detection, blood was collected into EDTA bottle and centrifuged at 1500 rpm for 10 minutes. The plasma was separated and labelled in a sample tube.

**Detection of LV RNA:****Inactivation procedures:**

The AVL tubes containing lysis buffer and other constituents were used for inactivation of samples. Approximately 70 $\mu\text{L}$  of the samples were added to AVL tubes, mixed and allowed to stand for 10mins. About 560 $\mu\text{L}$  of absolute ethanol was then added to the AVL tubes with pipette tips being changed at each time. The AVL tubes were decontaminated for RNA extraction (9).

**RNA extraction:**

Inactivated samples were transferred from the tubes to freshly labelled spin columns. The columns were subsequently centrifuged for 1 minute at 8000 rpm and the collection tubes were emptied and replaced. Subsequently, a series of wash steps were performed; 500 $\mu\text{L}$  of AW1 was added, followed by centrifugation at 8000 rpm; 500 $\mu\text{L}$  of AW2 was added, followed by centrifugation for 3 minutes at 14000 rpm. This process was repeated for AW2 and 14000 rpm centrifugation. Finally, the column was centrifuged at 14000 rpm for 10 minutes to dry the RNA. The spin column was placed on the elution tube, and 60 $\mu\text{L}$  of AVE was added. After incubating for 1 min, the column was centrifuged at 8000rpm for 1min to collect the trapped RNA (9).

**Master mixing and PCR:**

The RealStar® Lassa Virus RT-PCR Kit 2.0 containing 2 different RT-PCR assays with 48 reactions each was used for the assay. This contains two different positive controls; one for GPC gene-specific amplification 0.5 $\mu\text{M}$  primers OWS-1-fwd (GCG CAC CGG GGA TCC TAG GC), and one for the L gene-specific amplification 0.5 $\mu\text{M}$  primer OWS-1000-rev (AGC ATG TCA CAA AAY TCY TCA TCA TG). About 20 $\mu\text{L}$  each was pipetted into Master G reagent into the G labelled tubes and Master L reagent into the L labelled tubes. 1 $\mu\text{L}$  of internal control was added into the tubes. 10 $\mu\text{L}$  of the sample (extracted RNA) from the elution tube was added. Positive control was added to one tube of both the G and L tubes.

The RT-PCR mixture was subsequently incubated at  $50^{\circ}\text{C}$  for 30 minutes for reverse transcription, followed by 45 cycles in a thermocycler (Eppendorf, Germany), which included the following steps; denaturation at  $95^{\circ}\text{C}$  for 15 min, activation at  $95^{\circ}\text{C}$  for 30 sec, ann-

ealing at 55°C for 30 sec, elongation at 72°C for 30 sec, and extension at 30°C for 30 sec (15).

#### Liver enzymes analytical methods:

The levels of the 3 enzymes, alkaline phosphatase (ALP), aspartate transaminase (AST), and alanine transaminase (ALT) were assayed in the plasma using the Mindray Chemistry system, which utilizes the Architect c8000 and Roche Cobas c501 chemistry analyzers (16).

#### Statistical analysis:

Data were analysed using SPSS version 20.0 software. Continuous variables (e. g. mean) were compared using a *t*-test, while categorical variables (e. g. age and gender) were compared using the Chi-square test, with Odds ratio (OR) and confidence interval (CI). Statistical significance was set at  $p < 0.05$  with confidence level of 95%.

## Results:

#### Demographic characteristics of participants:

Table 1 shows the mean age of the LF

patients (case) as  $38.05 \pm 1.83$  years while that of the controls was  $42.03 \pm 1.92$  years. There were 36 (48.6%) males and 34 (51.4%) females in the case group, and 16 (53.3%) males and 14 (46.7%) females in the control group.

The age group 20-39 years had the highest frequency of LF (case) with 37.1% (26/70) and the age group 80-99 years had the lowest frequency of 2.9% (2/70). For the control group, the age group 40-59 years were the most frequently selected control (43.3%, 13/30) while the age group 20-39 years were the least frequently selected control (10.0%, 3/30).

#### Comparison of plasma alkaline phosphatase (ALP) levels between LF patients (case) and controls:

The mean ALP level in LF patients (case) is  $263.84 \pm 50.73$  U/L while that of the control is  $46.80 \pm 1.85$  U/L. A total of 32 out of the 70 LF patients (45.7%) had elevated (above normal value) ALP level, while all (100.0%) the controls had normal ALP levels (OR = 51.54,  $p < 0.0001$ ) (Table 2).

Table 1: Demographic characteristics of the study participants (case and control) at Federal Medical Center, Owo, Nigeria

Variable	LF patients (n=70)		Variable	Control patients (n=30)	
	Frequency	Percentage		Frequency	Percentage
<b>Age group (years)</b>			<b>Age group (years)</b>		
0-19	10	14.3	0-19	7	23.3
20-39	26	37.1	20-39	3	10.0
40-59	25	35.7	40-59	13	43.3
60-79	7	10.0	60-79	7	23.3
80-99	2	2.9			
<b>Mean age (<math>\pm</math>SD)</b>	38.05 $\pm$ 1.83		<b>Mean age (<math>\pm</math>SD)</b>	42.03 $\pm$ 1.92	
<b>Gender</b>			<b>Gender</b>		
Male	34	48.6	Male	14	46.7
Female	36	51.4	Female	16	53.3

SD = Standard deviation

Table 2: Comparison of plasma ALP levels between LF (case) and control patients at Federal Medical Center, Owo, Nigeria

ALP level	LF patients (n=70)		Control patients (n=30)		OR (95% CI)	p value
	Frequency	Percentage	Frequency	Percentage		
Normal value	38	54.3	30	100	51.54 (3.027 - 875.96)	<0.0001*
Above normal	32	45.7	0	0		
Mean $\pm$ SD (U/L)	263.84 $\pm$ 50.73		46.80 $\pm$ 1.85		$t = 35.740$	<0.0001*

ALP = Alkaline phosphatase; LF=Lassa fever; OR=Odd ratio; CI=confidence interval; SD = Standard deviation; \* = statistically significant at  $p < 0.05$

Table 3: Comparison of plasma ALT levels between LF (case) and control patients at Federal Medical Center, Owo, Nigeria

ALT level	LF patients (n=70)		Control patients (n=30)		OR (95% CI)	p value
	Frequency	Percentage	Frequency	Percentage		
Normal	21	30.0	28	93.3	32.667 (7.121 - 149.85)	<0.0001*
Above Normal	49	70.0	2	6.7		
Mean ± SD (U/L)	158.96±11.46		10.67±8.55		t = 71.405	<0.0001*

ALT = Alanine transaminase; LF=Lassa fever; OR=Odd ratio; CI=confidence interval; SD = Standard deviation; \* = statistically significant at  $p<0.05$

Table 4: Comparison of plasma AST levels between LF (case) and control patients at Federal Medical Center, Owo, Nigeria

AST level	LF patients (n=70)		Control patients (n=30)		OR (95% CI)	p value
	Frequency	Percentage	Frequency	Percentage		
Normal	10	14.3	28	93.3	84.00 (17.242 - 409.23)	<0.0001*
Above Normal	60	85.7	2	6.7		
Mean ± SD (U/L)	283.0±15.71		19.26±9.02		t = 105.60	<0.0001*

AST = Aspartate transaminase; LF=Lassa fever; OR=Odd ratio; CI=confidence interval; SD = Standard deviation; \* = statistically significant at  $p<0.05$

#### Comparison of plasma alanine transaminase (ALT) levels between LF (case) and control patients:

The mean ALT level in LF patients (case) is 158.96±11.46 U/L while that of the control is 10.67±8.55 U/L. A total of 49/70 (70.0%) LF patients had higher than the normal ALT levels, compared to only 2/30 (6.7%) control patients (OR=32.667,  $p<0.0001$ ) (Table 3).

#### Comparison of plasma aspartate transaminase (AST) levels between LF (case) and control patients:

The mean AST level in LF patients (case) is 283.0±15.71 U/L while that of the control is 19.26±9.02 U/L. A total of 60/70 (85.7%) LF patients had above-normal AST levels compared to only 2/30 (6.7%) control patients (OR=84.00,  $p<0.0001$ ) (Table 4).

### Discussion:

Despite the public outcry and efforts of international public health agencies to control the widespread LF characterized by high morbidity and mortality in several areas, the disease continues to spread in different communities from time to time. This highlights the need for continuous integrated surveillance and indicators including biochemical parameters for prompt detection of the disease in LF patients. In this study, the highest frequency LF of 37.1% was recorded within the age group 20-39 years which shows that the youth are the most vulnerable because they are usually exposed to predisposing factors such as games hunting, farming, healthcare delivery, and other cultural activities. This is consistent with a similar report by Grace et al., (17)

of the predominant age group affected being 21-30 years. Additionally, comparable findings have been reported in a study conducted in 20 States in Nigeria by Elimian et al., (18) in which the most vulnerable group is between the age group 31-40 years. Nevertheless, another study conducted in Nigeria (19) reported that individuals in age group 15-34 years were the most impacted, with the next highest prevalence observed among those in the age group 35-54 years. It is noteworthy that those mostly affected by LF are the economically productive age group, which aligns with the previous studies conducted in Jos and the neighbouring Bauchi State in Nigeria (20,21).

However, in our study, the frequency was lower among other age groups, with the lowest frequency of 2.9% recorded in the age group 80-99 years. This could be partly attributed to their limited exposure to the LV and social activities (20). The observed variability in findings may be linked to differences in study location, timeframe, and population characteristics. Additionally, our study revealed a slightly higher frequency among female compared to male. This disparity could be partly attributed to the fact that females are primarily responsible for household chores, including cleaning, cooking, and food storage, as well as their involvement in agricultural activities such as farming and crop harvesting (22).

It is noteworthy that these activities increase the likelihood of exposure to infected rodents and their excreta, as they often involve handling and storing food items that may be contaminated. This finding is consistent with a previous study conducted in Sierra Leone, where females were mostly affected by LF (23). The results of our study align with the

broader trends observed across West Africa, further confirming that LF disproportionately affects the female population in endemic regions (24). These findings have important implications for targeting prevention and control efforts to address the underlying social, behavioural, and biological factors driving this gender disparity (24, 25).

Furthermore, in this study, more than 70% of the LF patients had elevated liver enzymes, which agrees with the results obtained from a previous study by Hassan et al., (9) that LF, an acute viral hemorrhagic illness, greatly increased the levels of liver enzymes, specifically ALT, AST, and ALP, in the body. About 45.7% of LF patients had above-normal levels of ALP. This may be attributed to the direct viral-induced damage to the liver, which causes the release of this enzyme into the bloodstream. However, specific studies directly linking LF to ALP elevation remain limited. Further research is needed to understand the mechanisms and clinical implications of ALP changes in LF patients (26).

Moreover, 70.0% of the LF patients had above normal ALT levels compared to 2.0% of the controls. This may be partly due to the high levels of the ALT enzyme, which is primarily found in the liver, with lower concentrations observed in the heart, kidneys, skeletal muscle, pancreas, lung tissues, and spleen. The results of our study align with the findings of Gowda et al., (27) who reported that the normal concentration levels of ALT in the blood are usually low, however, when liver damage occurs, the liver releases more ALT into the blood causing the level to rise. Measurement of ALT is crucial in diagnosing hepatic damage and various liver diseases, including viral hepatitis and cirrhosis (28).

Alanine transaminase is frequently assessed alongside AST, an enzyme that is present in cells throughout the body and is most abundant in the liver and the heart, and to a lesser extent, in the muscle tissues and kidneys. In healthy individuals, blood AST levels remain low; however, when the liver or muscles sustain injury, AST is released into the bloodstream (29). Our study showed 85.7% of the LF patients had above-normal AST levels, compared to only 2% of the negative controls. The presence of liver damage, as evidenced by specific clinical or laboratory findings suggests LF. Our study is limited by the inability to obtain the cycle threshold (*ct*) value that is useful in classifying the increase of the viral load base. This is recommended for further study.

## Conclusion:

This study reports significant elevation in liver enzymes (ALT, AST, and ALP) in patients with LF. This finding suggests that LF dir-

ectly contributes to the increased production of liver enzymes, indicating potential liver damage. Adequate therapy will reduce the effects of LV on the liver and the observed elevated levels of liver enzymes (ALT, AST, and ALP) in LF patients.

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## Contributions of authors:

EJ and GBO collected blood samples and performed sample analysis. HAO conceived and designed the study. OTE, HAO, SWO, ASO, LAO, EJ, GBO and AAA contributed to the manuscript writing. OTE, HAO, SWO, ASO, and AAA performed data analysis. The manuscript was finally edited by AAA, HAO, SWO, and ASO. All authors approved the final reviewed draft of the manuscript for publication.

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## Conflicts of interest:

Authors declare no conflict of interest.

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