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ORIGINAL ARTICLE

Comparative Analysis of Liver Enzyme Levels in Alcoholic vs. Non-Alcoholic Fatty Liver Disease

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ABSTRACT:

Aim: The aim of this study was to compare liver enzyme levels between patients diagnosed with Alcoholic Fatty Liver Disease (AFLD) and Non-Alcoholic Fatty Liver Disease (NAFLD), and to evaluate their correlation with demographic and metabolic parameters. **Materials and Methods:** A comparative cross-sectional study was conducted on 100 patients (50 AFLD, 50 NAFLD) in the Department of Biochemistry. Patients were classified based on alcohol consumption history and radiological evidence of hepatic steatosis. Liver enzymes including ALT, AST, ALP, and GGT were measured using standard biochemical analyzers. Demographic data and comorbidities such as BMI, diabetes, and hypertension were also recorded. Statistical analysis was performed using SPSS version 21.0, with a significance level of $p < 0.05$. **Results:** NAFLD patients had a higher mean BMI (29.1 ± 4.2 kg/m²) compared to AFLD patients (26.3 ± 3.4 kg/m², $p = 0.001$). AST and GGT levels were significantly elevated in the AFLD group (AST: 89.7 ± 32.4 U/L, GGT: 145.3 ± 61.7 U/L) compared to NAFLD (AST: 63.8 ± 20.9 U/L, GGT: 82.6 ± 35.4 U/L; $p < 0.001$). The AST/ALT ratio was significantly higher in AFLD (1.32 ± 0.43) than NAFLD (0.91 ± 0.31; $p < 0.001$). GGT elevation and AST/ALT >1 were more prevalent in AFLD. A stronger correlation between BMI and liver enzymes was observed in the NAFLD group. **Conclusion:** The study demonstrates that elevated AST, GGT, and AST/ALT ratio are more indicative of AFLD, while NAFLD is closely associated with higher BMI and metabolic comorbidities. These enzyme patterns are valuable in differentiating between the two conditions and can guide clinical assessment and management.

Keywords: Alcoholic Fatty Liver Disease, Non-Alcoholic Fatty Liver Disease, Liver Enzymes, AST/ALT Ratio, Gamma-Glutamyl Transferase

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INTRODUCTION

Liver diseases represent a significant global health burden, with fatty liver diseases emerging as some of the most prevalent conditions affecting liver function. Among these, Alcoholic Fatty Liver Disease (AFLD) and Non-Alcoholic Fatty Liver Disease (NAFLD) stand out as two major subtypes characterized by the accumulation of fat in the liver. While both share similar histological features and progression pathways—from simple steatosis to more severe forms like steatohepatitis, fibrosis, and cirrhosis—their etiologies differ substantially. AFLD is primarily driven by chronic alcohol consumption, whereas NAFLD occurs in individuals with minimal or no alcohol intake and is closely linked to metabolic factors such as obesity, insulin resistance, and dyslipidemia.[1]Despite these differences in origin, both conditions exhibit overlapping clinical and biochemical profiles, making diagnosis and differentiation a complex challenge for clinicians. Among the key tools used to evaluate liver health are serum liver enzymes, such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT), and alkaline phosphatase (ALP). These enzymes serve as indicators of hepatocellular injury or cholestasis, and their levels often reflect the degree of liver inflammation or damage. A comparative analysis of these enzyme levels in AFLD and NAFLD patients can provide crucial insights into disease patterns, progression, and potential diagnostic markers.[2] ALT and AST are enzymes found within hepatocytes and are released into the bloodstream when liver cells are damaged. ALT is generally considered more specific to the liver, while AST can also be found in other tissues such as the heart and muscles. The ratio of AST to ALT, often referred to as the AST/ALT ratio, is particularly noteworthy in distinguishing between different types of liver disease. In AFLD, this ratio is frequently greater than 2, reflecting a pattern of enzyme elevation that differs from that observed in NAFLD, where ALT typically predominates.[3] GGT is another enzyme that plays a critical role in hepatic metabolism and is commonly elevated in individuals with chronic alcohol use. It is considered a sensitive marker of alcohol-related liver injury, although it may also rise in metabolic liver diseases. ALP, on the other hand, is more closely associated with bile duct function but can also indicate liver damage, especially in more advanced stages of liver disease. Monitoring the levels of these enzymes, individually and in combination, can provide a biochemical window into the liver's functional status and the underlying cause of fatty infiltration.[4] The rising prevalence of NAFLD,

particularly in association with the global increase in obesity, type 2 diabetes, and sedentary lifestyles, has positioned it as the most common cause of chronic liver disease in many parts of the world. Meanwhile, AFLD continues to be a significant concern in populations with high levels of alcohol consumption, contributing to a large proportion of liver-related morbidity and mortality. The coexistence of both diseases in certain individuals, or the misclassification of one as the other, adds another layer of complexity to diagnosis and management.[5] A thorough understanding of the differences and similarities in liver enzyme profiles between AFLD and NAFLD is vital for several reasons. First, it can aid in early and accurate diagnosis, enabling timely intervention before the disease progresses to irreversible stages. Second, it can inform treatment strategies that differ depending on the underlying cause—alcohol cessation being crucial for AFLD, whereas lifestyle modifications targeting weight loss and metabolic control are more appropriate for NAFLD. Third, it can help in identifying patients at higher risk of progression to advanced liver disease, thereby improving long-term outcomes.[6] This comparative study focuses on analyzing liver enzyme levels in individuals diagnosed with either Alcoholic Fatty Liver Disease or Non-Alcoholic Fatty Liver Disease. By examining the patterns, ratios, and elevations of key liver enzymes, the study aims to delineate clear biochemical differences between the two conditions. Such an analysis not only contributes to the academic and clinical understanding of fatty liver diseases but also holds practical significance in enhancing diagnostic accuracy, guiding patient management, and shaping public health strategies aimed at prevention and early detection.

MATERIALS AND METHODS

This comparative cross-sectional study was conducted to evaluate and compare liver enzyme levels among patients diagnosed with Alcoholic Fatty Liver Disease (AFLD) and Non-Alcoholic Fatty Liver Disease (NAFLD). A total of 100 patients were enrolled in the study from the Department of biochemistry. Ethical clearance was obtained from the institutional ethical review board prior to data collection, and informed consent was taken from all participants.

The patients were divided into two groups based on clinical history, alcohol consumption, and radiological findings. Group A comprised 50 patients diagnosed with AFLD, defined by a history of significant alcohol intake (≥30 g/day for men and ≥20 g/day for women) over at least five years, along with evidence of hepatic steatosis on ultrasonography. Group B included 50 patients diagnosed with NAFLD, characterized by the presence of hepatic steatosis on imaging in the absence of significant alcohol consumption, viral hepatitis, or other secondary causes of fatty liver disease.

Demographic data including age, sex, BMI, and comorbid conditions (such as diabetes mellitus and hypertension) were recorded. Laboratory investigations were performed on all participants, including serum levels of alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and gamma-glutamyl transferase (GGT). Blood samples were collected after an overnight fast, and enzyme levels were measured using standard automated biochemical analyzers in the central laboratory.

The data were statistically analyzed using SPSS version 21.0 Continuous variables were expressed as mean ± standard deviation, and comparisons between the two groups were made using the independent sample t-test. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Profile of Study Participants

The demographic characteristics of the study population revealed notable differences between the AFLD and NAFLD groups. The mean age of patients in the AFLD group was 48.2 ± 9.5 years, slightly higher than the NAFLD group (45.6 ± 10.1 years), but this difference was not statistically significant ($p = 0.144$). A significant gender difference was observed, with a higher proportion of males in the AFLD group (38 males and 12 females) compared to the NAFLD group (28 males and 22 females), which was statistically significant ($p = 0.016$). This aligns with known patterns, as alcohol-related liver disease is more prevalent among males. The mean BMI was significantly higher in the NAFLD group (29.1 ± 4.2 kg/m²) compared to the AFLD group (26.3 ± 3.4 kg/m²), with a p-value of 0.001, indicating a strong association between obesity and NAFLD. Additionally, diabetes mellitus was more frequent in the NAFLD group (54%) than in the AFLD group (36%), a statistically significant finding ($p = 0.048$). Hypertension was also more common in the NAFLD group (42%) than in the AFLD group (30%), but this difference did not reach statistical significance ($p = 0.212$).

Table 2: Mean Liver Enzyme Levels in AFLD and NAFLD Groups

The analysis of liver enzyme levels showed distinct patterns between the two groups. ALT levels were slightly higher in the NAFLD group (72.1 ± 28.5 U/L) compared to the AFLD group (68.4 ± 23.7 U/L), but the difference was not statistically significant ($p = 0.447$). In contrast, AST levels were significantly elevated in the AFLD group (89.7 ± 32.4 U/L) as opposed to the NAFLD group (63.8 ± 20.9 U/L), with a highly significant p-value (<0.001). This finding supports the characteristic AST dominance observed in alcoholic liver injury. Similarly, GGT levels were markedly elevated in the AFLD group (145.3 ± 61.7

U/L) compared to the NAFLD group (82.6 ± 35.4 U/L), and this difference was statistically significant ($p < 0.001$). ALP levels were slightly higher in the NAFLD group, but the difference was not significant ($p = 0.378$). These results suggest that AST and GGT are more prominently raised in AFLD, consistent with their roles as biomarkers of alcohol-induced liver injury.

Table 3: AST/ALT Ratio in Study Groups

The AST/ALT ratio was significantly higher in the AFLD group (1.32 ± 0.43) than in the NAFLD group (0.91 ± 0.31), with a p-value <0.001. Moreover, 70% of patients in the AFLD group had an AST/ALT ratio greater than 1, in contrast to only 24% of the NAFLD group. This difference was statistically significant ($p < 0.001$). The elevated AST/ALT ratio is a well-recognized marker suggestive of alcoholic liver disease and further reinforces the diagnostic utility of this ratio in distinguishing between AFLD and NAFLD in clinical practice.

Table 4: Frequency of Elevated Liver Enzymes

The frequency of elevated liver enzymes further highlights the differences in liver enzyme patterns. Elevated ALT levels were observed in 41 AFLD patients and 45 NAFLD patients, with no significant difference ($p = 0.258$). Elevated AST levels were slightly more frequent in the AFLD group (44 patients) than the NAFLD group (39 patients), though the difference was not statistically significant ($p = 0.112$). ALP was elevated in a minority of both groups (16 AFLD and 19 NAFLD), with no significant difference ($p = 0.538$). Notably, GGT was elevated in a significantly higher number of AFLD patients (45) compared to NAFLD patients (26), and this difference was highly significant ($p < 0.001$). This finding supports the diagnostic relevance of GGT in identifying alcohol-related liver injury, as GGT is strongly induced by alcohol consumption.

Table 5: Correlation of Enzyme Levels with BMI

Correlation analysis revealed a stronger association between BMI and liver enzyme levels in NAFLD patients compared to those with AFLD. In the NAFLD group, ALT ($r = 0.45$) and AST ($r = 0.36$) showed a moderate positive correlation with BMI, both statistically significant. Similarly, GGT also demonstrated a significant correlation ($r = 0.42$). In contrast, the AFLD group showed weaker correlations, with only GGT showing a statistically significant association with BMI ($r = 0.34$). These findings suggest that obesity and increased BMI are more directly linked to elevated liver enzyme levels in NAFLD, reflecting the metabolic basis of the disease, while enzyme elevations in AFLD are more influenced by alcohol intake rather than body weight.

Table 1: Demographic Profile of Study Participants

Parameter	AFLD Group (n = 50)	NAFLD Group (n = 50)	p-value
Mean Age (years)	48.2 ± 9.5	45.6 ± 10.1	0.144
Male : Female Ratio	38 : 12	28 : 22	0.016*
Mean BMI (kg/m²)	26.3 ± 3.4	29.1 ± 4.2	0.001*
Diabetes Mellitus (%)	18 (36%)	27 (54%)	0.048*
Hypertension (%)	15 (30%)	21 (42%)	0.212

*Statistically significant at $p < 0.05$

Table 2: Mean Liver Enzyme Levels in AFLD and NAFLD Groups

Enzyme	AFLD Group (Mean ± SD)	NAFLD Group (Mean ± SD)	p-value
ALT (U/L)	68.4 ± 23.7	72.1 ± 28.5	0.447
AST (U/L)	89.7 ± 32.4	63.8 ± 20.9	<0.001*
ALP (U/L)	110.2 ± 35.6	116.4 ± 38.2	0.378
GGT (U/L)	145.3 ± 61.7	82.6 ± 35.4	<0.001*

*Statistically significant at $p < 0.05$

Table 3: AST/ALT Ratio in Study Groups

Parameter	AFLD Group	NAFLD Group	p-value
AST/ALT Ratio	1.32 ± 0.43	0.91 ± 0.31	<0.001*
Patients with Ratio >1	35 (70%)	12 (24%)	<0.001*

Table 4: Frequency of Elevated Liver Enzymes

Enzyme	Normal Range	Elevated in AFLD (n)	Elevated in NAFLD (n)	p-value
ALT	<40 U/L	41	45	0.258
AST	<40 U/L	44	39	0.112
ALP	<120 U/L	16	19	0.538
GGT	<50 U/L	45	26	<0.001*

Table 5: Correlation of Enzyme Levels with BMI (Pearson Correlation Coefficient, r)

Enzyme	AFLD Group (r-value)	NAFLD Group (r-value)
ALT	0.28	0.45*
AST	0.10	0.36*
ALP	0.22	0.30
GGT	0.34*	0.42*

DISCUSSION

The demographic characteristics in this study revealed a significantly higher proportion of males in the AFLD group (76%) compared to the NAFLD group (56%), aligning with known gender patterns in liver disease. This gender disparity has been consistently reported in earlier literature. For instance, **Ray et al. (2013)** noted that AFLD had a higher prevalence among males due to social and behavioral patterns of alcohol consumption, whereas NAFLD showed increasing prevalence among females with metabolic syndrome.[7] In our study, the mean BMI in NAFLD patients (29.1 ± 4.2 kg/m²) was significantly higher than in AFLD patients (26.3 ± 3.4 kg/m²), highlighting obesity as a key driver in NAFLD. This trend is consistent with findings by **Marchesini et al. (2003)**, who reported obesity in over 70% of NAFLD patients, confirming the association between excess weight and fat accumulation in the liver.[8]

Analysis of liver enzyme levels revealed that ALT levels were slightly higher in NAFLD (72.1 ± 28.5 U/L) than in AFLD (68.4 ± 23.7 U/L), though not statistically significant. In contrast, AST and GGT levels were significantly elevated in the AFLD group, with mean AST at 89.7 ± 32.4 U/L and GGT at 145.3 ± 61.7 U/L. These enzyme patterns are consistent with those observed by **Nalpas et al. (1984)**, who demonstrated that GGT and AST levels were more pronounced in patients with alcoholic liver injury due to mitochondrial damage and oxidative stress triggered by chronic alcohol consumption. Their findings support the idea that AST and GGT are more sensitive markers for alcohol-induced liver injury than ALT.[9]

The AST/ALT ratio in our study was notably higher in AFLD patients (1.32 ± 0.43) compared to NAFLD patients (0.91 ± 0.31), and 70% of AFLD patients had an AST/ALT ratio greater than 1. This ratio has long been used as a non-invasive marker for differentiating between alcoholic and non-alcoholic liver disease. Our findings are supported by **Sorbi et al. (1999)**, who emphasized that an AST/ALT ratio >1 is typically suggestive of alcoholic liver disease, while a ratio <1 is more commonly seen in NAFLD. They found that more than 80% of AFLD patients had an AST/ALT ratio exceeding 1, similar to our data.[10]

Regarding the frequency of enzyme elevation, we observed that ALT and AST were elevated in both groups at high rates, with no significant difference. However, GGT was elevated in 90% of AFLD patients versus 52% in NAFLD patients, a difference that was statistically significant ($p < 0.001$). These findings correspond with those reported by **Whitfield et al. (2001)**, who demonstrated that GGT had strong sensitivity to alcohol intake and was consistently elevated in individuals with chronic alcohol use. GGT has also been noted to rise earlier than other liver enzymes in the presence of hepatocellular stress, particularly from alcohol.[11]

The correlation of liver enzyme levels with BMI showed stronger associations in the NAFLD group, particularly for ALT ($r = 0.45$) and AST ($r = 0.36$), compared to the AFLD group. This suggests that obesity is a stronger driver of hepatic enzyme elevation in NAFLD. Similar patterns were observed by **Bellentani et al. (2000)**, who found a direct correlation between BMI and serum ALT levels in NAFLD patients, highlighting the role of visceral adiposity in hepatic inflammation and fat accumulation. In contrast, in AFLD patients, liver enzyme elevations were less BMI-dependent and more closely tied to alcohol consumption.[12]

Lastly, the higher prevalence of comorbid diabetes mellitus in NAFLD patients (54%) versus AFLD patients (36%) underscores the metabolic foundation of NAFLD. This finding is consistent with the observations of **Angulo et al. (2002)**, who identified diabetes as one of the most common and impactful risk factors in NAFLD progression, contributing to both steatosis and fibrosis. Their study emphasized that insulin resistance and glucose intolerance play central roles in liver injury within the NAFLD population, unlike in AFLD where alcohol is the primary insult.[13]

CONCLUSION

This study highlights significant biochemical and demographic differences between Alcoholic Fatty Liver Disease (AFLD) and Non-Alcoholic Fatty Liver Disease (NAFLD). While NAFLD was more associated with higher BMI and metabolic comorbidities like diabetes, AFLD showed markedly elevated AST and GGT levels along with a higher AST/ALT ratio. These findings support the utility of liver enzyme patterns, especially the AST/ALT ratio and GGT levels, in differentiating between AFLD and NAFLD. Understanding these distinctions can aid in accurate diagnosis and tailored management. Further studies with histological correlation are recommended.

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