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Original Article**Assessment of Serum Lipid Profile among Patients with Non Alcoholic Fatty Liver Disease by Ultrasonography**Hossan MA^{1*}, Ray J², Acharjee U³

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Corresponding Author*Abstract**

Background: Non-alcoholic fatty liver disease (NAFLD) is a common chronic liver condition closely associated with metabolic abnormalities, including obesity and dyslipidaemia. Alterations in lipid metabolism may contribute to the development and progression of hepatic steatosis.

Objective: To evaluate the correlation between NAFLD with serum lipid profile and BMI status.

Material and Methods: This cross-sectional study was conducted in the Departments of Medicine and Hepatology at Sylhet MAG Osmani Medical College Hospital, Sylhet, Bangladesh, from July 2023 to June 2025. A total of 200 patients aged 18–70 years with ultrasonographically diagnosed NAFLD were enrolled. Clinical assessment, anthropometric measurements, and laboratory investigations, including fasting blood glucose, lipid profile, liver and renal function tests, and viral markers, were performed. Data were analyzed using SPSS version 25.0.

Results: The mean age was 39.84 ± 12.84 years, and 58% of participants were male. The mean BMI and waist circumference were 25.78 ± 2.58 kg/m² and 85.23 ± 5.61 cm, respectively. Obesity was present in 58% of participants. Mean triglyceride, LDL, HDL, and total cholesterol levels were 256.13 ± 69.41 , 118.83 ± 21.68 , 43.67 ± 7.41 , and 250.96 ± 52.41 mg/dL, respectively. Mild and moderate fatty liver were observed in 72% and 28% of participants, respectively. TG, LDL, and total cholesterol were significantly higher, while HDL was significantly lower, among patients with moderate fatty liver.

Conclusions: NAFLD is strongly associated with obesity, dysglycaemia, and dyslipidaemia. An increasingly adverse lipid profile is associated with greater severity of fatty liver disease.

Keywords: Non-alcoholic fatty liver disease (NAFLD), Serum lipid profile, Ultrasonography, Dyslipidemia, Fatty liver severity, Metabolic syndrome.

Introduction

Non-alcoholic fatty liver disease (NAFLD) is one of the most prevalent chronic liver diseases worldwide and encompasses a spectrum of hepatic disorders ranging from simple steatosis, characterized by excessive triglyceride accumulation within hepatocytes, to non-alcoholic steatohepatitis (NASH), which may progress to fibrosis, cirrhosis, and ultimately hepatocellular carcinoma.^{1,2} According to the American Association for the Study of Liver Diseases (AASLD), NAFLD is defined as the accumulation of fat in more than 5%–10% of the liver by weight.³ NAFLD is strongly associated with metabolic risk factors including obesity,

dyslipidaemia, insulin resistance, metabolic syndrome, and type 2 diabetes mellitus (T2DM).^{4,5} Metabolic syndrome, which is highly prevalent among South Asian populations, is considered a major risk factor for NAFLD. Bangladeshi ethnicity has also been identified as an independent risk factor for the development of NAFLD. Consequently, NAFLD is often regarded as the hepatic manifestation of metabolic syndrome and insulin resistance.^{4,6}

The prevalence of NAFLD has increased markedly in the Asia-Pacific region owing to rapid urbanization, sedentary lifestyles, increased dietary fat consumption, and the growing burden of T2DM.^{7,8} The occurrence of

NAFLD is influenced by several factors, including age, sex, ethnicity, obstructive sleep apnea, and endocrine disorders such as hypothyroidism, hypopituitarism, hypogonadism, and polycystic ovarian syndrome.⁹ NAFLD has been reported in approximately 40% of obese individuals and 15% of overweight individuals. Furthermore, a strong association exists between NAFLD and T2DM. NAFLD is frequently asymptomatic and is often diagnosed incidentally in patients without overt signs or symptoms of liver disease.¹⁰⁻¹²

Patients with cardiovascular disease (CVD) risk factors, particularly dyslipidaemia and diabetes mellitus, are more likely to develop NAFLD. Studies have demonstrated a strong association between NAFLD and hypertriglyceridaemia, elevated low-density lipoprotein (LDL) cholesterol, increased very low-density lipoprotein (VLDL) levels, and reduced high-density lipoprotein (HDL) cholesterol levels. This dyslipidaemic pattern is highly atherogenic and contributes significantly to the increased cardiovascular morbidity and mortality observed among NAFLD patients. Moreover, NAFLD itself may serve as an important marker of metabolic syndrome, insulin resistance, and cardiovascular risk.¹

Several observational studies have shown that individuals with NAFLD are at increased risk of developing extrahepatic complications, including metabolic syndrome, cardiovascular disease, and diabetes mellitus. The accumulation of triglycerides within hepatocytes is considered a central event in the pathogenesis of NAFLD, although the precise mechanisms remain incompletely understood. Elevated serum concentrations of VLDL, triglycerides, and LDL cholesterol, together with reduced HDL cholesterol levels, have consistently been associated with NAFLD and may contribute to the increased cardiovascular disease burden observed in these patients.¹⁻⁵

Although many patients with NAFLD remain asymptomatic, some may complain of fatigue, malaise, or a feeling of fullness and discomfort in the right upper quadrant of the abdomen. Hepatomegaly is often the only physical finding. In most cases, NAFLD is

detected incidentally during abdominal ultrasonography or during evaluation for associated conditions such as obesity, hypertension, or diabetes mellitus.¹³ The risk of progression from NASH to cirrhosis is estimated to range from 8% to 15%, and patients with NASH have a risk of cirrhosis comparable to that of patients with chronic hepatitis C virus infection.¹⁴

Recent evidence suggests that chronic systemic inflammation plays a pivotal role in the pathogenesis of metabolic dysfunction-associated fatty liver disease (MAFLD). C-reactive protein (CRP), a widely recognized biomarker of systemic inflammation, has been shown to be significantly associated with NAFLD in several recent studies.¹⁵⁻²⁰

Although liver biopsy remains the gold standard for the diagnosis and staging of NAFLD, it is an invasive procedure associated with pain, expense, patient discomfort, and potential complications. In contrast, ultrasonography is a safe, non-invasive, inexpensive, and readily available diagnostic modality for detecting fatty liver disease. It is widely used as the first-line imaging technique for the diagnosis and grading of NAFLD and for screening asymptomatic individuals with elevated liver enzymes.^{21,22,23} Ultrasonographic grading systems classify fatty liver into different severity grades that correlate reasonably well with histopathological findings and clinical outcomes.

Given the close relationship between NAFLD and dyslipidaemia, assessment of serum lipid abnormalities according to the severity of fatty liver disease may provide valuable information regarding disease progression and cardiovascular risk. Therefore, the present study was undertaken to evaluate the serum lipid profile among patients with ultrasonographically diagnosed NAFLD.

Materials and Methods

This cross-sectional study was conducted in the Departments of Medicine and Hepatology at Sylhet MAG Osmani Medical College Hospital, Sylhet, Bangladesh, from July 2023 to June 2025. The study aimed to assess the serum lipid profile and body mass

index (BMI) among patients with non-alcoholic fatty liver disease (NAFLD). The study population consisted of patients diagnosed with NAFLD who attended the Departments of Medicine and Hepatology at MMCH during the study period. A total of 200 patients were enrolled in the study. Patients aged 18–70 years who were diagnosed with NAFLD and agreed to participate were included in the study.

After enrollment, a detailed medical history was obtained, and a thorough physical examination was performed for each participant. Information regarding age, sex, residence, occupation, religion, monthly income, educational status, and associated comorbidities was recorded. Physical examination included measurement of blood pressure, height, weight, and waist circumference, along with calculation of body mass index (BMI). Laboratory investigations were performed using 5 mL of venous blood collected from each participant. The investigations included fasting blood sugar, fasting lipid profile, liver function tests, serum creatinine, thyroid function tests, hepatitis B surface antigen (HBsAg), and anti-hepatitis C virus (anti-HCV) antibody. General and systemic physical examination findings were documented in the data collection form. Following completion of the investigations, patients identified with one or more risk factors were counseled regarding the disease and its potential consequences. Data were collected using a structured questionnaire from patients attending the Departments of Medicine and Hepatology at MMCH. The collected data were processed and analyzed using the Statistical Package for the Social Sciences (SPSS), version 25.0. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Student's t-test was used to compare continuous variables, whereas the chi-square test or Fisher's exact test was applied for categorical variables, as appropriate. A p-value <0.05 was considered statistically significant for all analyses.

Results

Table I: Socio-demographic characteristics of the study population (n=200)

Characteristics	No. of patient	Percentage (%)
Age in years		
≤ 25	22	11.0
26-30	28	14.0
31-35	26	13.0
36-40	46	23.0
>40	78	39.0
Mean $\pm$ SD	39.84 $\pm$ 12.84	
Sex		
Male	116	58.0
Female	84	42.0

A total of 200 patients were included in the study. The mean age of the participants was 39.84 $\pm$ 12.84 years, with the majority (39.0%) being aged above 40 years, followed by 23.0% aged 36–40 years. Male participants predominated (58.0%), while females constituted 42.0% of the study population (Table I).

Table II: Distribution of the study according to waist circumference, BMI and blood pressure (n=200)

Variables	No. of patient	Percentage (%)
Waist circumference (cm)		
Normal	68	34.0
≥ 90 (men) ≥ 80 (women)	132	66.0
Mean $\pm$ SD	85.23 $\pm$ 5.61	
Range (min-max)	(75-100)	
BMI (kg/m ²)		
<23 (normal)	22	11.0
23-25 (over weight)	62	31.0
>25 (Obesity)	116	58.0
Mean $\pm$ SD	25.78 $\pm$ 2.58	
Range (min-max)	(20.95-29.95)	

Assessment of anthropometric parameters showed that 66.0% of the subjects had increased waist circumference (≥ 90 cm in men and ≥ 80 cm in women), with a mean waist circumference of 85.23 $\pm$ 5.61 cm. Regarding body mass index, obesity (BMI >25 kg/m²) was observed in 58.0% of the patients and overweight (BMI 23–25 kg/m²) in 31.0%, whereas only 11.0% had normal BMI. The mean BMI was 25.78 $\pm$ 2.58 kg/m².

Table III: Distribution of study subject according to SGPT, SGOT and FBS (n=200)

Variables	No. of patient	Percentage (%)
SGPT (U/L)		
<60	14	7.0
>60	186	93.0
Mean±SD	68.43±9.11	
Range (min-max)	(31-189)	
SGOT (U/L)		
<60	26	13.0
>60	174	87.0
Mean±SD	49.13±7.58	
Range (min-max)	(39-71)	
Fasting blood sugar		
<6.1	48	24.0
≥6.1	116	58.0
≥7.1 mmHg	36	18.0
Mean±SD	7.17±2.35	
Range (min-max)	(3.8-25.8)	

Serum SGPT levels exceeded 60 U/L in 93.0% of patients, with a mean value of 68.43±9.11 U/L, while SGOT levels were >60 U/L in 87.0%, with a mean of 49.13±7.58 U/L. Fasting blood sugar levels were ≥6.1 mmol/L in 76.0% of the subjects, and the mean fasting blood sugar was 7.17±2.35 mmol/L.

Table IV: Distribution of the study subject according to fasting lipid profile (n=200)

Variables	No. of patient	Percentage (%)
TG (mg/dl)		
<150	24	12.0
>150	176	88.0
Mean±SD	256.13±69.41	
Range (min-max)	(139-398)	
LDL (mg/dl)		
<100	36	18.0
≥100	164	82.0
Mean±SD	118.83±21.68	
Range (min-max)	(90-181)	
HDL (mg/dl)		
<40 (male)<50 (female)	152	76.0
≥40 (male)≥50 (female)	48	24.0
Mean±SD	43.67±7.41	
Range (min-max)	(31-59)	
TC (mg/dl)		
<200	32	16.0
≥200	168	84.0
Mean±SD	250.96±52.41	
Range (min-max)	(159-399)	

Regarding lipid profile, hypertriglyceridemia (TG >150 mg/dl) was present in 88.0% of participants, elevated LDL cholesterol (≥100 mg/dl) in 82.0%, low HDL cholesterol in 76.0%, and raised total cholesterol (≥200 mg/dl) in 84.0%. Mean values of TG, LDL, HDL, and total cholesterol were 256.13±69.41 mg/dl, 118.83±21.68 mg/dl, 43.67±7.41 mg/dl, and 250.96±52.41 mg/dl.

Table V: Distribution of the study subject according to fatty liver on USG (n=200)

	No. of patient	Percentage (%)
Mild	144	72.0
Moderate	56	28.0

Ultrasonographic evaluation showed that 72.0% of patients had mild fatty liver, whereas 28.0% had moderate fatty liver changes (Table V).

Table VI: Comparison between USG and Serum Lipid Profile

Serum lipid profile (mg/dl)	Mild fatty liver (Mean ± SD)	Moderate fatty liver (Mean ± SD)	p-value
TG	161.70 ± 51.59	222.56 ± 118.51	0.001
LDL	104.98 ± 25.26	124.67 ± 31.18	0.001
HDL	44.28 ± 5.67	41.72 ± 4.78	0.001
TC	185.24 ± 36.52	215.29 ± 47.69	0.001

Comparison of serum lipid parameters according to the severity of fatty liver demonstrated that patients with moderate fatty liver had significantly higher mean levels of triglycerides (222.56±118.51 mg/dl vs. 161.7±51.59 mg/dl), LDL cholesterol (124.67±31.18 mg/dl vs. 104.98±25.26 mg/dl), and total cholesterol (215.29±47.69 mg/dl vs. 185.24±36.52 mg/dl) compared with those with mild fatty liver. Conversely, HDL cholesterol was significantly lower in the moderate fatty liver group (41.72±4.78 mg/dl) than in the mild fatty liver group (44.28±5.67 mg/dl). These differences were statistically significant (p=0.001), indicating a strong association between worsening fatty liver severity and an adverse lipid profile.

Discussion

Non-Alcoholic Fatty Liver Disease (NAFLD) is a clinico-pathological condition where fat (predominantly Triglyceride) accumulates in liver.²⁴ NAFLD is emerging as the most common chronic liver condition in the Western world. It is associated with insulin resistance and frequently occurs with features of the metabolic syndrome.¹⁰ Common metabolic aberrations like obesity, hyperglycemia, dyslipidemia, and are known as major health risk factors worldwide leading to an increase in hepatic steatosis regardless of age and gender.⁵ This was a hospital based observational study was carried out with an aim to evaluate the correlation between NAFLD with serum lipid profile. The present study findings were discussed and compared with previously published relevant studies.

This study shows the mean age of the patients was 39.84 (SD $\pm$ 12.84) years. It was found that more patients were from >40 years age group (39%) followed by 36-40 years age group (23%). In a study by Agarwal et al.²⁵ maximum numbers of patients were between 3rd and 4th decades of age and mean age was found 42.70 $\pm$ 10.09. This is almost similar in this study. Similar study Adam et al.²⁴ who reported mean age 45.0 $\pm$ 11.0 with the range of 19-65 years. In western communities, studies had shown mean age of subjects ranging from 41-45 years.²⁶

In the study, NAFLD had male predominance with almost 58% cases were found males. The current study is in agreement to the previous studies in Khanal et al.²⁷ Similar results were found by Som et al.²⁸ in which male predominance was noted in cases of NAFLD. Tanwani et al.²⁹ also studied the sex distribution among people with NAFLD and found that it was predominant in males.

This study found waist circumference, the mean waist circumference was found in 85.23 $\pm$ 5.61 cm. Person who have waist circumference $\geq$ 90 cm (man) or $\geq$ 80 cm (women) was 66%. Normal waist circumference was found 34%. Increase in abdominal girth is more linked to develop NAFLD probably due to different distribution of body fat in Asian, like abdominal fat, which influence to develop fatty liver as apple type of

abdomen and high waist circumference is more consistent with metabolic syndrome or due to follow the Asian parameter. Jian-Gao et al.³⁰ found the mean waist circumference was 83.79 $\pm$ 9.70 cm and 78.06 $\pm$ 9.69 cm in man and women respectively. This is almost similar in my study. On the other hand, Marchesini et al.³¹ obtained the mean waist circumference was 91 $\pm$ 8 cm in NASH and 89 $\pm$ 4 cm in control groups.

In this study body mass index (BMI) of participants varied from 20.95 to 29.95 kg/m² with mean value of 25.78 $\pm$ 2.58 kg/m². Most (58%) were of obese (BMI >25 kg/m²), 31% were overweight (BMI 23-25 kg/m²), 11% were normal BMI (BMI <23 kg/m²). Similar study Bhusal et al.³² found body mass index (BMI) of participants varied from 18.14 to 44.75 kg/m² with mean value of 27.97 $\pm$ 4.28 kg/m². Most (42%) were of normal BMI, 34% were overweight (BMI 25-29 kg/m²), 23% were obese (BMI >30kg/m²), and 1% underweight (BMI <18kg/m²). This is almost similar in my study. Another study Khanal et al.²⁷ found only 30% had normal weight. 70% cases had increased weight with 56% being overweight, 16% had Class I obesity, and 9% had Class II obesity. In a study conducted by Juurinen et al.³³ it was found that 52.8% were overweight and 22.6% were obese. These findings in other studies correlate quite well with this study showing that there is higher prevalence of overweight and obesity in people with NAFLD.

The mean SGPT was found 68.44 $\pm$ 9.05 U/L. The mean SGOT was 50.0 $\pm$ 7.89 U/L. The commonest presentation of fatty liver is increased SGPT. The mean fasting blood sugar was found 7.13 $\pm$ 2.30 mmol/l. Fasting blood sugar >6.1 was found in 57(57%) and $\geq$ 7.0 mmol/l were found in 18(18%) and <6.1 was found in 25(25%) cases. This findings consistent with Brea et al.³⁴ they found mean fasting glucose 6.4 $\pm$ 1.3 mmol/L in patients and 5.5 $\pm$ 0.7 mmol/L in control.

This study shows regarding the fasting lipid profile, the mean TG was found 256.13 $\pm$ 69.41 mg/dl. The mean LDL was found 118.83 $\pm$ 21.68 mg/dl. The mean HDL was found 43.67 $\pm$ 7.41 mg/dl. The mean TC was found 250.96 $\pm$ 52.41 mg/dl. Pagano et al.³⁵ showed the mean triglycerides was 99 $\pm$ 43 mg/dl in NASH and

75±31 mg/dl in control, mean total cholesterol was 175±36 mg/dl in NASH and 185±27 mg/dl in control, mean HDL cholesterol was 47±9 mg/dl in NASH and 59±17 mg/dl in control and mean LDL cholesterol was 108±36 mg/dl in NASH and 106±27 mg/dl in control group. Similar observation also documented by Park et al.³⁶ which are comparable with the current study. This is comparable may be different type of methodological study.

This study shows ultrasonogram findings of the fatty liver. Mild fatty changes was found in 72(72%) and moderate change in 28(28%). We had no enrolled subject of severe fatty liver. Similar study showed by Bhusal et al.³² among the enrolled 100 patients, 83% had mild fatty liver and 17 % had moderate fatty liver also confirming. They had no enrolled subject of severe fatty liver.

This study shows the cholesterol value was abnormal in 84(84%), while normal in remaining 16 (16%) patients. Triglycerides was abnormal in 88 (88%) while in 12(12%) patients was normal. HDL in 76 (76%) patients was abnormal while 24(24%) patients had normal values. Low density lipoprotein value in 82 (82%) patient was abnormal and in 18 (18%) patient was normal. Previous study reported total serum cholesterol and serum triglyceride levels increased in fatty liver (non-alcoholic disease) patients as compared with controls.¹⁴⁻²⁰

Another study Tanwani et al.³² found the cholesterol value was abnormal in 186 (62%), while normal in remaining 114 (38%) patients. Triglycerides were abnormal in 152 (50.7%) while in 148 (49.3%) patients was normal. HDL in 155 (51.7%) patients was abnormal while 145 (48.3%) patients had normal values. Low density lipoprotein value in 117 (39%) patient was abnormal and 183 (61%) patient was normal. Very low-density lipoprotein in 117 (39%) patients was abnormal and 183 (61%) patient was normal.

This study shows comparison of lipid changes in different grades of NAFLD by statistical analysis using analysis of variance test (student 't' test). P values <0.05 were considered as significant. It was

observed that increasing grades of NAFLD were significantly associated with increasing levels of serum total cholesterol (P value-0.001), TG (P value-0.001), LDL (P value-0.001) and decreasing HDL (P value-0.001) and increasing grades of ultrasonographically diagnosed NAFLD. The current study is in agreement to the previous studies in Mahaling et al.³⁷ they found NAFLD were significantly associated with increasing levels of serum total cholesterol (P value-0.001), LDL (P value-0.000) and VLDL (P value-0.003) and decreasing HDL (P value-0.000). No significant association was found between serum triglyceride levels (P value-0.05) and increasing grades of sonographically diagnosed NAFLD.

Ultrasonographic findings along with considerably raised fasting lipid profile are the safe, cheap, easy, and accurate available diagnostic tool for fatty liver (non-alcoholic disease).^{1,5,15-20,38} Ultrasound (USG) foremost imaging technique used to establish and categorize the fatty liver disease and extensively used for the suspects of NAFLD and also asymptomatic subjects having raised hepatic enzymes. In current study, ultrasound provided excellent utility for diagnosis of fatty liver (NAFLD) by means of raised levels of fasting lipid profile. This is detected earlier by ultrasonography. There is statistically significant relation in subjects diagnosed on ultrasound and serum fasting lipid profile of fatty liver (non-alcoholic disease). Ultrasound is cost effective technique to analyze the changes seen in various grades of NAFLD.

The present study had certain limitations. The sample size was relatively small, which may limit the generalizability of the findings. In addition, no follow-up of the participants was performed to reassess clinical or biochemical changes over time, thereby restricting evaluation of disease progression and long-term outcomes. Moreover, as the study was conducted in a tertiary care hospital, the study population may not accurately represent the general community, and thus may not reflect the true population burden of the disease. Therefore, larger community-based studies are recommended to provide a more comprehensive understanding of the condition in the country.

Conclusion

In conclusion, the present study highlights a strong association between non-alcoholic fatty liver disease (NAFLD) and metabolic abnormalities, particularly dyslipidaemia. Most patients demonstrated elevated serum triglyceride, total cholesterol, and LDL levels, along with reduced HDL levels, indicating an atherogenic lipid profile. Ultrasonographic grading showed that the majority of patients had mild fatty liver, while a smaller proportion had moderate disease. Significant worsening of lipid parameters was observed with increasing severity of NAFLD, suggesting that dyslipidaemia is closely associated with disease progression. These findings emphasize that NAFLD is strongly linked to adverse metabolic risk factors and underscore the importance of early detection and management of lipid abnormalities to prevent disease progression and reduce cardiovascular risk.

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