Non-alcoholic fatty liver (NAFL) is defined as having more than 5% hepatic steatosis without hepatocellular injury such as hepatocyte ballooning. NAFLD plays a role in the development of type 2 diabetes and cardiovascular disease. The diagnosis requires exclusion of alcohol consumption of ≥30 g/day for men and ≥20 g/day for women, and other secondary causes. NAFLD is evolving as a major cause of liver disease in low-income countries such as India. According to epidemiological studies from India, 9–32% of the general population and 65–75% of the overweight or obese as well as those who have diabetes or prediabetes are affected.

Non-alcoholic fatty liver disease (NAFLD) is one of the commonest liver pathologies and is increasing due to increasing obesity. Non-alcoholic fatty liver disease-liver fat score is a non-invasive diagnostic tool with a sensitivity and specificity of 95%. Methods: This was a cross-sectional observational study on 50 overweight and obese individuals with a body mass index (BMI) of more than or equal to 25 kg/m² and fatty liver on ultrasonography (USG). Alcoholics (≥30 g/day for men and ≥20 g/day for women), other etiologies like drugs and patients who had bowel resection surgeries for obesity were excluded from the study. Non-alcoholic fatty liver disease-liver fat score of more than -0.64 ruled in NAFLD. Data were entered into Microsoft Excel and analyzed using the SPSS (Statistical Package for Social Sciences) Software 20.

Results: About 33/50 patients had a score of more than -0.64. Metabolic syndrome was present in 29 (58%), dyslipidemia in 38 (76%), and diabetes mellitus (46%) was the commonest comorbidity. There was a statistically significant difference in the mean age, weight, BMI, blood pressure, liver enzymes, fasting lipid profile, serum albumin, glycosylated Hemoglobin A1C (HBA1C), international normalised ratio (INR), and fasting blood sugars between the two groups with scores >-0.64 and ≤-0.64. There was a negative correlation of high-density lipoprotein and a positive correlation of liver enzymes, triglycerides, low-density lipoprotein, total cholesterol, fasting blood sugar level, and HBA1c with a score of >-0.64. Conclusion: Higher BMI, metabolic syndrome, diabetes mellitus, and dyslipidemia were significantly associated with a score of >-0.64. This score confirmed the ultrasonographically diagnosed fatty liver.

Keywords: Body mass index, diabetes mellitus, dyslipidemia, hypertension, liver fat score, metabolic syndrome, non-alcoholic fatty liver disease

Introduction
Non-alcoholic fatty liver disease (NAFLD) is one of the most common liver pathologies and has been on the rise in recent years due to an increase in the prevalence of obesity. It is one of the most frequent causes of abnormal liver function tests (LFT) and the need for a liver transplant. It ranges from mild steatosis, steatohepatitis (nonalcoholic steatohepatitis (NASH)), and fibrosis to severe cirrhosis.[1]
The age of more than 40 years, central obesity, high body mass index (BMI $\geq 25$ kg/m$^2$), male gender, high aspartate transaminase (AST) and alanine transaminase (ALT) levels, and raised fasting blood sugar (FBS) are risk factors for NAFLD.\(^8\)

Metabolic syndrome and insulin resistance are more common in Indian NAFLD patients. NAFLD can affect both thin and obese people. Metabolic syndrome comprises raised waist circumference, hypertension, dyslipidemia, and raised fasting plasma glucose levels.\(^9\)

The pathophysiology of NAFLD is linked to obesity being associated with increased insulin resistance, deposition of intrahepatic triglycerides, reduced adiponectin levels, and insufficient free fatty acid oxidation.\(^6\)

In today’s time, non-invasive diagnosis for NAFLD is radiological imaging with ultrasound, computed tomography (CT) scans, and magnetic resonance elastography (MRE) quantifying liver fat. There is an emphasis on an effective non-invasive scoring system. NAFLD-liver fat score (LFS) is one such scoring system which uses the easily available parameters such as type 2 diabetes, fasting serum insulin levels, AST/ALT ratio, fasting serum AST levels, and metabolic syndrome. A value of less than or equal to -0.640 ruled out NAFLD and more than -0.640 ruled in NAFLD.\(^8\)

NAFLD-LFS was developed by Kotronen et al.,\(^6\) which showed the highest sensitivity and specificity of 95%, which was higher compared to the other scores such as Fibrosis-4 (FIB-4), NAFLD Activity Score (NAS), Steato Test, and Fatty Liver Index (FLI). Extensive research using this score is lacking in western India. Hence, this score was chosen for the present study.

This study aims at evaluating the clinical profile and NAFLD-LFS in overweight individuals with a BMI of $\geq 25$ kg/m$^2$ according to the World Health Organization (WHO) classification, and to compare the score with the ultrasonography (USG) findings.

India ranks third in the Global Obesity Index with a prevalence of 40.3%,\(^7\) which is significantly associated with the prevalence of NAFLD. The early detection of the fatty liver using non-invasive tests would help in preventing the progression of the disease to fibrosis. NAFLD-LFS is the best non-invasive score to rule in fatty liver, thereby, helping family physicians in early diagnosis and in educating patients to change their lifestyle and control the comorbidities to prevent the progression of the disease to fibrosis.

**Material and Methods**

This was a cross-sectional observational study on 50 overweight and obese individuals at a tertiary care center in western India. The epidemiological studies indicate that NAFLD is prevalent in around 9–32% of the Indian general population, with a higher prevalence in overweight/obese people and with diabetes or prediabetes.\(^8\) For the present study, 15% ($P = 0.15$) prevalence was considered. The sample size was calculated using the formula $N = 4pq/I^2$, $p = 0.15$, $q = 1-p$, $I = 0.15$, using purposive sampling. The sample size came to 49 which was rounded off to 50 subjects.

All adults with a BMI of $\geq 25$ kg/m$^2$ (according to the WHO classification) showing fatty infiltration of the liver on the USG were included. The alcoholics ($\geq 30$ g/day for men and $\geq 20$ g/day for women), other etiologies like drugs (amiodarone, steroids, methotrexate, tamoxifen, calcium channel blockers), and the patients who had undergone bowel resection surgeries for obesity were excluded from the study.

The Institutional Ethics Committee clearance was obtained before the start of the study and written informed consent was taken from the participants.

Overweight and obesity were defined according to WHO classification\(^8\):
- Overweight: 25–29.9 kg/m$^2$
- Obese class 1: 30–34.9 kg/m$^2$
- Obese class 2: 35–39.9 kg/m$^2$
- Obese class 3: $\geq 40$ kg/m$^2$.

Overweight and obese persons with a BMI of $\geq 25$ kg/m$^2$ were subjected to USG of the abdomen which was graded as follows\(^8\):
- Grade 1: Mild increase in the hepatic echogenicity with normal visualization of the diaphragm and intrahepatic vessel borders.
- Grade 2: Moderate increase in the hepatic echogenicity with slight impairment in the visualization of intrahepatic vessels and diaphragm.
- Grade 3: Marked increase in the echogenicity with poor penetration of the posterior segment of the right lobe of the liver and poor or no visualization of the hepatic vessels and diaphragm.’’
- In all those subjects who had fatty liver on USG, the NAFLD-LFS was calculated.

**NAFLD -LFS:**\(^8\)

\[-2.89 + 1.18 \times \text{metabolic syndrome (Yes} = 1/\text{No} = 0) + 0.45 \times \text{Type 2 diabetes mellitus (Yes} = 2/\text{No} = 0) + 0.15 \times \text{fasting serum insulin (mU/L)} + 0.04 \times \text{fasting AST (U/L)} - 0.94 \times \text{AST/ALT}^\]

Values: ≤-0.640: ruled out NAFLD

>-0.640: ruled in NAFLD

The score was calculated from the MdApp website (“https://www.mdapp.co/non-alcoholic-fatty-liver-disease-liver-fat-score-nafld-lfs-calculator-358/”).

NAFLD-LFS has the following gradings:
- No steatosis: score ≤-0.64
Investigations such as hemogram, LFT, serum proteins, prothrombin time-International normalized ratio (PT-INR), fasting lipid profile, fasting plasma glucose levels, and HBA1c were measured.

The fasting serum insulin levels were measured in the blood collected after 8 h of overnight fast using Architect Insulin 8K41 Kit by Chemiluminescent Microparticle Immunoassay. The normal fasting levels are 2.6–25 µU/mL.

The USG was done using the 3–5 MHz curvilinear probe on machine Aloka Prosound Alfa 6 Static serial number M08293L1.

The metabolic syndrome was defined as the presence of at least three of the following according to the harmonizing definition\[10\]: Elevated waist circumference (≥80 cm in females; ≥90 cm in males) in the South Asian population, elevated triglycerides (TG >150 mg/dL) or on drug treatment, low high-density lipoprotein (HDL <40 mg/dL in males; <50 mg/dL in females) or on drug treatment, elevated blood pressure (systolic ≥130 mmHg or diastolic ≥85 mmHg) or on treatment, elevated fasting glucose (≥100 mg/dL) or on treatment, or previously diagnosed type 2 diabetes mellitus.

Data analysis
Data were entered into Microsoft Excel and analyzed using the SPSS (Statistical Package for Social Sciences) Software 20. The categorical variables were expressed in terms of frequency and percentage and the continuous variables in terms of mean and standard deviation (SD). The difference in the mean ± SD of quantitative variables between two groups (NAFLD-LFS > -0.64 vs. ≤ -0.64) was analyzed using the Student’s t-test and Mann–Whitney U test. The Chi-square test and Fischer’s exact test were used to find the association between the categorical variables. The correlation between the variables was calculated using the Pearson correlation coefficient. The \( P \) value of <0.05 was considered as statistically significant at a 95% confidence interval.

Results
The age range in the study was 21–78 years with a mean age of 46.72 ± 14.8 years. Thirty-four (68%) subjects were above the age of 40 years [Table 1, Figure 1].

The male subjects were predominant among this study group. The male to female ratio was 1.08:1 [Table 2, Figure 2].

The NAFLD-LFS > -0.64 indicated the presence of NAFLD according to this score and was seen in 33 subjects (66%) [Table 3, Figure 3].

Two groups with NAFLD-LFS >-0.64 and ≤-0.64 were compared and there was a statistically significant difference in the mean age, weight, BMI, AST, ALT, lipid profile, serum albumin, HBA1C, INR, FBS, and systolic and diastolic blood pressures [Table 4].

Diabetes was the commonest comorbidity and was found in 20 of the 33 subjects who qualified for NAFLD (60.6%), followed by hypertension which was found in 13 of the 33 subjects who qualified for NAFLD (39.4%). On comparison between the two groups of scores >-0.64 and ≤-0.64, a significantly greater number of subjects with the score >-0.64 had comorbidities [Table 5, Figure 4].

There was a statistically significant difference in the number of subjects belonging to the overweight and obese category on comparison of the two groups with NAFLD-LFS >-0.64 and ≤-0.64. [Table 6, Figure 5].

There was no statistically significant difference between the number of subjects having different grades of fatty liver

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| Age group (years) | Number of subjects (n=50) | Percentage |
|-------------------|---------------------------|------------|
| 21-30             | 7                         | 14%        |
| 31-40             | 9                         | 18%        |
| 41-50             | 15                        | 30%        |
| 51-60             | 10                        | 20%        |
| >60               | 9                         | 18%        |

| Gender            | Number of subjects (n=50) | Percentage |
|-------------------|---------------------------|------------|
| Female            | 24                        | 48%        |
| Male              | 26                        | 52%        |

| STEATOSIS          | NAFLD-LFS | NUMBER OF PARTICIPANTS |
|--------------------|-----------|------------------------|
| ABSENT             | ≤-0.64    | 17 (54%)               |
| MILD               | >-0.64 TO 0.16 | 10 (20%)               |
| MODERATE: SEVERE   | >0.16     | 23 (46%)               |

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in the two groups with NAFLD-LFS >-0.64 and ≤-0.64. [Table 7, Figure 6].
comparing the two groups with NAFLD-LFS > -0.64 and ≤-0.64. [Table 8, Figure 7].

Twenty-six of the 33 subjects (78.8%) with NAFLD-LFS > -0.64 had metabolic syndrome. There was a statistically significant difference in the number of patients with metabolic syndrome on comparing the two groups with NAFLD-LFS > -0.64 and ≤-0.64. [Table 9, Figure 8].

There was a statistically significant mild positive correlation of the liver enzymes, a mild negative correlation HDL, and a moderate positive correlation of the triglycerides, LDL, total cholesterol, fasting blood sugar level, and HBA1c with NAFLD-LFS > -0.64 [Table 10].

Discussion

In the present study, 50 subjects with a BMI of ≥ 25 kg/m² and fatty liver on USG were included. The age range was 21–78 years with a mean age of 46.72 ± 14.8 years. Thirty-four subjects were above the age of 40 years. The M: F ratio was 1.08:1. These findings were consistent with the studies by Gaharwar R, et al.[11] and Khoonsari M, et al.[12]

The NAFLD-LFS was evaluated, and the study subjects were grouped into two with a score of >-0.64 which ruled in NAFLD and the score of ≤-0.64 ruled out NAFLD. Thirty-three subjects (66%) had a score of >-0.64 and were ruled in for NAFLD whereas 17 subjects (34%) had a score of ≤-0.64 and were ruled out for NAFLD. This finding was consistent with the prevalence rates of NAFLD in overweight and obese subjects according to the studies by Fabbrini et al.[6] (65–75%), Duseja et al.[13] (65–75%), and Fabbrini et al.[6] (65–85%).

The mean values for age, weight, BMI, blood pressure, fasting triglycerides, LDL, total cholesterol, AST, ALT, INR, and HBA1c levels were significantly higher and the serum albumin levels were significantly lower in the subjects with NAFLD-LFS > -0.64 (which ruled in NAFLD) (P < 0.05). In a study by Lee CO, et al.[13] Cheung CL, et al.[14] and Musa N, et al.[13], there were significantly higher mean levels of AST, ALT, fasting plasma glucose levels, HBA1c, INR, blood pressures, and lower levels of serum albumin in the NAFLD subjects.

Type 2 diabetes mellitus was seen in 20 of the 33 subjects who qualified for NAFLD (60.6%), and hypertension was seen in 13 of 33 subjects who qualified for NAFLD (39.4%). A higher BMI was significantly associated with a greater number of subjects having NAFLD according to the score. Metabolic syndrome and dyslipidemia were significantly associated with the presence of NAFLD. The present study showed a mild positive correlation of liver enzymes, a mild negative correlation of triglycerides, LDL, total cholesterol, fasting blood sugar level, and HBA1c with NAFLD-LFS > -0.64

![Figure 6: USG – NAFLD-LFS](image)

**Table 5: Relation of comorbidities with NAFLD-LFS**

| Comorbidities       | NAFLD-LFS | Total | P  |
|---------------------|-----------|-------|----|
| >-0.64 (n=33)       | ≤-0.64 (n=17) |       |    |
| Diabetes Mellitus   | 20 (60.6%) | 3 (17.6%) | 23 | 0.004* |
| Hypertension        | 13 (39.4%) | 1 (5.9%) | 14 | 0.018* |
| Hypothyroid         | 3 (9.1%)   | 0      | 3  | 0.542 |
| Ischemic heart disease | 2 (6.1%)  | 0      | 2  | 0.542 |

*Chi-square test

**Table 6: Relation of BMI GROUPS with NAFLD-LFS**

| BMI (kg/m²)               | NAFLD-LFS | Total | P  |
|---------------------------|-----------|-------|----|
| >-0.64 (n=33)             | ≤-0.64 (n=17) |       |    |
| Overweight: 25-29.9        | 04 (12.12%) | 11 (64.71%) | 15 | 0.00001* |
| Obese class 1: 30-34.9     | 13 (39.39%) | 05 (29.4%) | 18 | 0.0524* |
| Obese class 2: 35-39.9     | 12 (36.36%) | 1 (5.88%) | 13 | 0.018 |
| Obese class 3: >40         | 04 (12.12%) | 0      | 4  |       |

*Fischer’s exact test

**Table 7: Relation of USG findings with NAFLD-LFS**

| USG Findings               | NAFLD-LFS | Total | P  |
|----------------------------|-----------|-------|----|
| >-0.64 (n=33)              | ≤-0.64 (n=17) |       |    |
| Grade 1 Fatty Liver        | 9 (27.27%) | 9 (52.94%) | 18 | 0.0524* |
| Grade 2 fatty Liver        | 17 (51.52%) | 8 (47.06%) | 25 |       |
| Grade 3 Fatty Liver        | 7 (21.21%) | 0      | 7  |       |

*Fischer’s exact test

**Table 8: Relation of dyslipidemia with NAFLD-LFS**

| Lipid parameters           | NAFLD-LFS | Total | P  |
|----------------------------|-----------|-------|----|
| >-0.64 (n=33)              | ≤-0.64 (n=17) |       |    |
| TG (>150)                  | 20 (60.60%) | 2 (11.7%) | 22 | 0.002* |
| HDL (<40 in Males; <50 in Females) | 25 (75.8%) | 6 (35.3%) | 31 | 0.005* |
| LDL (>100)                 | 16 (48.5%) | 2 (11.8%) | 18 | 0.01* |
| TC (>200)                  | 10 (30.3%) | 1 (5.9%) | 11 | 0.073 |

*Chi-square test, †TG: Triglycerides, ‡HDL: High-density lipoprotein, §LDL: Low-density lipoprotein, ‡TC: Total cholesterol

**Table 9: Relation of metabolic syndrome with NAFLD-LFS**

| Metabolic syndrome | NAFLD-LFS | Total | P  |
|--------------------|-----------|-------|----|
| >-0.64 (n=33)      | ≤-0.64 (n=17) |       |    |
| No                 | 7 (21.2%) | 14 (82.4%) | 21 | 0.0001* |
| Yes                | 26 (78.8%) | 3 (17.6%) | 29 |       |

*Chi-square test
of HDL, and a moderate positive correlation of HBA1c, triglycerides, LDL, total cholesterol, and FBS with NAFLD-LFS > -0.64. These findings were like the studies by Kotronen et al.[6], Gaharwar et al.[11], Cheung CL, et al.[14], and Bajaj et al.[16].

The USG can be used as a screening tool, but NAFLD-LFS can be used to confirm the diagnosis as of the 50 subjects with fatty liver, 33 subjects had a score of > -0.64 and 17 had a score of ≤ -0.64. This raises suspicion of the interobserver variability and proves less sensitivity and specificity than the score. According to the studies by Kotronen et al.[6], Cheung CL, et al.[14], and Musa N, et al.[15], the sensitivity of NAFLD-LFS was higher than the USG.

In a study by Jung et al.[17] the fatty liver diagnosis by ultrasound has 71.7% sensitivity and 67.2% specificity. The ultrasound and MRI had a diagnostic accuracy of 70.9% for fatty liver, while NAFLD-LFS and MRI had a diagnostic accuracy of 72.7%.

**Conclusion**

Non-invasive tests like ultrasound can be used for initial screening, but NAFLD-LFS has a better diagnostic value with a sensitivity and specificity of 95%. An early diagnosis with prompt lifestyle modifications and control of comorbidities prevents the progression of the disease.

Key take-home message

NAFLD-LFS has a better diagnostic ability to rule in NAFLD than USG as findings on the USG can have interobserver variability. Obesity and comorbidities like diabetes and hypertension are the main causes of NAFLD.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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