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Original Research Article

CLINICAL PROFILE, METABOLIC RISK FACTORS, AND SHORT-TERM OUTCOMES OF PATIENTS WITH METABOLIC DYSFUNCTION-ASSOCIATED STEATOTIC LIVER DISEASE: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Obesity, diabetes, hypertension, and dyslipidaemia are closely associated with metabolic dysfunction-associated steatotic liver disease (MASLD), which frequently remains undiagnosed. This study assessed the clinical characteristics, metabolic risk factors, fibrosis risk, and short-term outcomes of patients with MASLD enrolled at Down Town Hospital, Guwahati, Assam, India.

Materials and Methods: This prospective observational study included 500 consecutive patients aged 18–40 years with MASLD who were enrolled at Down Town Hospital, Guwahati, Assam, India, between January and December 2024. Each participant was followed for three months from the date of enrolment, with the final follow-up assessment completed in March 2025. Demographic, anthropometric, metabolic, biochemical, and ultrasonographic data were collected. Fibrosis risk was assessed using the fibrosis-4 (FIB-4) index. Follow-up outcomes included clinical or biochemical improvement, stable disease, clinical or biochemical worsening, and loss to follow-up. Data were summarised using descriptive statistics.

Results: The mean age was 31.4 ± 6.1 years, and 310 (62%) patients were male. Overweight and obesity were present in 170 (34%) and 235 (47%) patients, respectively, while 330 (66%) had central obesity. Diabetes, prediabetes, hypertension, and dyslipidaemia were identified in 150 (30%), 120 (24%), 125 (25%), and 290 (58%) patients, respectively. Elevated alanine aminotransferase and aspartate aminotransferase levels were observed in 210 (42%) and 145 (29%) patients. Ultrasonography demonstrated grade I, II, and III steatosis in 265 (53%), 185 (37%), and 50 (10%) patients, respectively. FIB-4 classified 405 (81%) patients as low risk, 75 (15%) as intermediate risk, and 20 (4%) as high risk. Among 470 patients with follow-up data, 230 (48.9%) improved, 205 (43.6%) remained stable, and 35 (7.4%) worsened, while 30 (6%) were lost to follow-up.

Conclusion: MASLD was associated with a high burden of adiposity and metabolic abnormalities. Early metabolic evaluation, fibrosis risk stratification, and structured follow-up may facilitate timely identification of patients at risk of disease progression and improve long-term management.

Keywords: MASLD; metabolic risk factors; hepatic steatosis; liver fibrosis; young adults; Northeast India.

INTRODUCTION

Previously known as non-alcoholic fatty liver disease, the disorder is now known as metabolic dysfunction-associated steatotic liver disease (MASLD). It is distinguished by the presence of at least one cardiometabolic risk factor and fat in the liver, which demonstrates how strongly it is associated with metabolic problems.[1] MASLD can range from modest hepatic fat buildup to more serious disorders such as metabolic dysfunction-associated steatohepatitis, which can cause cirrhosis, liver cancer, and progressive liver scarring.

MASLD is one of the leading causes of chronic liver disease worldwide, with an estimated global prevalence of approximately 30%.[2] In India, the disease burden is increasing because of rising obesity, central adiposity, type 2 diabetes mellitus, and sedentary lifestyles. A systematic review reported a pooled prevalence of 38.6% among Indian adults, increasing to 52.8% in populations with metabolic risk factors.[3] These findings indicate that MASLD is increasingly affecting younger adults.

The disease is often asymptomatic and is frequently detected during abdominal ultrasonography, evaluation of elevated liver enzymes, or assessment of metabolic disorders. Obesity, central obesity, insulin resistance, diabetes, hypertension, and dyslipidaemia are common risk factors.[4] However, MASLD can also occur in individuals with a normal body mass index, particularly among Asian Indians, in whom visceral adiposity and metabolic abnormalities may exist despite normal body weight. Therefore, body mass index alone may underestimate metabolic risk.

Fibrosis stage is the most important factor in predicting liver-related problems and death in people with MASLD.[5] Current guidelines recommend beginning with an early assessment of heart and metabolic health, and evaluating fibrosis risk gradually using non-invasive methods such as the fibrosis-4 (FIB-4) index. If necessary, liver stiffness measurement should be performed next.[6] Identifying high-risk individuals early allows for the timely initiation of lifestyle changes and management of related metabolic conditions.

Despite the growing burden of metabolic dysfunction-associated steatotic liver disease (MASLD) in India, prospective data focusing specifically on younger patients from Northeast India remain limited. Regional variations in ethnicity, dietary habits, lifestyle, and socioeconomic factors may influence the occurrence and clinical characteristics of MASLD in this population.[7] Therefore, the present prospective observational study was conducted among younger patients aged 18–40 years at Down Town Hospital, Guwahati, Assam, India, with the aim of determining the incidence of MASLD and describing their clinical, anthropometric, biochemical, and ultrasonographic profile. The study also aimed to evaluate associated metabolic risk factors, assess fibrosis risk using the fibrosis-4 (FIB-4) index, and document short-term clinical outcomes.

Aim and Objectives

Aim

To determine the incidence and assess the clinical profile, metabolic risk factors, fibrosis risk, and short-term outcomes of MASLD among younger patients aged 18–40 years.

Objectives

1. To determine the incidence of MASLD among younger patients aged 18–40 years.
2. To evaluate the clinical profile, metabolic risk factors, fibrosis risk, and three-month outcomes of younger patients with MASLD.

MATERIALS AND METHODS

Study design and setting

This prospective observational study was conducted at Down Town Hospital Ltd., G.S. Road, Bormotoria, Dispur, Guwahati, Assam 781006, India. Participants were enrolled from 1 January to 31 December 2024 and followed for three months from their respective dates of enrolment, with the final follow-up assessment completed by 31 March 2025. A total of 500 consecutive patients aged 18–40 years who were diagnosed with metabolic dysfunction-associated steatotic liver disease (MASLD) were enrolled in the study. The study findings were reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[18]

Study population

Patients who visited the inpatient and outpatient departments underwent eligibility screening. After ruling out other causes of hepatic steatosis, MASLD was identified by the presence of hepatic steatosis on abdominal ultrasonography along with at least one cardiometabolic risk factor.[1,6] Prior to enrolment, each participant provided written informed consent.

Inclusion Criteria

- Age 18–40 years.
- Hepatic steatosis confirmed by abdominal ultrasonography.
- At least one cardiometabolic risk factor, including overweight/obesity, central obesity, prediabetes or diabetes mellitus, hypertension, elevated triglycerides, or reduced high-density lipoprotein cholesterol.
- Alcohol intake below the threshold for metabolic dysfunction-associated alcohol-related liver disease (MetALD) or alcohol-associated liver disease.
- Willingness to provide informed consent, undergo study investigations, and attend follow-up.

Definition of cardiometabolic risk factors

Cardiometabolic risk factors included body mass index ≥23 kg/m² or central obesity (waist circumference ≥90 cm in men and ≥80 cm in women), fasting plasma glucose ≥100 mg/dL, glycated haemoglobin ≥5.7%, previously diagnosed diabetes or antidiabetic treatment, blood pressure ≥130/85 mmHg or antihypertensive therapy, triglycerides ≥150 mg/dL or lipid-lowering treatment, and HDL cholesterol ≤40 mg/dL in men or ≤50 mg/dL in women. The presence of at least one of these criteria was required for the diagnosis of MASLD.

Exclusion Criteria

- Current or previous alcohol consumption exceeding 140 g/week in women or 210 g/week in men, determined through clinical history and, where available, a validated alcohol-use questionnaire.
- Evidence of hepatitis B or hepatitis C infection.
- Known autoimmune hepatitis, Wilson disease, haemochromatosis or another established chronic liver disease.
- Hepatic steatosis secondary to medications such as corticosteroids, amiodarone, methotrexate, tamoxifen or sodium valproate.
- Previous bariatric surgery or major gastrointestinal surgery affecting nutritional status.
- Pregnancy or lactation.
- Cirrhosis caused by an established non-metabolic aetiology.
- Active malignancy or severe systemic illness likely to interfere with assessment or follow-up.
- Incomplete baseline clinical or laboratory information.
- Refusal to provide informed consent.

Clinical and anthropometric assessment

Demographic details, medical history, metabolic comorbidities, and medication use were recorded using a standardised case-record form. Height, weight, waist circumference, and blood pressure were measured using standard procedures. Body mass index was calculated using Asian Indian cut-offs.

Laboratory assessment

Fasting venous blood samples were analysed for platelet count, fasting plasma glucose, glycated haemoglobin, lipid profile, alanine aminotransferase, aspartate aminotransferase, and viral hepatitis markers. Diabetes, prediabetes, hypertension, and dyslipidaemia were defined according to accepted clinical criteria or ongoing treatment.

Ultrasonographic assessment

Abdominal ultrasonography was performed by an experienced radiologist using standard ultrasound equipment. Hepatic steatosis was graded using the following sonographic criteria:

- **Grade I:** Mild diffuse increase in hepatic echogenicity with normal visualisation of the diaphragm and intrahepatic vessels.
- **Grade II:** Moderate increase in echogenicity with mildly impaired visualisation of intrahepatic vessels and the diaphragm.
- **Grade III:** Marked increase in echogenicity with poor visualisation of the diaphragm, intrahepatic vessels and posterior liver.

Fibrosis-risk assessment

The fibrosis-4 index was calculated using:

$$\text{FIB-4} = \frac{\text{Age} \times \text{AST}}{\text{Platelet count} \times \sqrt{\text{ALT}}}$$

Participants were categorised as low risk (<1.3), intermediate risk (1.3–2.67) or high risk (>2.67). Because FIB-4 has limited diagnostic accuracy in individuals aged 35 years or younger, results in this age group were interpreted cautiously [8].

Follow-up and outcomes

Each participant was followed for three months from the date of enrolment. At the end of the three-month follow-up period, outcomes were classified as clinical or biochemical improvement, stable disease, clinical or biochemical worsening, or loss to follow-up. Improvement was defined as a favourable change in symptoms, body weight, metabolic control, or liver enzyme levels without deterioration in the other assessed domains. Stable disease was defined as the absence of any clinically meaningful improvement or deterioration in the assessed parameters. Worsening was defined as deterioration in clinical status, metabolic control, liver biochemistry, ultrasonographic grade of hepatic steatosis, or FIB-4 risk category. Participants who did not attend the scheduled three-month follow-up assessment and could not be contacted were considered lost to follow-up.

Sample size and statistical analysis

All eligible consecutive patients presenting during the recruitment period from 1 January to 31 December 2024 were included; therefore, no formal sample size calculation was performed. Data were analysed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Baseline analyses included all 500 participants, whereas follow-up outcomes were calculated among the 470 patients with available follow-up data. As this was a descriptive study, no inferential statistical analyses were performed.

Ethical considerations

The study was approved by the Institutional Ethics Committee of Down Town Hospital Ltd., Guwahati, Assam, India. Administrative permission was obtained from the hospital authorities, and written informed consent was obtained from all participants before enrolment. Participant confidentiality was maintained throughout the study.

RESULTS

Demographic and anthropometric characteristics

A total of 500 patients with MASLD were included. The mean age was 31.4 ± 6.1 years, with 310 (62%) males and 190 (38%) females. Based on body mass index, 95 (19%) participants had normal weight, 170 (34%) were overweight, and 235 (47%) were obese. Overall, 405 (81%) participants were either overweight or obese. [Table 1]

Table 1: Demographic and anthropometric characteristics of the study population

Characteristic	Number
Total participants	500
Age, years, mean ± SD	31.4 ± 6.1
Male	310 (62%)
Female	190 (38%)
Normal body weight	95 (19%)
Overweight	170 (34%)
Obesity	235 (47%)
Overweight or obesity	405 (81%)

Table note: Data are presented as number (percentage) unless otherwise specified. SD, standard deviation.

Metabolic risk-factor profile

Central obesity was the most common metabolic abnormality, affecting 330 (66%) patients, followed by dyslipidaemia in 290 (58%). Diabetes mellitus, prediabetes, and hypertension were present in 150 (30%), 120 (24%), and 125 (25%) patients, respectively. Elevated alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels were observed in 210 (42%) and 145 (29%) patients, respectively. [Table 2]

Table 2: Metabolic and liver biochemical profile of patients with MASLD

Variable	Number	Percentage
Central obesity	330	66%
Dyslipidaemia	290	58%
Obesity	235	47%
Diabetes mellitus	150	30%
Hypertension	125	25%
Prediabetes	120	24%
Elevated ALT	210	42%
Elevated AST	145	29%

Table note: Metabolic factors were not mutually exclusive. ALT and AST were classified using the upper limits of normal specified by the study laboratory. ALT, alanine aminotransferase; AST, aspartate aminotransferase.

Ultrasonographic profile

Ultrasonography demonstrated grade I hepatic steatosis in 265 (53%) patients, grade II in 185 (37%), and grade III in 50 (10%). Overall, moderate-to-severe steatosis (grades II and III) was present in 235 (47%) participants. [Table 3]

Table 3: Ultrasonographic grading of hepatic steatosis

Ultrasonographic grade	Number	Percentage
Grade I steatosis	265	53%
Grade II steatosis	185	37%
Grade III steatosis	50	10%
Total	**500**	**100%**

Table note: Grade I represented mild steatosis, grade II represented moderate steatosis and grade III represented severe steatosis. Grades II and III together accounted for 47% of the study population.

Fibrosis-risk profile and clinical outcomes

FIB-4 assessment classified 405 (81%) patients as low risk for advanced fibrosis, while 75 (15%) and 20 (4%) were categorised as intermediate and high risk, respectively (Table 4). Among the 470 patients who completed the three-month follow-up assessment, 230 (48.9%) showed clinical or biochemical improvement, 205 (43.6%) remained stable, and 35 (7.4%) demonstrated clinical or biochemical worsening. Thirty patients (6% of the enrolled cohort) were lost to follow-up. [Table 5, Figure 1]

Table 4: Distribution of FIB-4 risk categories

FIB-4 category	Number	Percentage
Low risk (<1.3)	405	81%
Intermediate risk (1.3–2.67)	75	15%
High risk (>2.67)	20	4%
Total	**500**	**100%**

Table note: FIB-4 categories represent estimated fibrosis risk and not histologically confirmed fibrosis. Interpretation should be cautious in participants aged 35 years or younger.

Table 5: Clinical outcomes during follow-up

Outcome	Number	Percentage
Clinical or biochemical improvement	230	48.9%
Stable disease	205	43.6%
Clinical or biochemical worsening	35	7.4%
Total with follow-up data	470	100%
Lost to follow-up	30	6.0% of enrolled

Table note: Percentages for clinical or biochemical improvement, stable disease and clinical or biochemical worsening were calculated using the 470 participants with available follow-up data as the denominator. Loss to follow-up was calculated using all 500 enrolled participants as the denominator. Outcome classifications are defined in the Methods section.

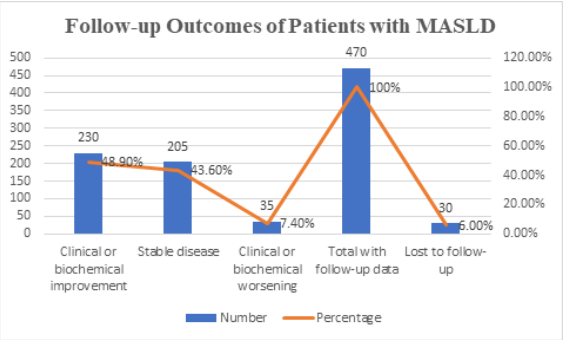

Figure 1: Distribution of clinical and biochemical outcomes during follow-up among patients with MASLD

Figure note: Clinical or biochemical improvement, stable disease and clinical or biochemical worsening were assessed among 470 patients with available follow-up data. Loss to follow-up was calculated among all 500 enrolled patients.

DISCUSSION

This prospective observational study describes the clinical and metabolic profile of 500 patients with MASLD enrolled at Down Town Hospital, Guwahati, Assam, India. The findings demonstrate a high burden of obesity, metabolic abnormalities, moderate-to-severe hepatic steatosis, and intermediate-to-high fibrosis risk in a substantial proportion of patients. Nearly half of the participants with follow-up data showed clinical or biochemical improvement, whereas only a small proportion demonstrated disease worsening.

The mean age of 31.4 years and male predominance (62%) are consistent with previous epidemiological studies showing that MASLD increasingly affects younger adults, particularly men.[2,9] Early onset is clinically important because prolonged exposure to obesity, dysglycaemia, and dyslipidaemia may increase the lifetime risk of progressive liver disease and cardiovascular complications.

Excess adiposity was a prominent finding, with 81% of participants being overweight or obese and 66% having central obesity. These findings agree with previous Indian studies demonstrating a high prevalence of MASLD among individuals with metabolic risk factors.[3] However, body mass index alone may underestimate risk in Asian Indians because visceral adiposity and metabolic dysfunction can occur despite normal body weight.[11,12] Therefore, waist circumference should be assessed routinely along with body mass index.

Dyslipidaemia was the most frequent metabolic abnormality, followed by diabetes, prediabetes, and hypertension. This clustering reflects the close relationship between MASLD and insulin resistance. Because diabetes is strongly associated with steatohepatitis, advanced fibrosis, and adverse liver-related outcomes, comprehensive metabolic evaluation should be part of routine MASLD management.[4,6,10]

Although elevated ALT and AST were observed in 42% and 29% of participants, many patients had ultrasonographic steatosis despite normal liver enzyme levels. This finding highlights that normal aminotransferase values do not exclude clinically significant MASLD and supports the combined use of metabolic assessment, imaging, and non-invasive fibrosis tests.[4,6]

FIB-4 identified 19% of participants as having intermediate or high fibrosis risk, indicating the need for further assessment with liver stiffness measurement or other validated non-invasive methods.[6] However, because FIB-4 has lower diagnostic accuracy in individuals aged 35 years or younger, these findings should be interpreted cautiously.[8]

Among patients with available follow-up data, 48.9% demonstrated clinical or biochemical improvement, whereas 7.4% worsened. Although lifestyle modification and weight reduction may improve MASLD, the observational design of this study does not permit attribution of these outcomes to any specific intervention.[16] The association between MASLD, fibrosis, and cardiovascular disease further emphasises the importance of long-term metabolic risk reduction.[15,17]

The strengths of this study include its prospective design, relatively large sample size, and focus on young adults from Northeast India, where prospective MASLD data remain limited. The systematic assessment of clinical, metabolic,

biochemical, ultrasonographic, and fibrosis-related parameters provides a comprehensive description of disease characteristics in this population.

Limitations

This study has several limitations. Its single-centre, hospital-based design at Down Town Hospital, Guwahati, Assam, may limit the generalisability of the findings and introduce selection bias. Ultrasonography is less sensitive for mild steatosis, while liver biopsy and elastography were unavailable. FIB-4 has limited accuracy in younger adults, and the relatively short follow-up period prevented assessment of long-term hepatic and cardiovascular outcomes. Self-reported alcohol consumption and lifestyle information may have introduced recall bias. In addition, loss to follow-up and the absence of a non-MASLD comparison group limited causal interpretation.

CONCLUSION

MASLD in this cohort was characterised by a high prevalence of overweight, obesity, central adiposity, dyslipidaemia, and abnormal glucose metabolism. Although most participants had a low FIB-4 risk, nearly one-fifth required further fibrosis evaluation. Almost half of the patients with follow-up data demonstrated clinical or biochemical improvement. These findings highlight the importance of early diagnosis, comprehensive metabolic assessment, fibrosis risk stratification, and structured follow-up. Larger multicentre studies with longer follow-up and liver stiffness assessment are needed to validate these findings.

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