RESEARCH ARTICLE

NAFLD becomes MASLD, frequency and characteristics of non-obese metabolic dysfunction associated steatotic liver disease (MASLD) among patients seeking care at a tertiary medical facility

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Abstract

Objective: To determine the frequency and clinical characteristics of non-obese metabolic dysfunction-associated steatotic liver disease, distinguishing it from simple steatosis without metabolic dysfunction.

Method: The cross-sectional, observational study was conducted at Indus Hospital Karachi, Pakistan from October 2021 to March 2022, and comprised adult patients of either gender with hepatic steatosis confirmed by abdominal ultrasonography. Body mass index of each patient was classified as per the Asia-Pacific cut-offs. Metabolic dysfunction-associated steatotic liver disease was diagnosed on the basis of the presence of hepatic steatosis with at least one cardiometabolic risk factor. Physical activity levels of the subjects were assessed using the World Health Organisation guidelines. Data was analysed using SPSS 26.

Results: Of the 158 patients, 112(70.9%) were female and 46(29.1%) were male. The overall median age was 49 years (interquartile range: 40.5-58 years). Of the total, 30(19%) patients were classified as non-obese, and 128(81%) as obese. Among the non-obese subjects, 22(73.3%) had at least one metabolic abnormality and were classified as non-obese Metabolic dysfunction-associated steatotic liver disease cases, while 8(26.7%) patients had no identifiable metabolic dysfunction and were labelled as simple steatosis cases. There was a significant difference in comorbidities between obese and non-obese metabolic dysfunction-associated steatotic liver disease (p<0.001). There was no significant difference noted in terms of physical activity between the groups (p>0.05).

Conclusion: About three-fourth of non-obese individuals with fatty liver met the diagnostic criteria for metabolic dysfunction-associated steatotic liver disease. Considering the benefits of early lifestyle interventions in such cases, clinicians should be aware of this diagnostic spectrum.

Keywords: MASLD, Non-obese MASLD, NAFLD, Hepatic steatosis, Metabolic dysfunction. (JPMA 76: 1232; 2026)

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Introduction

Metabolic dysfunction-associated steatotic liver disease (MASLD), formerly known as non-alcoholic fatty liver disease (NAFLD), is defined as the presence of hepatic steatosis on imaging or histology in the absence of any secondary identifiable causes of hepatic fat accumulation with at least one cardiometabolic risk factor.[1] Due to its strong association with central obesity, dyslipidaemia and type 2 diabetes mellitus (T2DM), MASLD qualifies as being a hepatic manifestation of metabolic syndrome.[2]

MASLD encompasses a spectrum of liver conditions ranging from simple steatosis to steatohepatitis (metabolic-associated steatohepatitis [MASH]), which is associated with inflammation and hepatocyte injury leading to liver fibrosis, where each progressive stage increases the risk of liver cirrhosis and liver-related mortality.[1,3] Studies have shown moderately increased risk of developing certain extrahepatic malignancies and cardiovascular complications in patients with NAFLD, stressing its significance as a multisystem disorder with far-reaching public health implications.[4]

The past two decades have shown a steady rise in the prevalence of MASLD worldwide due to the rising global obesity and diabetes mellitus (DM) epidemic.[5] It is estimated that 32% of the world population is affected by MASLD.[6] In Asia, the overall prevalence of MASLD is estimated to be approximately 30%.[7] As per the World Gastroenterology Organisation Global Guidelines 2014, the formerly known NAFLD prevalence rate in the general Pakistani population was 18%.[8]

MASLD, despite its strong relation with obesity and metabolic syndrome, has also been found in non-obese individuals, called the non-obese or lean MASLD. Visceral obesity has shown to be one of the key factors in the

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pathogenesis of non-obese MASLD.[9] In Asia, up to 19% of MASLD cases occur in non-obese individuals, investigated under the definition of non-obese NAFLD.[10-12]

Due to the absence of typical clinical features, non-obese MASLD may remain undetected, leading to significant liver damage, progressing to MASH, fibrosis or cirrhosis, calling for an early detection and management of this disease entity alongside strategies for prevention of disease progression.

With evolving new terminology and scarcity of local data in mind, the current study was planned to determine the frequency and clinical characteristics of non-obese MASLD, distinguishing it from simple steatosis without metabolic dysfunction.

Patients and Methods

The cross-sectional, observational study was conducted at Indus Hospital Karachi, Pakistan from October 2021 to March 2022. After approval from the Institutional Review Board (IRB), the sample size was calculated using Open Epi v3.01, based on 27.7% frequency of non-obese patients among NAFLD population[13] with 95% confidence interval (CI) and 7% absolute precision. The sample was raised using non-probability consecutive sampling technique. Those included were adult patients of either gender with ultrasound findings of increased echogenic liver parenchymal suggestive of fatty liver. Verbal informed consent was obtained from all the patients. Those with hepatitis B and C or other underlying liver diseases were excluded.

Data was collected through a structured questionnaire regarding age, gender, marital status, education, occupation, medications, dietary habits and smoking status. Comorbidities, such as DM, hypertension (HTN), dyslipidaemia, hypothyroid or hyperthyroid, ischaemic heart disease (IHD), chronic kidney disease (CKD), were assessed on the basis of history and laboratory results. For body mass index (BMI), anthropometric data, including height and weight, were recorded using standard metric scales. Body mass index (BMI) was classified according to the WHO Expert Consultation recommendations for Asian populations. Participants with a BMI ≥25 kg/m^2 were classified as obese and those with a BMI <25 kg/m^2 as non-obese for the purpose of analysis, as Asian populations, including South Asians, are at increased cardio metabolic risk at lower BMI values than European populations.[14] Blood pressure (BP) readings were recorded using standard a BP measuring apparatus.

MASLD was classified as per the recent European clinical practice guidelines,[1] evidence of hepatic steatosis, and presence of at least one of the cardiometabolic risk factors that include overweight or obesity, T2DM, HTN, dyslipidaemia or increase waist circumference (WC). Non-obese MASLD was defined as patients with BMI <25kg/m^2 with hepatic steatosis and ≥1 cardiometabolic risk factors, including T2DM, prediabetes, HTN, dyslipidaemia and insulin resistance (IR).[1]

Physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ), developed by the World Health Organisation (WHO), designed to estimate an individual's level of physical activity in the domains of work, transport and leisure time, and time spent in sedentary behaviour.[15] The participants were asked about the total time spent in physical activity during a typical week, which was categorised into vigorous, moderate and sedentary lifestyle as per the intensity of the physical activity reported. All data elements were recorded in a predesigned proforma.

Data was analysed using SPSS 26. Descriptive data was presented as median with interquartile range (IQR) for quantitative variables after assessing data normality with the Shapiro-Wilk test, such as age, years of education, number of cigarettes smoked, duration of smoking, height, weight, BMI, serum cholesterol levels, high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglycerides (TG), glycated haemoglobin (HBA1c). Qualitative variables were presented as frequencies and percentages, such as gender, ethnicity, marital status, comorbidities, occupation, lifestyle modification, smoking status, family history of NAFLD and factors like medications. The association of MASLD with demographics and clinical parameters was analysed using Pearson's chi-square test for categorical variables and Mann-Whitney test for continuous variables. P<0.05 was considered statistically significant.

Results

Of the 158 patients, 112(70.9%) were female and 46(29.1%) were male. The overall median age was 49 years (IQR: 40.5-58 years; range: 18-81 years). Baseline demographic and clinical characteristics were noted for all the participants (Table 1-2). Of the total, 30(19%) patients were classified as non-obese, and 128(81%) as obese (Figure). Among the non-obese subjects, 22(73.3%) had at least one metabolic abnormality and were classified as non-obese MASLD cases, while 8(26.7%) patients had no identifiable metabolic dysfunction and were labelled as simple steatosis cases.

There was no significant difference between obese and non-obese cases regarding demographic characteristics (Table 3).

There was a significant difference in comorbidities and

Table-1: Demographic characteristics of the patients (n=158).

Variables	n (%)
Gender	
Male	46 (29.1)
Female	112 (70.9)
Age (Years)	
Median (IQR)	49 (40.5-58)
Min-Max	18-81
Ethnicity	
Sindhi	37 (23.4)
Urdu	92 (58.2)
Punjabi	12 (7.6)
Balochi	3 (1.9)
Pashto	9 (5.7)
Other	5 (3.2)
Marital Status, (n=155)	
Married	136 (86.1)
Unmarried	11 (7)
Divorced	1 (0.6)
Widow	7 (4.4)
Education	
Median (IQR)	10 (5-10)
Min-Max	0-16
Occupation, (n=157)	
Homemaker	100 (63.3)
Student	2 (1.3)
Factory worker	13 (8.2)
Shop keeper	13 (8.2)
Labourer	4 (2.5)
Driver	5 (3.2)
Retired	4 (2.5)
Other	16 (10.1)

IQR: Interquartile range.

HbA1c between obese and non-obese patients (Table 4).

Discussion

MASLD, previously known as NAFLD, affects approximately 31% of the global population, making it one of the leading causes of chronic liver disease (CLD).[16] In the Western world, it has surpassed viral hepatitis following therapeutic advancements in the management of chronic hepatitis B and C virus. Previously considered a disease of obese individuals only, there is growing evidence of hepatic steatosis in non-obese individuals, formerly known as non-obese or lean NAFLD.[17]

In the current study, the frequency of non-obese individuals with hepatic steatosis identified on abdominal ultrasound was 19% which matched with the global prevalence of non-obese NAFLD, estimated to be around 20% within the NAFLD population.[18] In a systematic review regarding the global NAFLD population, 40% patients were classified as non-obese and one-fifth as lean, underscoring the importance of this phenotype in the overall burden of liver disease.[17]

Table-2: Clinical characteristics of the patients.

Variables	n (%)
Family History of Fatty Liver	
Yes	2 (1.3)
No	92 (58.2)
Don't Know	64 (40.5)
Smoking Status, (n=151)	
Smoker	2 (1.3)
Ex-Smoker	3 (1.9)
Non-Smoker	146 (92.4)
Duration of smoking (years)	
Median (IQR)	15 (11.2 - 15)
Min-Max	10 - 15
Comorbidities	
None	31 (19.6)
Diabetes	65 (41.1)
Hypertension	37 (23.4)
Ischaemic heart disease	2 (1.3)
Dyslipidaemia	6 (3.8)
Chronic Kidney Disease	2 (1.3)
Hypothyroid	4 (2.5)
Others	11 (7.0)
Lifestyle Modification	
Vigorous	13 (8.2)
Moderate	98 (62)
Sedentary	90 (57)
Height (cm)	
Median (IQR)	155.5 (150-166)
Min-Max	135 – 186
Weight (kg)	
Median IQR	71.5 (62-83)
Min-Max	31-134
Blood Pressure (mmHg)	
Median IQR	130.7 (120.6-140.7)
Min-Max	90-180
BMI (kg/m^2)	
Median (IQR)	29.2 (24.5-33.7)
Min-Max	13-79
Serum Cholesterol (mg/dl)	
Median (IQR)	151 (123-183)
Min-Max	43-252
HDL cholesterol (mg/dl)	
Median (IQR)	36 (27-43)
Min-Max	5-101
LDL cholesterol (mg/dl)	
Median (IQR)	95 (67-125.5)
Min-Max	18-203
Triglycerides (mg/dl)	
Median (IQR)	147 (103-197)
Min-Max	38-592
Last **HbA1c**	
Median (IQR)	6 (5.5-7.5)
Min-Max	3.8-14
Does U/S abdomen diagnose NAFLD (n=157)	
Yes	149 (94.3)
No	8 (5.1)

BMI: Body mass index, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, HbA1c: Glycated haemoglobin, NAFLD: Non-alcoholic fatty liver disease, IQR: Interquartile range.

Zaigham et al. showed that 22.5% participants had hepatic steatosis with lean phenotype during a screening camp for hepatitis in 2010-11 in Karachi.[19]

In the current study, as per the reclassified MASLD criteria, among 30 non-obese participants 73.3% (n=22) individuals had at least one metabolic dysfunction, thus classifying them as non-obese MASLD, whereas 26.7% (n=8) individuals were labelled as simple steatosis since they had no metabolic risk factor.

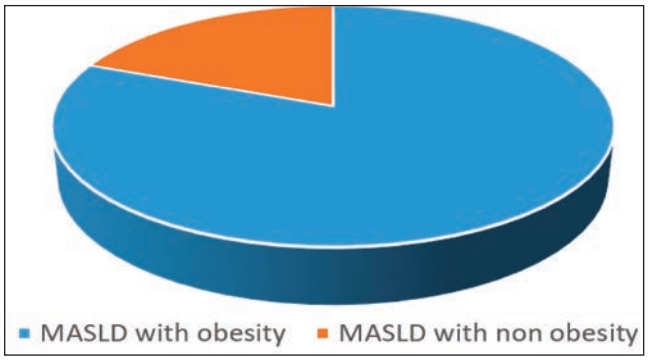

Figure: Distribution of metabolic dysfunction-associated steatotic liver disease (MASLD) with and without obesity.

In the current study, obese MASLD showed a higher prevalence of metabolic abnormalities, including T2DM and HTN compared to non-obese MASLD, reinforcing the association between obesity and metabolic dysfunction. This heterogeneity in the pathogenesis between obese and non-obese MASLD is underscored by the significant difference in the comorbidity distribution between the two groups (p<0.001). In prior studies, the gut microbiota composition in lean patients with non-alcoholic steatohepatitis (NASH) was shown to have a pathogenesis on liver injury independent of food consumption.[20] Francanzani et al. highlighted similar findings. demonstrating lean NAFLD patients to have thinner carotid

Table-3: Association of sociodemographic characteristics with metabolic dysfunction-associated steatotic liver disease (MASLD).

Variables	MASLD		*p*-value
	Non–obese (n=30) [n (%)]	**Obese** (n=128) [n (%)]	
Gender			0.906a
Male	9 (30)	37 (28.9)	
Female	21 (70)	91 (71.1)	
Age (years)			
Median (IQR)	46 (40.7 - 57.2)	49.5 (40 - 58)	0.906c
Min – Max	19 - 74	18 - 81	
Ethnicity			
Sindhi	9 (30)	28 (21.9)	0.665b
Urdu	17 (56.7)	75 (58.6)	
Punjabi	1 (3.3)	11 (8.6)	
Balochi	1 (3.3)	2 (1.6)	
Pashto	2 (6.7)	7 (5.5)	
Other	-	5 (3.9)	
Marital Status			
Married	24 (80)	112 (89.6)	0.162b
Unmarried	3 (10)	8 (6.4)	
Divorced	1 (3.3)	-	
Widow	2 (6.7)	5 (4)	
Occupation			
Homemaker	20 (66.7)	80 (63)	0.921b
Student	-	2 (1.6)	
Factory worker	2 (6.7)	11 (8.7)	
Shop keeper	2 (6.7)	11 (8.7)	
Labourer	1 (3.3)	3 (2.4)	
Driver	2 (6.7)	3 (2.4)	
Retired	-	4 (3.1)	
Other	3 (10)	13 (10.2)	
Education			
Median (IQR)	9 (5 - 10)	10 (5 - 10)	0.631c
Min – Max	0 - 14	0 – 16	

*p-value significant, a = Chi Square, b = Fisher Test, c = Mann- Whitney Test
IQR: Interquartile range

Table-4: Association of clinical characteristics with metabolic dysfunction-associated steatotic liver disease (MASLD).

Variables	MASLD		*p*-value
	Non–obese (n=30) [n (%)]	**Obese** (n=128) [n (%)]	
Smoking Status			0.119b
Smoker	-	2 (1.6)	
Ex-Smoker	2 (6.7)	1 (0.8)	
Non-Smoker	26 (86.7)	120 (97.6)	
Comorbidities			<0.001b*
None	8 (26.7)	23 (18)	
Diabetes	10 (33.3)	55 (43)	
Hypertension	2 (6.7)	35 (27.3)	
Ischaemic heart disease	-	2 (1.6)	
Dyslipidaemia	1 (3.3)	5 (3.9)	
Chronic Kidney Disease	2 (6.7)	-	
Hypothyroid	-	4 (3.1)	
Others	7 (23.3)	4 (3.1)	
Family History of Fatty Liver			0.791b
Yes	-	2 (1.6)	
No	19 (63.3)	73 (57)	
Don't Know	11 (36.7)	53 (41.4)	
Lifestyle Modification			
Vigorous Activity			0.714b
Yes	3 (10)	10 (7.8)	
No	27 (90)	118 (92.2)	
Moderate Activity			0.502a
Yes	17 (56.7)	81 (63.3)	
No	13 (43.3)	47 (36.7)	
Sedentary			0.434a
Yes	19 (63.3)	71 (55.5)	
No	11 (36.7)	57 (44.5)	
Last **HbA1C**			
Median (IQR)	5.5 (5 - 6.4)	6.1 (5.7 - 7.6)	0. 014*c
Min – Max	4 - 13	3.8 - 14	

*p value significant, a = Chi Square, b = Fisher Test, c = Mann- Whitney Test.
HbA1c: Glycated haemoglobin, IQR: Interquartile range.

intima media thickness which led to a lesser atherosclerotic burden in them compared to obese NAFLD.[21] Similar results were observed by Chakrabarty et al.[22]

Among non-obese study participants, 26.7% did not meet the criteria for MASLD due to no identifiable cardiometabolic risk factors. This entity represents a distinct subtype referred to as cryptogenic or non-MASLD steatosis.[23]

The current participants showed no significant difference in the level of physical activity between the two groups although sedentary lifestyle predominated among the non-obese compared to the obese group. This could be explained by a few cohort studies that have shown a weight-gain even within a non-obese BMI range leading to incident non-obese NAFLD, indicating the significance of body composition and weight trajectory over absolute BMI.[24] Therefore, despite a lean phenotype, a weight reduction of 5% in lean/non-obese individuals can be effective in the reversal of hepatic steatosis along with physical activity, dietary modifications and strict control of comorbidities.[25]

The current study has limitations as it was conducted at a single tertiary-care facility with a small sample size that comprised only patients who presented in the Radiology Department for ultrasound examination.

Despite the limitations, however, the current study is among the preliminary studies in Pakistan that have evaluated the reclassification of non-obese MASLD population, and, therefore, can serve as an important foundation for future larger studies at community level to further understand the disease progression in non-obese MASLD.

Conclusion

About three-fourth of non-obese individuals with fatty liver met the diagnostic criteria for MASLD. Considering the lack of easily recognisable phenotype of obesity, physicians should have a high clinical suspicion in individuals with metabolic dysfunction for early identification of this disease entity.

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Conflict of Interest: None.

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Author Contribution:

SJ: Concept, design, writing, supervision and final approval.
FFH: Data collection, patient recruitment, data analysis, interpretation, writing and final approval.
AA: Writing, revision, statistical analysis and interpretation of results.
MH: Literature review, editing, formatting, study design and final approval.