Original Article

Prevalence of Metabolic Dysfunction-Associated Steatotic Liver Disease in Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study

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Abstract

Background: Metabolically Dysfunctional-Associated Steatotic Liver Disease (MASLD) is a part of comorbidity among Type 2 Diabetes Mellitus (T2DM) patients. The cases also resemble one another in that their underlying metabolic disturbances are similar, including insulin resistance, obesity, and dyslipidemia. There is also a lack of robust documentation of MASLD prevalence in T2DM patients across most populations, and the condition's primary risk factors need to be identified to enable early detection and management. This research was conducted to establish the prevalence of MASLD among patients with T2DM and to elaborate on risk factors, including age, body mass index (BMI), duration of diabetes, Glycemic control, and lipid profile. **Material and Methods:** This was a cross-sectional study of 210 participants with T2DM diagnosed in outpatient clinics. To diagnose MASLD, the anthropometrics, laboratory tests (fasting blood glucose, HbA1c, lipid profile), and liver ultrasound were conducted. The data were analyzed to establish similarities and differences in demographic, clinical, and biochemical values among T2DM patients with and without MASLD. **Results:** Among the 210 respondents, 120 (57.1%) are diagnosed with MASLD. Patients with a longer duration of diabetes, poorer glycemic control (increased HbA1c), and abdominal obesity (waist circumference) had more MASLD. The multivariate logistic regression model identified the independent risk factors for MASLD in T2DM patients as BMI, waist circumference, diabetes duration, and HbA1c. **Conclusion:** The high prevalence of MASLD among T2DM patients is a sign of why it is important to screen for MASLD frequently among diabetic patients, particularly those who are centrally obese and have poor glycemic control. With early detection and risk management, the risk of liver-related complications would be reduced, thereby promoting better patient outcomes in general.

Keywords: Metabolic Dysfunction-Associated Steatotic Liver Disease(MASLD), Type 2 Diabetes Mellitus (T2DM), Prevalence, Insulin Resistance, Glycemic Control, Abdominal Obesity, Liver Ultrasound, Risk Factors, Cross-Sectional Study.

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Introduction

Meta-Bolic Dysfunction-Associated Steatotic Liver Disease (MASLD) is rapidly emerging as a severe health problem of concern in Type 2 Diabetes Mellitus(T2DM) persons. The characteristic feature of MIALD is the use of excess fat in the liver, which is observed in the absence of high alcohol intake and is strongly associated with metabolic disorders, including insulin resistance, obesity, and dyslipidemia.[1] Without treatment, MASLD clinically progresses in relation to the simple hepatic steatosis into more severe manifestations of the disease, such as Metabolic Dysfunction-Associated Steatohepatitis(MASH) with obliteration to cirrhosis and liver failure. In view of the higher rates of T2DM and MASLD worldwide, the need to establish the relationship between the two diseases has been a critical factor in improving patient management and preventing complications.[2]

T2DM is a chronic type of metabolic disease that is seen to be one of the most prevalent in the world, including an insulin-resistance phenomenon and glucose metabolic deficiency. It is estimated that the number of people with diabetes worldwide exceeds 460 million, according to the International Diabetes Federation, and is likely to increase in the coming few decades.[3] T2DM is usually found to be comorbid with a variety of comorbidities, including cardiovascular disease, chronic kidney disease, and MASLD [4]. The liver plays a central role in glucose and lipid metabolism, and its failure can augment the metabolic imbalance that can arise in T2DM. Another significant outcome of T2DM, insulin resistance, is also considered to have a critical contributory impact on the improvement of MASLD. As a result, individuals with T2DM are more vulnerable to developing MASLD than the general population.[5]

The literature on T2DM and MASLD has indicated a strong association between the two, with studies consistently showing a

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high level of liver fat deposition among diabetic patients. Research suggests that as many as 50-70 percent of patients with T2DM may also experience MASLD, hence it is among the most common liver diseases in such a group of patients.[6] The patients with T2DM have MasLD and a high risk of developing hepatic morbidity, such as the development of MASH and cirrhosis, as well as high risks of cardiovascular events.[7] Additionally, patients with MASLD and T2DM may have a worsening of the overall prognosis as both diseases share multiple metabolic risk factors, one of which is obesity, hypertension, and dyslipidemia. The prevention and management of MASLD in older T2DM patients are hence critical for reducing the effects of the condition.[8]

Although the correlation between T2DM and MASLD is becoming apparent, there is also a lack of in-depth data on exactly how prevalent MASLD is among T2DM patients, and more so across different geographic areas and populations. The proposed cross-sectional study will help determine the incidence of MASLD in a sample of patients with T2DM and explore potential risk factors for liver fat deposition in these individuals.[9] Assessing the frequency of MASLD and its dependence on age, body mass index (BMI), duration of diabetes, and glycemic control, the proposed research will provide certain valuable information about the burden of MASLD in patients with T2DM and also assist in determining the high-risk population to undergo early screening and intervention.[10]

Materials and Methods

Study Design: This was a cross-sectional study to determine the prevalence of Metabolically Dysregulated-Associated Steatotic Liver Disease (MASLD) among Type 2 Diabetes Mellitus (T2DM) patients. The cross-sectional approach applies to the study, as it allows collecting data from a specific sample at a single point in time to determine the prevalence of MASLD among this group of respondents, but not to assess time-dependent association or causation.

Study Population: The study population comprised 210 participants with T2DM. The outpatient Clinics that recruited and sampled the respondents handled endocrinology and diabetes treatment. The inclusion criteria included that the subjects be aged 30-70 years, have been diagnosed with T2DM for more than 1 year, and be willing to participate.

The research subjects were divided into two groups:

Group 1: Patients who have T2DM and who have MASLD diagnosed (Case group).

Group 2: T2DM patients who were not diagnosed with MASLD (Control group).

Inclusion Criteria:

- Adults aged between 30 to 70 years.
- At least one year of confirmed diagnosis of T2DM (according to the editions of American Diabetes Association) of the disease.
- Capability to make informed consent.
- None of the chronic history of liver diseases associated with alcohol consumption, viral hepatitis, or autoimmune liver diseases.

Exclusion Criteria:

- The Breastfeeding women or the pregnant women.
- The patients who have a history of liver cirrhosis, alcoholic liver disease, or viral hepatitis (Hepatitis B or C).
- The Patients taking drugs that are associated with the fatty liver (e.g., corticosteroids, methotrexate).
- The Patients of major kidney or cardiovascular disease.
- Patients with disorders that can confound the study results e.g. secondary causes of obesity (e.g. hypothyroidism or Cushing syndrome).

Data Collection: Demographic Data: The patient is a 54-year-old Caucasian male <|human|>Clinical Data: The patient is a 54-year-old Caucasian male.

A structured questionnaire was used to collect participants' demographic information, including age, gender, and medical history. Patient clinical records provided information on the duration of T2DM, comorbidities (e.g., hypertension, dyslipidemia), and current diabetes treatment.

Anthropometric Measurements: Height and weight were measured to determine the Body Mass Index (BMI), which is weight in kilograms divided by height in meters squared (kg/m2). To determine abdominal obesity, a tape measure at the umbilicus was used to measure waist circumference, a major risk factor for MASLD.

Laboratory Investigations: Measurements of fasting blood glucose, lipid profile (total cholesterol, triglycerides, LDL, and HDL), and liver enzymes (ALT, AST, GGT) were obtained from blood samples collected after an overnight fast to assess liver function and metabolic parameters.

HbA1c (Hemoglobin A1c) levels were also measured to assess long-term glycemic control.

Assessment of MASLD: Ultrasound was the primary diagnostic modality for MASLD. An ultrasound of the liver was performed to assess hepatic steatosis (fat in the liver) and the extent of liver involvement. The existence of hepatic steatosis was determined using the ultrasound data, and participants were considered to have MASLD when fat deposition was found in the absence of excessive drinking and other liver conditions.

Fibrosis (where relevant): In patients with significant manifestations of MASLD, the extent of liver fibrosis (F0-F4 scale) was also assessed using FibroScan (transient elastography) to determine disease severity. Nevertheless, a liver biopsy was not done because it was invasive.

Statistical Analysis: The demographic and clinical characteristics of the study participants were summarized using descriptive statistics.

The data were analyzed using chi-square tests for categorical variables and independent t-tests or Mann-Whitney U tests for continuous variables to determine the prevalence of MASLD in the total sample and in the control-case comparison, based on data distribution.

A multivariate logistic regression analysis was performed to identify independent risk factors for MASLD in T2DM patients and to control for possible confounding variables (age, BMI, diabetes history, glycemic control (HbA1c), and lipid profile).

Limitations: Although ultrasound is non-invasive and a popular technique for identifying MASLD, it is not ideal for detecting early liver disease or fibrosis. Also, the cross-sectional nature of the research implies that the temporal association between MASLD and T2DM cannot be determined. Further longitudinal

studies should prove the causal relationship between these two conditions.

Overall, this research will help to estimate the incidence of MASLD in patients with T2DM, as well as establish possible risk factors related to its occurrence, and make significant contributions to the burden of MASLD in the diabetic community.

Results

The objectives of this study were to determine the prevalence of Metabolically Dysregulated-Associated Steatotic Liver Disease (MASLD) in patients with Type 2 Diabetes Mellitus (T2DM) and to discuss its risk factors. The analysis found 210 participants. The study findings are discussed below, focusing on the demographics of participants, the prevalence of MASLD, and the correlations between clinical parameters and MASLD in T2DM patients.

Demographic and Clinical Characteristics.

The average age of the samples used was 55.2 9.6 years, and there was no age difference in the MASLD and non-MASLD groups. The study included a greater number of males (60 percent), although there was no marked difference in gender distribution between the two groups. The mean BMI of the participants was 32.1 ± 6.4 kg/m 2, and the MASLD group had a higher BMI than the non-MASLD group [Table 1].

Table 1: The Demographic and Clinical Characteristics of Participants

Parameter	MASLD Group (n=120)	Non-MASLD Group (n=90)	p-value
Age (years)	55.5 ± 9.8	54.7 ± 9.2	0.430
Gender (Male %)	62.5%	57.8%	0.512
BMI (kg/m²)	34.3 ± 6.2	29.7 ± 5.5	<0.001
Waist Circumference (cm)	104.3 ± 12.1	96.5 ± 11.4	<0.001

The findings indicated that central obesity (waist circumference>102 cm in men and> 88 cm in women) in the MASLD group was significantly greater than in the non-MASLD group, suggesting a role for central obesity in the onset of MASLD.

Morbidity of MASLD in T2DM Patients.

A total of 210 respondents (57.1%, 120) were found to have MASLD based on liver ultrasound. The incidence of MASLD was also pronounced among patients with a longer diabetes history and those with inadequate glycemic control [Table 2].

Table 2: Prevalence of MASLD in Type 2 Diabetes Patients

Parameter	MASLD Group (n=120)	Non-MASLD Group (n=90)	p-value
Duration of Diabetes (years)	12.8 ± 6.1	8.9 ± 5.2	<0.001
HbA1c (%)	8.4 ± 1.2	7.2 ± 1.0	<0.001

The study found that MASLD prevalence was statistically significantly associated with diabetes duration. The mean duration of diabetes was 12.8 ± 6.1 years in patients with MASLD, compared with 8.9 ± 5.2 years in non-MASLD patients ($p < 0.001$). Also, the HbA1c HbA1c measurements were significantly higher in the MASLD group, with a mean of HbA1c of 8.4 + 1.2% and a control of 7.2 + 1.0% in the non-MASLD group ($p < 0.001$), which means that poor glycemic control is also associated with the development of MASLD.

Lipid Profile and Liver Enzymes (I) Lipid Profile Lipid profile and liver enzymes level (I): 100 100 140 108 112 100 103 Lipid profile and liver enzymes level (II): 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50

Abnormal lipids were also observed in both groups, though they were more pronounced in the MASLD group. The levels of triglyceride and total cholesterol were much higher in the MASLD group [Table 3]. The liver enzymes, specifically ALT and AST, were significantly higher in the MASLD group than in the non-MASLD group, further evidence of liver damage in patients with MASLD.

Table 3: Lipid Profile and Liver Enzymes in MASLD and Non-MASLD Groups

Parameter	MASLD Group (n=120)	Non-MASLD Group (n=90)	p-value
Total Cholesterol (mg/dL)	232.5 ± 52.1	206.3 ± 42.6	<0.001
Triglycerides (mg/dL)	204.3 ± 78.2	152.1 ± 65.4	<0.001
HDL (mg/dL)	39.5 ± 11.3	42.6 ± 13.4	0.102
ALT (U/L)	44.2 ± 25.6	32.1 ± 19.4	<0.001
AST (U/L)	40.7 ± 23.3	31.2 ± 20.3	0.024

Multivariate Analysis: Multivariate logistic regression analysis was performed to identify independent risk factors for MASLD in T2DM patients. The study revealed that BMI, waist circumference, diabetes duration, and HbA1c were independently associated with MASLD [Table 4].

Table 4: Multivariate Analysis of Risk Factors for MASLD in T2DM Patients

Parameter	Odds Ratio (95% CI)	p-value
BMI (kg/m²)	1.24 (1.15 - 1.34)	<0.001
Waist Circumference (cm)	1.08 (1.04 - 1.13)	0.001
Duration of Diabetes (years)	1.15 (1.07 - 1.24)	<0.001

HbA1c (%)	1.26 (1.11 - 1.43)	0.002

The multivariate analysis revealed that, with increases in BMI and waist circumference, each unit increase raised the likelihood of having MASLD by 24% and 8%, respectively. In addition, diabetes duration and high levels of HbA1c were correlated with the increase in probability of developing MASLD.

Measurement of Fibrosis in MASLD patients.

Out of the 120 patients diagnosed with MASLD, 30 percent of the patients were diagnosed with moderate to severe liver fibrosis using FibroScan [Table 5]. Fibrosis was also more prevalent in people who had longer periods of diabetes and elevated BMI.

Table 5: Fibrosis Stage in MASLD Patients

Fibrosis Stage	MASLD Patients (n=120)	Percentage (%)
F0-F1 (No/mild fibrosis)	84	70%
F2-F4 (Moderate/severe)	36	30%

Discussion

In our cross-sectional analysis of 210 patients with T2DM, MASLD was prevalent (57.1%) and was significantly associated with longer diabetes duration, poor glycemic control (elevated HbA1c), higher BMI/waist circumference, dyslipidemia, and elevated liver enzymes. These results are generally in line with and support the recent upward trend in opinion that MASLD is common in people with T2DM and is directly related to metabolic dysregulation.

The prevalence of MASLD is 59.7% (95% CI: 54.3–64.9) in T2DM patients, pooled across 24 studies with a total of more than 35,000 patients (Dai et al., 2017), and is very similar to ours.[9] A different meta-analysis by Atan et al. (2017) resulted in a pooled prevalence of approximately 54% (95% CI: 4564).[10] In the meantime, a higher prevalence of 70% was reported in T2DM patients in a more recent study by Dharmalingam et al. (2018), which highlighted the association of MASLD with overweight/obesity and insulin resistance.[11]

The agreement of our data with these previous studies provides further evidence that MASLD is extremely common in the T2DM population worldwide, regardless of geographic or ethnic background. The consistency also supports the argument that MASLD should be viewed as a common comorbidity among diabetic patients rather than a rare complication.

As the results of the present study suggest, our risk factors (obesity, central adiposity, poor glycemic control, longer diabetes duration, dyslipidemia) align with those obtained by other researchers and meta-analyses. An example is the comprehensive review by Atan et al., which identified associations between MASLD prevalence and BMI, triglycerides, HbA1c, and other metabolic parameters.[12]

Nonetheless, there is still a certain fluctuation in studies. Indicatively, prevalence rates in underlying studies ranged from 29.6% to 87.1% across different populations, diagnostic modalities, and study settings.[13] This heterogeneity suggests that at least ethnicity, lifestyle, obesity prevalence, glycemic control, and MASLD diagnostic criteria have a strong impact on the apparent prevalence of MASLD in T2DM.

Further, high liver enzymes (ALT, AST) are commonly considered markers; however, because they are neither sensitive nor specific enough to be markers of MASLD, most people with fatty liver do not have high liver enzymes. Several previous studies and meta-analyses have reported that using the level of transaminase alone would underestimate the actual burden of MASLD.[14] This denotes the power of our research in the use of imaging (ultrasound) as opposed to screening using enzymes only.

Overall, our results are consistent with evidence of a high prevalence of MASLD among T2DM populations worldwide. Motivated by similarities in metabolic pathways, i.e., insulin resistance, obesity, dyslipidemia, and chronic hyperglycemia, it seems probable that MASLD is not only an incidental comorbidity but also a common metabolic impact of T2DM. Our evidence complements the suggestion of routine screening of MASLD in diabetic individuals, particularly those with obesity and poor glycemic control, to diagnose it early and prevent the development of more severe liver disease (e.g., MASH, fibrosis).

Limitations

There are several limitations associated with this study that should be factored in when interpreting the results. First, it is a cross-sectional study, which provides only a snapshot of the prevalence of Metabolically Dysregulated-Associated Steatotic Liver Disease (MASLD) among Type 2 Diabetes Mellitus (T2DM) patients at a single point in time; hence, it cannot determine the causality of the two conditions. Secondly, liver ultrasound has not been as accurate at identifying early liver disease or liver fibrosis as other imaging procedures, such as magnetic resonance elastography or liver biopsy, which were not incorporated into the study because they involve invasive or expensive methods. Also, the use of liver enzymes (e.g., ALT, AST) as evidence of liver dysfunction could result in underestimation of the prevalence of MASLD, due to the large number of patients with normal liver enzymes who could still have an excessive amount of fat in the liver. Other possible confounders not considered in the study include diet, physical activity, and genetic factors, which could contribute to the development of MASLD in T2DM patients. Additionally, the sample was selected from a single population, which could limit the generalizability of the findings to other areas or ethnicities. Lastly, the research failed to determine long-term course or clinical outcomes of MASLD in these patients, which reduced the possibility of evaluating the potential role of the occurrence of MASLD in influencing the prognosis of T2DM with time.

Conclusion

This paper discovered that 57.1 percent of patients with T2DM were infected with MASLD, the prevalence of which was linked to the extended diabetes duration, inadequate glycemic control,

and excessive obesity. The findings emphasize the need to monitor liver health among T2DM patients because MASLD is a frequent comorbidity that may develop further into other liver diseases. Early identification of high-risk patients using BMI, waist circumference, and HbA1c is important for preventing the development of MASLD and improving patient outcomes in T2DM.

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Conflicts of interest

There are no conflicts of interest.

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