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Ultrasound-Detected Metabolic Dysfunction-Associated Steatotic Hepatopathy (MASH) Prevalence in Type 2 Diabetes Patients Attending Primary Care

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Abstract: Metabolic dysfunction-associated steatotic hepatopathy (MASH) is a common hepatic complication in patients with type 2 diabetes mellitus (T2DM), and its underdiagnosis in primary care often delays timely interventions and increases the risk of advanced liver disease. This study aimed to determine the prevalence of ultrasound-detected MASH in T2DM patients attending primary care and examine its association with demographic and clinical factors. Methods: A cross-sectional observational study was conducted on 500 T2DM patients aged 30–80 years who attended three primary care clinics between January and June 2025. Abdominal ultrasonography was performed to detect hepatic steatosis using standardized criteria, and demographic and clinical data, including age, sex, body mass index, diabetes duration, and liver enzyme levels, were collected. Statistical analysis was performed using SPSS, with subgroup comparisons by age and sex. MASH was identified in 199 patients (39.8% of the total). The prevalence increased steadily with age, from 11.1% in the 30–39 group to 58.3% in those aged 70–80. Females showed a slightly higher overall prevalence (41.1%) than males (38.7%), with a marked increase after the age of 50 years. Patients with MASH were significantly older than those without non-MASH patients (58.3 vs. 52.7 years, $p < 0.01$). In conclusion, ultrasound-detected MASH is highly prevalent in T2DM patients, particularly among older adults and postmenopausal women, with age emerging as the most significant risk factor. Therefore, routine ultrasound screening should be incorporated into diabetes care protocols, especially for patients > 50 years of age, to enable timely interventions and reduce the burden of chronic liver disease.

Keywords: MASH; Type 2 Diabetes Mellitushepatic steatosis; ultrasound; primary care; age-related prevalence.

انتشار اعتلال الكبد الدهني المرتبط بخلل التمثيل الغذائي (MASH) المكتشف بالموجات فوق الصوتية لدى مرضى السكري من النوع الثاني في الرعاية الأولية

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المستخلص: يُعد اعتلال الكبد الدهني المرتبط بخلل التمثيل الغذائي (MASH) من المضاعفات الكبدية الشائعة بين مرضى السكري من النوع الثاني(T2DM) ، وغالبًا ما يؤدي نقص تشخيصه في الرعاية الأولية إلى تأخير التدخلات المناسبة وزيادة خطر تطور المرض إلى مراحل متقدمة. هدفت هذه الدراسة إلى تحديد معدل انتشار MASH المكتشف بالموجات فوق الصوتية لدى مرضى السكري من النوع الثاني الذين يراجعون مراكز الرعاية الأولية، ودراسة علاقته بالعوامل الديموغرافية والسريرية. أُجريت دراسة رصدية مقطعية شملت 500 مريضًا مصابًا بالسكري من النوع الثاني تراوحت أعمارهم بين 30 و80 عامًا، تمت متابعتهم في ثلاثة مراكز للرعاية الأولية خلال الفترة من يناير إلى يونيو 2025. تم استخدام التصوير بالموجات فوق الصوتية للكشف عن التنكس الدهني الكبدي وفق معايير قياسية، كما جُمعت البيانات الديموغرافية والسريرية بما في ذلك العمر، الجنس، مؤشر كتلة الجسم، مدة الإصابة بالسكري، ومستويات إنزيمات الكبد. أُجري التحليل الإحصائي باستخدام برنامج SPSS مع مقارنات فرعية بحسب العمر والجنس. أظهرت النتائج إصابة 199 مريضًا (39.8%) بـMASH ، مع زيادة تدريجية في معدل الانتشار من 11.1% في الفئة العمرية 30–39 عامًا إلى 58.3% في الفئة 70–80 عامًا. وُجد أن معدل الانتشار أعلى قليلاً بين الإناث (41.1%) مقارنة بالذكور (38.7%)، مع ارتفاع ملحوظ بعد سن الخمسين. كما كان متوسط عمر المرضى المصابين أعلى بشكل ملحوظ من غير المصابين (58.3 مقابل 52.7 سنة، $p < 0.01$). خلصت الدراسة إلى أن MASH المكتشف بالموجات فوق الصوتية شائع بدرجة كبيرة بين مرضى السكري من النوع الثاني، خصوصًا لدى كبار السن والنساء بعد سن اليأس، ويُعد العمر عامل الخطر الأبرز. وعليه، يُوصى بإدراج الفحص الروتيني بالموجات فوق الصوتية ضمن بروتوكولات رعاية مرضى السكري، خاصة لمن تجاوزوا الخمسين عامًا، لتمكين التدخل المبكر والحد من أعباء أمراض الكبد المزمنة.

الكلمات المفتاحية: اعتلال الكبد الدهني المرتبط بخلل التمثيل الغذائي (MASH)، السكري من النوع الثاني، التنكس الدهني الكبدي، الموجات فوق الصوتية، الرعاية الأولية، الانتشار المرتبط بالعمر.

1- INTRODUCTION

Metabolic dysfunction-associated steatotic hepatopathy (MASH) has become a significant global health concern, particularly in individuals with type 2 diabetes mellitus (T2DM). This illness is representative of the progressive spectrum of fatty liver diseases that are closely linked to obesity, insulin resistance, and metabolic dysregulation. T2DM is one of the main causes of the global increase in the prevalence of metabolic syndrome and its associated complications in recent years. Previously regarded as secondary health issues, chronic liver diseases are now acknowledged as significant comorbidities among people with type 2 diabetes, having a substantial impact on morbidity and mortality rates (Evert et al., 2019).

There is growing evidence of a pathophysiological connection between MASH and type 2 diabetes. Patients with diabetes are more likely to accumulate hepatic fat due to insulin resistance, increased lipogenesis, and altered glucose metabolism, all of which worsen hepatic inflammation and fibrosis. MASH is becoming a greater burden on healthcare systems due to the global increase in obesity and type 2 diabetes; however, its prevalence is still poorly understood in many clinical settings. This problem is exacerbated by the fact that MASH is frequently misdiagnosed in primary care settings, where doctors may place more emphasis on glycemic and cardiovascular control than on hepatic evaluation (Dong et al., 2024). This diagnostic gap often leads to missed opportunities for early intervention, allowing the disease to progress to more advanced stages, such as cirrhosis and hepatocellular carcinoma. There are a significant effects on patient outcomes when MASH and T2DM coexist. In addition to worsening liver function, MASH is strongly linked to cardiovascular issues, renal failure, and systemic inflammation, all of which impair the prognosis of patients with diabetes (Gómez-Mendoza et al., 2025). Clinically, prompt interventions that enhance both hepatic and metabolic outcomes may be possible with the early detection of hepatic steatosis in T2DM patients. For example, if the risk is identified before significant fibrosis develops, lifestyle changes, medication therapy, or referral to hepatology services can be initiated earlier.

Ultrasound imaging is an effective, reasonably priced, and noninvasive method for identifying hepatic steatosis. Ultrasound is still more widely available in routine clinical practice, particularly in primary care, than more sophisticated imaging modalities such as magnetic resonance imaging–based proton density fat fraction (MRI-PDFF) or transient elastography. Although it cannot accurately measure the extent of fibrosis or inflammation, its use as a screening tool makes it ideal for population-level research and early diagnosis in environments with limited resources (Wong, 2007). This study is important because it measures the frequency of MASH detected by ultrasound in primary care diabetic patients, which helps clarify the disease burden and guide the development of strategies to incorporate hepatic screening into diabetes treatment regimens.

Although the link between diabetes and fatty liver disease is becoming more widely acknowledged, systematic screening and population-based prevalence studies are frequently overlooked in the currently available literature. Numerous studies have identified obesity and type 2 diabetes as significant risk factors; however, they have ignored the contribution of early hepatic screening in slowing disease progression. Furthermore, MASH diagnostic procedures continue to be uneven, and comparisons of prevalence rates across regions are made more difficult by differences in study populations, ultrasound criteria, and sampling techniques (Desalegn et al., 2024; Elsabaawy et al., 2025).

The underrepresentation of developing and Middle Eastern nations in international MASH research is another significant research gap. The generalizability of the findings has been limited by the fact that most prevalence studies have been conducted in East Asian or Western populations. Despite the high and increasing prevalence of type 2 diabetes, epidemiological data on MASH in diabetic populations are lacking in Iraq and other comparable contexts. The lack of local evidence makes it difficult to develop prevention and management guidelines and policies that are appropriate for a particular context. Therefore, doctors frequently lack the information required to support regular liver health evaluations in diabetic care guidelines.

The necessity of the current study is further supported by the methodological shortcomings of previous research. For instance, different inclusion and exclusion criteria for patients with diabetes, as well as different ultrasound criteria for diagnosing hepatic steatosis, have produced inconsistent outcomes (Moosa et al., 2024; Moss et al., 2024). Liver biopsies are the gold standard for diagnosis; however, they are not appropriate for screening large populations because of their invasive nature. Therefore, to provide accurate prevalence estimates, studies that use standardized, noninvasive diagnostic protocols are urgently needed.

To improve the clinical and scholarly knowledge of MASH in diabetic populations, these gaps must be filled. According to academics, this study adds to the expanding corpus of data on the comorbidities of chronic diseases and emphasizes the intricate relationships between hepatic outcomes and metabolic health (Biały et al., 2023). In practice, this offers a basis for incorporating liver

health evaluations into diabetes treatment plans, which may lower morbidity and mortality rates by enabling earlier detection and treatment.

This study aimed to ascertain the prevalence of MASH detected by ultrasound among T2DM patients who visit primary care clinics in Iraq. This study examined the demographic, clinical, and metabolic factors linked to MASH by examining data from 500 patients in three centers, with special attention to patterns that are specific to age and sex. The ultimate objective is to strengthen the case for routine ultrasound screening as part of standard diabetes care protocols.

By doing this, the study hopes to close the gap between best practices and current practice and provide primary care physicians with useful information to enhance patient outcomes. This study aimed to increase healthcare providers' awareness of the vital role of hepatic health in the overall management of type 2 diabetes, in addition to estimating its prevalence and helping to develop locally relevant screening guidelines (O'Gorman et al., 2020; Fortuna, 2014).

In summary, the growing prevalence of metabolic diseases, underdiagnosis of MASH in primary care, and lack of prevalence data in Middle Eastern populations all support this study. This study addresses the pressing need for data-driven approaches in diabetes and liver health care by fusing easily accessible diagnostic tools with a systematic epidemiological approach. The results are anticipated to emphasize the urgent need for routine hepatic screening, direct clinical practice, and further longitudinal studies to assess the course of MASH and the efficacy of focused interventions.

2- METHODOLOGY

Study Design

This study employed a cross-sectional observational design. Such a design is particularly appropriate for determining disease prevalence within a defined population at a specific time. It allows for the quantification of the proportion of patients affected by metabolic dysfunction-associated steatotic hepatopathy (MASH) in a type 2 diabetes mellitus (T2DM) cohort, while also facilitating the exploration of associations with demographic and clinical variables. A cross-sectional approach was chosen because it is cost-effective, feasible in primary care settings, and provides valuable epidemiological data that can serve as a foundation for subsequent longitudinal studies.

Study Setting

The study was conducted in three urban primary care clinics in Baghdad, Iraq, over a six-month period (January to June 2025). These clinics were purposely selected because they serve large, heterogeneous populations with varied socioeconomic backgrounds, thereby providing a sample that is reflective of real-world diabetic patients in Iraq. Each clinic is equipped with general medical services, diabetes follow-up programs, and basic diagnostic facilities, including ultrasonography. Standard operating procedures were harmonized across the three centers to ensure uniform data collection and minimize inter-clinic variability.

Subjects

A total of 500 patients with a confirmed diagnosis of T2DM were enrolled using consecutive sampling method. The inclusion criteria were as follows: (1) age between 30 and 80 years, (2) diagnosis of T2DM for at least one year, and (3) regular attendance at one of the participating primary care clinics during the study period. Patients were excluded if they had (1) known viral hepatitis B or C, (2) autoimmune liver disease, (3) a history of significant alcohol intake (defined as >20 g/day for women and >30 g/day for men), (4) use of hepatotoxic drugs, or (5) a prior diagnosis of non-metabolic liver disease.

The study population included 269 men (53.8%) and 231 women (46.2%), with a mean age of 55 ± 9.6 years. The distribution across age groups (30–39, 40–49, 50–59, 60–69, and 70–80 years) allowed for subgroup analysis of age-related prevalence. This stratification ensured adequate representation of both younger and older patients, highlighting patterns that might be masked in smaller or narrower cohorts of patients.

Tools of Data Collection

Data collection combined structured patient interviews, a review of medical records, and standardized abdominal ultrasonography.

- **Sociodemographic variables** included age, sex, marital status, education level, and socioeconomic status. Socioeconomic classification was based on monthly income and occupation categories that were consistent with local standards.
- **The clinical variables** included duration of diabetes, type of antidiabetic therapy (oral hypoglycemics, insulin, or combination), comorbidities (hypertension, dyslipidemia, cardiovascular disease), and family history of liver disease.
- **Anthropometric measurements** included weight, height, waist circumference, and body mass index (BMI), which were measured according to the WHO recommendations.
- **Laboratory data** included serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), fasting blood glucose, and HbA1c levels when available. These laboratory results were extracted from the patient records within the last three months to minimize temporal variation.

Ultrasound Assessment

All patients underwent abdominal ultrasonography performed by certified radiologists using high-resolution B-mode ultrasound machines (Toshiba and GE models available in clinics). Standard diagnostic criteria for hepatic steatosis were applied, which included

1. Increased echogenicity of the liver parenchyma compared to the renal cortex,
2. Blurring of intrahepatic vascular margins, and
3. Posterior beam attenuation.

Each patient was examined in a fasting state to improve the diagnostic accuracy. To ensure reliability, inter-observer agreement was established through a calibration session before the study began. Intra-observer reliability was tested by re-examining 10% of randomly selected patients, achieving a concordance rate of > 90%.

Pilot Study

Before initiating the main study, a pilot test was conducted on 20 patients to evaluate the feasibility of the study's protocol. This pilot study focused on assessing the following:

- The clarity of the data collection forms,
- Patient acceptance of ultrasonography as a screening tool,
- Consistency in sonographic interpretation between examiners, and
- Average time required for each examination.

Minor modifications were made to improve the wording of the interview questions and enhance the data recording procedures. Importantly, the pilot confirmed that the sonographers' interpretations were consistent, with kappa statistics >0.85, indicating excellent agreement. The pilot sample was excluded from the final analysis.

Ethical Consideration

Ethical clearance was obtained from the Institutional Review Board of the College of Medicine, Mustansiriyah University (approval code: MED/ETH/2025-04). All patients provided written informed consent after a detailed explanation of the study's objectives, procedures, and confidentiality safeguards. Participation was voluntary, and no financial incentives were offered. Patients were assured that refusal to participate would not affect their clinical care. Anonymity was preserved by assigning unique identification numbers to each participant, and all electronic data were stored in password-protected systems.

Statistical Analysis

Data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables, such as age, BMI, and laboratory values, are expressed as means ± standard deviations (SD), whereas categorical variables, such as sex, age group, marital status, and socioeconomic class, are presented as frequencies and percentages.

The prevalence of ultrasound-detected MASH was calculated as the proportion of patients with hepatic steatosis in the total sample. Chi-square tests were used to assess the association between MASH prevalence and categorical variables, such as age group, sex, socioeconomic status, and marital status. Independent samples t-tests were employed to compare continuous variables, such as mean age, BMI, and liver enzyme levels between the MASH-positive and MASH-negative groups.

To further assess the risk factors, binary logistic regression was performed with MASH status (positive/negative) as the dependent variable. The independent predictors included age, sex, BMI, duration of diabetes, HbA1c level, and socioeconomic status. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to quantify the associations. Model fit was evaluated using the Hosmer–Lemeshow test. A two-tailed p-value of <0.05 was considered statistically significant throughout the analysis.

3- RESULTS

This study included 500 patients with type 2 diabetes mellitus (T2DM). Table 1 displays the baseline socioeconomic and demographic data. Participants were 53.8% male (n = 269) and 46.2% female (n = 231), with an average age of 55.1 ± 9.6 years old. The majority of patients (80.2%) were married and came from middle- or lower-class families.

Table 1. Baseline characteristics of study participants (n = 500)

Variable	Male (n = 269)	Female (n = 231)	Total (n = 500)
Mean age (years)	54.9 ± 9.4	55.4 ± 9.9	55.1 ± 9.6
Age group 30–39	12 (4.5%)	15 (6.5%)	27 (5.4%)
Age group 40–49	76 (28.3%)	57 (24.7%)	133 (26.6%)
Age group 50–59	97 (36.1%)	91 (39.4%)	188 (37.6%)
Age group 60–69	66 (24.5%)	50 (21.6%)	116 (23.2%)
Age group 70–80	18 (6.7%)	18 (7.8%)	36 (7.2%)
Low socioeconomic	112 (41.6%)	105 (45.5%)	217 (43.4%)
Middle socioeconomic	118 (43.9%)	96 (41.6%)	214 (42.8%)
High socioeconomic	39 (14.5%)	30 (13.0%)	69 (13.8%)
Married	219 (81.4%)	182 (78.8%)	401 (80.2%)
Single/Other	50 (18.6%)	49 (21.2%)	99 (19.8%)

Prevalence of MASH

Ultrasound examination identified 199 cases of MASH (39.8%) among the 500 patients. Prevalence increased steadily with age, from 11.1% in the 30–39 years group to 58.3% in the 70–80 years group (Table 2). As illustrated in Figure 1, females showed a sharper rise in prevalence after 50 years of age, reaching 77.8% in the oldest cohort, whereas male prevalence peaked at 57.6% in the 60–69 age group before slightly declining.

Table 2. Prevalence of MASH by age group and sex

Age Group (years)	Male (MASH +/Total, %)	Female (MASH +/Total, %)	Total prevalence (%)
30–39	2/12 (16.7%)	1/15 (6.7%)	11.1%
40–49	22/76 (28.9%)	13/57 (22.8%)	26.3%
50–59	35/97 (36.1%)	45/91 (49.5%)	42.6%
60–69	38/66 (57.6%)	22/50 (44.0%)	51.7%
70–80	7/18 (38.9%)	14/18 (77.8%)	58.3%
Total	104/269 (38.7%)	95/231 (41.1%)	39.8%

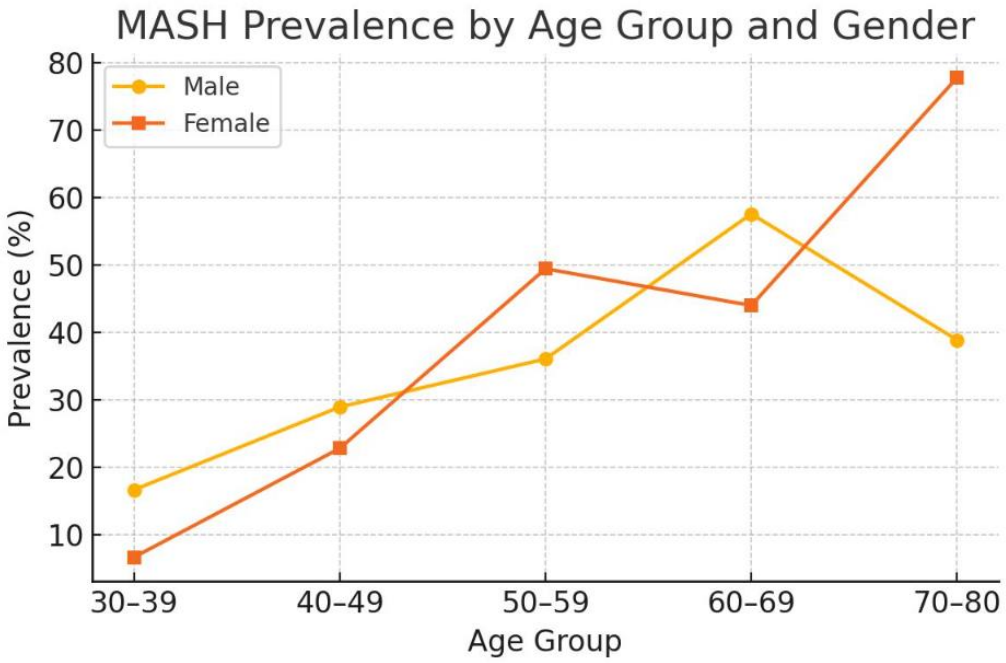

Figure 1. MASH Prevalence by Age Group and Gender

Socioeconomic and Marital Status

MASH prevalence varied across socioeconomic levels: 44.7% in low-income, 37.9% in middle-income, and 30.4% in high-income groups. Marital status showed no significant association, with prevalence of 40.2% among married patients and 38.8% among unmarried patients.

Table 3. Prevalence of MASH by socioeconomic and marital status

Variable	Total Patients	MASH Positive	Prevalence (%)
Low socioeconomic	217	97	44.7
Middle socioeconomic	214	81	37.9
High socioeconomic	69	21	30.4
Married	401	161	40.2
Single/Other	99	38	38.8

Quantitative Association with Age

The mean age of patients with MASH was significantly higher than those without MASH (58.3 ± 8.6 vs. 52.7 ± 10.1 years, $p < 0.01$), confirming the strong correlation between ageing and the risk of developing hepatic steatosis. This association is further illustrated in Figure 2, which highlights the progressive increase in MASH prevalence across age groups.

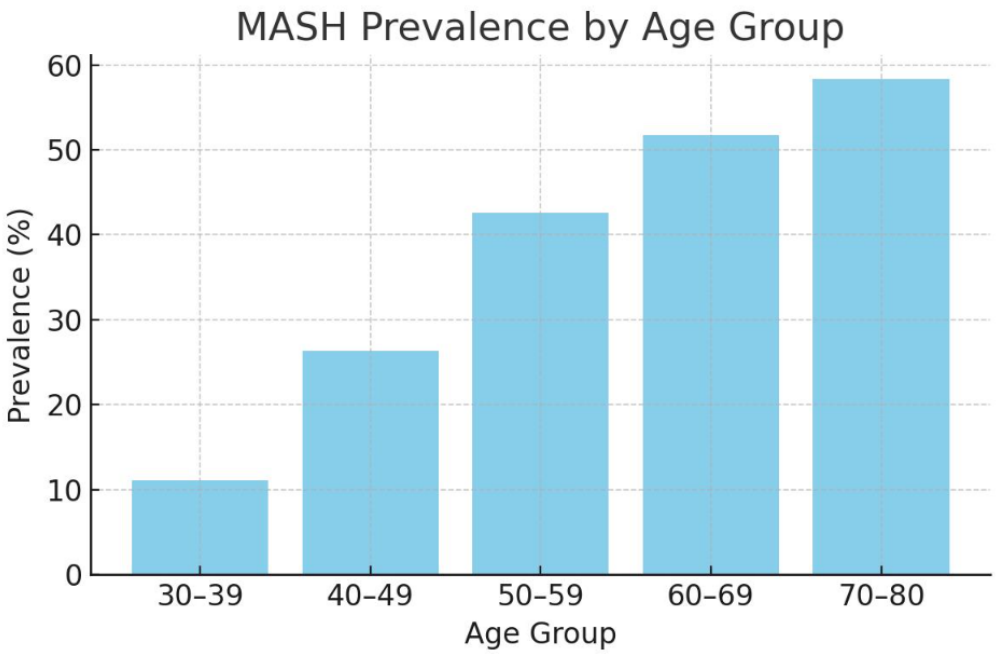

Figure 2: MASH Prevalence by Age Group

DISCUSSIONS

The current study highlighted the clinical significance of liver involvement in the diabetic population by showing that nearly two out of five patients with type 2 diabetes mellitus (T2DM) in primary care had metabolic dysfunction-associated steatotic hepatopathy (MASH), which was detected by ultrasound. Although the overall prevalence (39.8%) is in line with recent global estimates ranging from 30% to 45% (Biały et al., 2023; Gómez-Mendoza et al., 2025), it underscores the pressing need for systematic screening in settings with limited resources.

Gender and Age Patterns

According to our analysis, the prevalence of MASH increased gradually with age, reaching 58.3% among patients aged 70–80 years. This pattern is consistent with earlier studies that highlighted cumulative metabolic stress and deteriorating hepatic resilience with aging (O'Gorman et al., 2020; Desalegn et al., 2024). Interestingly, the percentage of female patients increased more sharply after the age of 50 years, reaching a peak of 77.8% in the oldest cohort (Figure 1). This observation may be a result of increased metabolic vulnerability and postmenopausal hormonal changes, which have also been observed in longitudinal cohorts (Roomaney et al., 2021).

Marital and Socioeconomic Status

The highest prevalence (44.7%) was observed in patients with low socioeconomic status, which may be related to barriers to using healthcare, sedentary lifestyles, and limited access to nutritious diets. Despite the lack of a significant correlation between marital status and MASH, minor variations may be related to lifestyle and psychosocial support, which calls for more qualitative research in this area.

Clinical Ramifications

Age was a significant risk factor, as evidenced by the significant difference in mean age between patients with and without MASH (58.3 vs. 52.7 years, $p < 0.01$) (Figure 2). Relying exclusively on biochemical tests may understate the disease burden because MASH is a silent condition, and certain symptoms do not appear until the disease is advanced. As shown here, ultrasound provides a useful and affordable tool for early detection in primary care, especially in areas where biopsy or advanced imaging is impractical.

Literature Comparison

Although similar prevalence rates have been reported in several international studies, this study is one of the few to measure the burden of MASH in patients with diabetes in Iraq. The results add to the body of literature by combining clinical, socioeconomic, and demographic correlates into a single all-inclusive framework. The need for standardized protocols is highlighted by the possibility that variations among studies are caused by variations in diagnostic criteria, sample size, and population characteristics (Elsabaawy et al., 2025; Moosa et al., 2024).

Limitations and Strengths

The large sample size (n = 500) and the study's foundation in actual primary care clinics, which improves generalizability, are two of its main strengths. Contextual depth was added by including socioeconomic and marital factors. Although useful, ultrasound cannot accurately differentiate between steatosis and more advanced stages of fibrosis, and the cross-sectional design restricts the ability to draw conclusions about causality. These findings should be confirmed and extended in subsequent longitudinal investigations employing elastography or histological confirmation.

In conclusion, this study confirms that patients with type 2 diabetes have a high burden of MASH and emphasizes the importance of age, sex, and socioeconomic background as significant determinants of MASH. The data clearly favor incorporating routine ultrasound screening into diabetes care to facilitate early detection and focused interventions, which will slow the development of advanced liver disease.

CONCLUSION

The high and age-dependent prevalence of metabolic dysfunction-associated steatotic hepatopathy (MASH) in patients with type 2 Diabetes Mellitus (T2DM) who visit primary care clinics is highlighted in this study. These findings support the necessity of routine hepatic screening in the management of diabetes, especially in older adults and postmenopausal women, as nearly 40% of the participants had ultrasound-detected hepatic steatosis, with a prevalence of over 50% in patients over 60 years of age.

Ultrasound imaging is an efficient first-line method for identifying hepatic steatosis using minimal resources. Although age-related hormonal changes in females seem to contribute to increased risk in later decades, the lack of significant sex differences in overall prevalence suggests that age, rather than sex, may be the more dominant risk factor.

Liver screening procedures could enhance early detection, enable prompt intervention, and possibly lower long-term hepatic and metabolic complications if incorporated into standard T2DM care pathways. To confirm these results and to aid in the creation of focused intervention plans, more multicentre and longitudinal studies are required.

Recommendation

According to the study's findings, diabetes treatment regimens should include routine ultrasound screening for metabolic dysfunction-associated steatotic hepatopathy (MASH), particularly in patients over 50 years of age and postmenopausal women. National guidelines should be revised to highlight the incorporation of liver screening into routine diabetic care, and primary care physicians should be trained on the significance of hepatic health in patients with diabetes. Additional multicenter and longitudinal studies are needed to confirm these results, gauge the course of MASH, and analyze the efficacy of focused intervention techniques.

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