



Review Article

Extrahepatic manifestations of metabolic dysfunction-associated steatotic liver disease: An updated clinical overview

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ABSTRACT

Metabolic dysfunction-associated steatotic liver disease (MASLD) is the most common liver disease worldwide and is closely linked to obesity, insulin resistance, type 2 diabetes, and dyslipidemia. It ranges from simple steatosis to steatohepatitis (metabolic dysfunction-associated steatohepatitis), which can progress to fibrosis, cirrhosis, or liver cancer. Beyond liver-related issues, MASLD is a systemic disease strongly associated with extrahepatic complications such as cardiovascular disease (CVD), chronic kidney disease (CKD), cancers, endocrine disorders, musculoskeletal problems, and sleep apnea. CVD and cancer are the leading causes of death in MASLD patients, with liver-related mortality ranking third. Fibrosis severity is the key predictor of overall and cause-specific mortality. MASLD significantly increases the risk and progression of type 2 diabetes, CVD, and CKD. It is also linked to increased risks of extrahepatic cancers, particularly colorectal, pancreatic, and breast cancers. Endocrine conditions such as hypothyroidism and polycystic ovary syndrome and musculoskeletal disorders, including sarcopenia and osteoporosis, frequently co-occur with MASLD. Obstructive sleep apnea independently contributes to the severity of liver disease and shares overlapping metabolic pathways. Surgical and transplant outcomes are worse in patients with MASLD due to impaired liver regeneration and increased postoperative risks. The recent approval of resmetirom offers a new therapeutic option, whereas lifestyle changes remain the cornerstone of management. Given the multisystemic impact of MASLD, a patient-centered approach is essential for effective treatment and improved long-term results. In this article, we provide an overview of key extrahepatic conditions commonly associated with MASLD and their clinical significance.

KEYWORDS: Cardiovascular diseases, Fibrosis, Liver diseases, Metabolic syndrome, Prognosis

INTRODUCTION

Metabolic dysfunction-associated steatotic liver disease (MASLD) is the most common liver disease worldwide. It includes simple steatosis and steatohepatitis, which can progress to fibrosis, cirrhosis, or hepatocellular carcinoma. MASLD often coexists with metabolic conditions such as type 2 diabetes, obesity, dyslipidemia, and insulin resistance and is related to extrahepatic complications such as cardiovascular disease (CVD), chronic kidney disease (CKD), malignancies, musculoskeletal problems, and sleep apnea [Table 1] [1,2].

MASLD arises from excessive energy intake exceeding metabolic capacity, leading to fat accumulation, increased hepatic lipogenesis, and elevated free fatty acids [Figure 1]. These changes trigger insulin resistance and systemic

inflammation [3]. Adipose tissue promotes disease progression through adipokines and pro-inflammatory cytokines such as tumor necrosis factor- α and interleukin-6. Fat cell lipid intermediates damage liver cells, causing stress, apoptosis, and fibrosis. Kupffer cells worsen the injury by releasing signals after engulfing dead hepatocytes [4].

The gut microbiota also plays a key role. Intestinal barrier dysfunction allows bacterial products to reach the liver, promoting inflammation. Altered bile acid signaling

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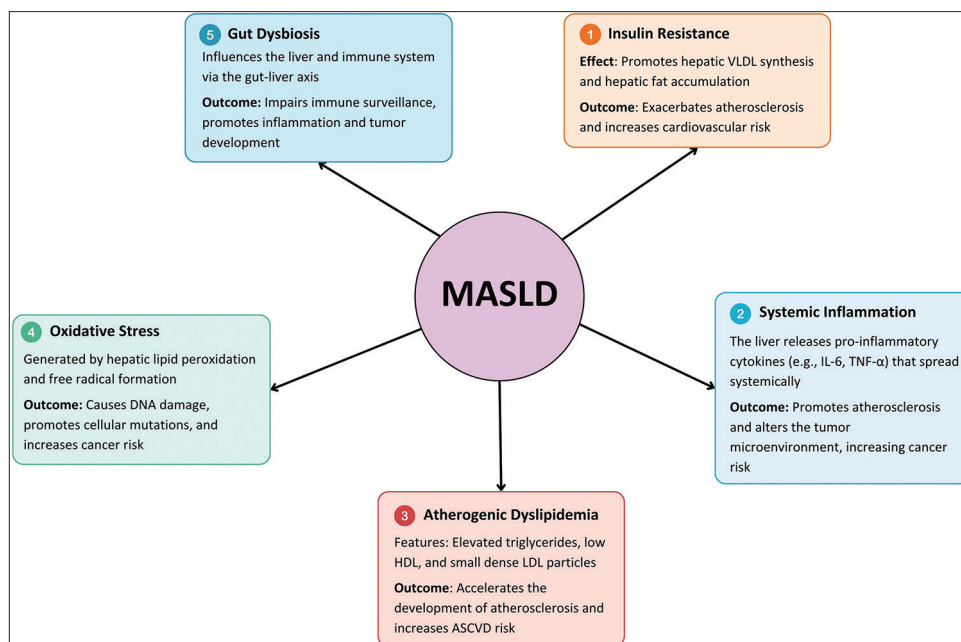


Figure 1: Mechanisms and links between metabolic dysfunction-associated steatotic liver disease and the extrahepatic manifestations. MASLD: Metabolic dysfunction-associated steatotic liver disease; ASCVD: Atherosclerotic cardiovascular disease

and oxidative stress also contribute to liver injury and fibrosis [5]. The gut–liver axis and oxidative stress are central to the progression of MASLD. The disrupted gut microbiota, increased gut permeability, and ROS imbalance form a complex pathogenic network that can be targeted for therapy [6].

In summary, MASLD is a systemic disease driven by metabolic, inflammatory, and microbial factors that require a holistic approach to diagnosis and treatment.

EXTRAHEPATIC DISEASES AND CLINICAL OUTCOMES IN METABOLIC DYSFUNCTION-ASSOCIATED STEATOTIC LIVER DISEASE

Previously, it was widely believed that liver-related complications were the primary cause of mortality in patients with MASLD. However, clinical evidence has revealed that liver-related causes rank third among the leading causes of death in this population of patients. CVDs and malignancies have become the first and second most common causes of mortality in patients with MASLD, respectively.

A landmark epidemiological cohort study conducted by the Mayo Clinic in Minnesota from 1980 to 2000 followed 420 community-diagnosed patients with MASLD. Researchers found that people with MASLD exhibited significantly higher overall mortality compared to the general population. Furthermore, the risk of death was independently associated with age, fasting glucose levels, and the presence of liver cirrhosis. Importantly, the study confirmed that liver-related deaths were the third leading cause of mortality in patients with MASLD, rather than the primary cause [7].

Similarly, a large-scale international study with medical centers in the United States, Europe, and Thailand

retrospectively analyzed the data from 619 patients with biopsy-confirmed MASLD collected between 1975 and 2005. The study found that CVD and nonliver malignancies were the leading causes of death, while liver-related complications were the third most common cause [8].

One of the key findings of this investigation was the critical role of liver fibrosis severity in the prediction of the long-term clinical outcomes. Patients with more severe fibrosis faced greater risks of liver-related complications, liver transplantation (LT), and death, as well as increased all-cause mortality, including liver- and nonliver-related causes. These results highlight liver fibrosis not only as a determinant of liver-related mortality but also as a significant predictor of death from diseases in MASLD patients [8].

Collectively, increasing clinical evidence has shown that MASLD is closely associated with a wide spectrum of extrahepatic diseases [Table 1], which not only co-exist but also mutually influence the clinical progression and mortality risks of each other.

In the following paragraphs, we will provide an overview of common and clinically significant extrahepatic diseases for which abundant clinical evidence supports a close association with MASLD.

EXTRAHEPATIC DISEASES ASSOCIATED WITH METABOLIC DYSFUNCTION-ASSOCIATED STEATOTIC LIVER DISEASE

Metabolic disorders and metabolic dysfunction-associated steatotic liver disease

Because cardiometabolic risk factors, including body mass index (BMI), blood pressure, blood sugar, triglyceride, and HDL, are the criteria for defining a patient with MASLD [1],

Table 1: Systemic diseases associated with metabolic dysfunction-associated steatotic liver disease

Obesity
Type 2 diabetes mellitus
Dyslipidemia
Metabolic syndrome
CVD
CKD
Malignancies (e.g., colorectal, pancreatic, and breast)
PCOS
Hypothyroidism
OSA
Osteoporosis
Hypopituitarism
Hypogonadism
Sarcopenia
Psoriasis

History of pancreaticoduodenectomy

CKD: Chronic kidney disease, CVD: Cardiovascular disease, OSA: Obstructive sleep apnea, PCOS: Polycystic ovary syndrome

MASLD is no doubt closely related to metabolic disorder. Among the vast literature, diabetes mellitus is perhaps the most illustrative example. A meta-analysis, which included more than 80 clinical studies and data from 49,419 people with diabetes, estimated the global prevalence of MASLD in diabetic patients to be approximately 55.5%.

Beyond prevalence, other studies have examined the bidirectional relationship between MASLD and diabetes. Another meta-analysis, incorporating data from 19 studies and nearly 300,000 participants (around one-third diagnosed with MASLD) with a median follow-up of 5 years [9], found that patients with MASLD had a 2.2-fold higher risk of developing diabetes compared to those without MASLD. Furthermore, the risk was closely related to the severity of liver steatosis and fibrosis. For patients with advanced fibrosis, the risk of developing diabetes was approximately 4.74 times higher compared to those with minimal fibrosis [10].

A Japanese research team from Ogaki conducted a long-term cohort study of 1562 adult patients with early-stage liver fibrosis (FIB-4 index <1.3) and MASLD. During a 10-year follow-up, 186 patients progressed to advanced liver fibrosis (FIB-4 index >2.67). Diabetes was identified as an independent factor associated with the progression of fibrosis [11]. These findings underscore the close and mutually influential relationship between MASLD and diabetes, highlighting the need for clinicians to monitor and manage both conditions simultaneously to mitigate their combined impact on patient health.

Metabolic dysfunction-associated steatotic liver disease and cardiovascular disease

The clinical relationship between MASLD and CVD is particularly well documented. A meta-analysis in 2016, which pooled data from 16 studies involving 34,043 adults (36.3% of whom had MASLD), showed a clear link between MASLD and an elevated risk of cardiovascular events [12]. During an average follow-up of 6.9 years, nearly 2600 cardiovascular

events were recorded. The study concluded that MASLD not only increased the risk of fatal cardiovascular events but also nonfatal events.

Furthermore, the study found that the risk of cardiovascular complications increased in parallel with the severity of liver steatosis. Patients with more severe MASLD had a 2.58-fold higher risk (Odds ratio [OR]: 2.58) of fatal and nonfatal cardiovascular events compared to those without steatosis.

A recent study from Korea, including 5,666,728 participants and 10.6 years of follow-up, further identified the increased adjusted hazard ratio (HR) for myocardial infarction (1.23; 95% confidence interval [CI], 1.18–1.27), ischemic stroke (1.12; 95% CI, 1.07–1.17), and congestive heart failure (1.18; 95% CI, 1.15–1.21) in individuals with MASLD compared to those without steatosis [13].

In another study from Italy, the researchers compared the cardiovascular risk of 85 patients with biopsy-confirmed MASLD with 160 matched controls. They measured carotid intima-media thickness (cIMT) as an early marker of atherosclerosis and a predictor of future cardiovascular risk [14]. The results revealed that patients with MASLD had significantly thicker cIMT than those without fatty liver. Moreover, the severity of liver histological features – including steatosis, lobular inflammation, and fibrosis – showed a positive correlation with cIMT, suggesting that MASLD plays a role in the development and progression of atherosclerotic CVD from its earliest stages through to more severe clinical events.

Metabolic dysfunction-associated steatotic liver disease and chronic kidney disease

MASLD is also closely associated with CKD. A 2014 meta-analysis which combined data from 33 studies and more than 63,000 individuals confirmed that patients with MASLD had significantly higher prevalence and incidence rates of CKD compared to non-MASLD populations. This association was consistent regardless of the diagnostic method used to identify MASLD, whether histology, imaging, or elevated liver enzyme levels [15].

Furthermore, the severity of MASLD was shown to correlate directly with the risk of CKD: The more advanced the liver disease, the higher the likelihood of renal impairment. A recent study used the database of the Third National Health and Nutrition Examination Survey (NHANES) (1988–1994) further confirming that the severity of MASLD (i.e. NAFLD fibrosis score [NFS] ≥ 0.676) was associated with 1.34-fold higher risk of prevalent CKD ($P < 0.05$) [16].

Notably, a cohort study from Korea followed 1525 CKD patients for 10 years and demonstrated that MASLD not only increased the risk of CKD progression but was also associated with the changes in estimated glomerular filtration rate (eGFR) over time [17]. Specifically, patients with MASLD experienced a more rapid decrease in eGFR compared to individuals without MASLD. In addition, when liver fibrosis was evaluated using the NFS, patients with more advanced fibrosis (NFS ≥ -1.455) also exhibited an accelerated decline in renal function.

Metabolic dysfunction-associated steatotic liver disease and extrahepatic malignancies

In addition to liver cancer, MASLD has been associated with an elevated risk of extrahepatic cancers. A large-scale analysis using the data from the US Census Bureau and the National Center for Health Statistics mortality records, which tracked nearly 27 million American adults between 2000 and 2017, revealed that cancer-related mortality from extrahepatic malignancies, including solid tumors and hematologic cancers, has steadily increased among patients with MASLD. The age-standardized mortality rate for extrahepatic cancers increased from 0.013 in 2007 to 0.059, with an average annual percentage increase of 15.1%. The most common cancers observed in this cohort were lung, pancreatic, breast, colorectal, and lymphoma [18].

In addition, a population-based study from the Mayo Clinic analyzed the medical records from Olmsted County, Minnesota, over a 20-year period. The cohort included 4722 patients diagnosed with MASLD using an algorithm-based approach and 14,441 matched controls [19]. During the follow-up, 2224 participants were newly diagnosed with cancer. The presence of MASLD was associated with a significantly higher cancer risk – patients with MASLD had a 1.9-fold higher incidence of newly diagnosed cancers compared to non-MASLD individuals. Specifically, the study reported an increase in the risk of liver cancer (2.8 times), endometrial cancer (2.3 times), gastric cancer (2.3 times), pancreatic cancer (2.0 times), and colorectal cancer (1.8-fold). In particular, the analysis suggested that MASLD is a stronger predictor of cancer risk than obesity alone (incidence rate ratio, IRR: 2.0 for MASLD versus 1.0 for obesity).

In 2024, a large meta-analysis that included 18 cohort studies (approximately 16.7 million participants) showed that patients with MASLD have a higher risk of gastric (HR = 1.47, 95% CI 1.07–2.01), colorectal (HR = 1.33, 95% CI: 1.16–1.53), pancreatic (HR = 1.41, 95% CI: 1.11–1.79), biliary tract (HR = 1.27, 95% CI: 1.18–1.37), thyroid (HR = 1.46, 95% CI: 1.02–2.09), urinary system (HR = 1.45, 95% CI: 1.25–1.69), breast (HR = 1.17, 95% CI: 1.08–1.26), and female genital organ cancers (HR = 1.36, 95% CI: 1.11–1.66), but not with head and neck, esophageal, lung, prostate or small intestine cancer [20].

Polycystic ovary syndrome and metabolic dysfunction-associated steatotic liver disease

Polycystic ovary syndrome (PCOS) is another endocrine disorder strongly linked to MASLD, especially in women of reproductive age. A 2018 meta-analysis, which included 17 studies with data from 2715 patients with PCOS and 1265 healthy controls, identified PCOS as an independent risk factor for MASLD. The pooled OR was 2.25 (95% CI: 1.95–2.60) – highlighting the considerable overlap between these two conditions, believed to be the result of shared mechanisms including hyperandrogenism and insulin resistance [21].

A separate retrospective study from the University of California, published in 2020, reviewed the clinical records of 102 women of reproductive age with biopsy-confirmed MASLD, 37 of whom had PCOS. Analysis revealed that PCOS was not only independently associated

with MASLD but was also a significant predictor of the presence of steatohepatitis (metabolic dysfunction-associated steatohepatitis [MASH]) [22]. Moreover, PCOS was correlated with the severity of histological features – patients with both PCOS and MASLD exhibited more severe hepatocyte ballooning, and a higher risk of advanced liver fibrosis compared to MASLD patients without PCOS.

Hypothyroidism and metabolic dysfunction-associated steatotic liver disease

Hypothyroidism has been repeatedly shown to be associated with MASLD. A study by Seoul National University Hospital in 2012 analyzed the clinical data from 4648 adults who underwent routine health examinations and found a significant correlation between hypothyroidism, elevated liver enzymes (alanine aminotransferase [ALT]), and ultrasound-diagnosed MASLD. The OR for MASLD in patients with hypothyroidism was 1.38 (95% CI 1.17–1.62), and the risk increased progressively with the severity of thyroid dysfunction [23].

Furthermore, an observation survey that examined the relationship between thyroid-stimulating hormone (TSH) levels and MASLD histological characteristics in youth found that mean levels of TSH, total thyroxine (T4), total triiodothyronine, and free T4 were higher ($P < 0.001$) in MASH patients with MASH ($n = 218$) than in individuals ($n = 2198$). Notably, there was an association between TSH and the severity of steatosis in individuals with normal thyroid hormone concentrations, indicating an independent role for TSH in MASLD [24].

A subsequent study analyzed the clinical and histological data from 425 patients with biopsy-confirmed MASLD. The researchers reported that hypothyroidism was not only more prevalent among patients with MASLD but also correlated with more severe histological features, including steatosis, ballooning, fibrosis, and advanced liver fibrosis. Compared to MASLD patients with normal thyroid function, those with hypothyroidism exhibited more advanced stages of liver injury [25].

Finally, a recent study in China that included the analysis of 30,091 people who attended a Health Management Center between 2019 and 2021 and used vibration-controlled transient elastography to assess liver fibrosis found that liver fibrotic burden is highly prevalent in subjects with overt hypothyroidism, and the fibrotic burden increased throughout the spectrum of hypothyroidism (from 50.3% in men with strict normal thyroid function to 62.9% in men with overt hypothyroidism, and 16.5% to 33.4% in women) [26].

Obstructive sleep apnea and metabolic dysfunction-associated steatotic liver disease

Obstructive sleep apnea (OSA) is another extrahepatic condition that shares a close bidirectional relationship with MASLD. Although traditionally thought to be driven by shared risk factors such as obesity and insulin resistance, several studies have suggested that OSA may independently influence the progression of MASLD.

A French study analyzed 163 patients with polysomnography-confirmed OSA and reported that severe OSA was associated with higher levels of insulin resistance, elevated liver enzymes, increased liver necroinflammation, and

more advanced fibrosis, even after adjustment for BMI [27]. The fact that these associations were observed in patients with similar body weights suggested that OSA is an independent risk factor for the progression of MASLD.

A 2018 meta-analysis, which combined nine clinical studies and nearly 2300 patients with histologically confirmed liver diagnoses, reinforced these findings. OSA was associated with more severe liver steatosis, elevated ALT, advanced fibrosis, hepatocellular ballooning, and inflammation, confirming that OSA is an independent predictor of liver damage in patients with MASLD [28].

Finally, a recent study that examined data from the 2015 to 2018 NHANES found that participants with OSA had a higher prevalence of sarcopenia (12% vs. 5.5%, $P < 0.01$) and sarcopenic obesity (10.3% vs. 4.0%, $P < 0.01$) than those without OSA, and both conditions share metabolic pathways with MASLD. Further mediation analyses identified that OSA may induce muscle loss through unhealthy diet habits, increased BMI, and insulin resistance, all closely related to MASLD [29].

Neurological disorders and metabolic dysfunction-associated steatotic liver disease

MASLD has also been associated with various neurologic disorders, including cognitive impairment, white matter hyperintensities (WMH), dementia, and increased risk of stroke in CKD. A cross-sectional analysis of 5662 adults from the NHANES III database revealed that those with MASLD performed worse on cognitive tests, especially to measure reaction time and learning. The risk of cognitive impairment was significantly higher in those with moderate-to-severe liver steatosis and metabolic dysfunction [30].

A longitudinal cohort study of 2155 people over 4.1 years showed that MASLD was associated with a high risk of WMH, a marker of small vessel disease. The presence of liver steatosis was independently associated with WMH, regardless of other metabolic abnormalities. In addition, greater liver fat accumulation correlated with declines in executive function, particularly among nonobese individuals [31].

Another prospective study from the UK Biobank, which included 403,506 participants (38.4% diagnosed with MAFLD and 27.7% with MASLD), demonstrated that both MAFLD and MASLD may increase the risk of vascular dementia. Notably, the associations with Alzheimer's disease were only present in those without MASLD [32].

Furthermore, a study that examined the relationship between MASLD and stroke risk in people with CKD revealed that MASLD significantly increased stroke risk in patients with CKD (HR, 1.34 [95% CI, 1.23–1.45]). However, this association was not observed in individuals without CKD, indicating a synergistic effect between MAFLD and CKD on stroke risk [33].

Osteoporosis and metabolic dysfunction-associated steatotic liver disease

MASLD has also been associated with poor bone mineral density and increased risk of osteoporosis. A study from

Turkey using dual energy X-ray absorptiometry to evaluate 82 obese adolescents and 30 healthy controls found that those with MASLD had lower bone mineral density and higher insulin resistance compared to their counterparts [34].

Similarly, a large community study from Shanghai involving 7797 adults 40 and older found that men with MASLD had a significantly higher risk of osteoporosis-related fractures compared to those without MASLD. The OR for fracture risk in MASLD males was 2.53 (95% CI: 1.26–5.07) [35].

Furthermore, a study from Japan examined the data of 1410 patients with MASLD and identified several potential risk factors for decreased BMD. Patients with a lower BMI or a smaller waist circumference (OR: 0.48, 95% CI: 0.34–0.67), hypertriglyceridemia (OR: 1.29, 95% CI: 1.00–1.65) or weak grip strength (OR: 0.98, 95% CI: 0.97–1.00) had a higher risk of decreased BMD in patients with MAFLD [36].

Sarcopenia and metabolic dysfunction-associated steatotic liver disease

Sarcopenia, defined as the progressive loss of skeletal muscle mass and strength, shares overlapping pathophysiological pathways with MASLD, including insulin resistance, chronic inflammation, and hormonal imbalances. Therefore, it is not surprising that these two conditions frequently coexist.

A Korean study of 309 biopsy-confirmed MASLD patients found that those with sarcopenia had a 3.8-fold higher risk of MASLD. The prevalence also rose with increasing liver fibrosis and ballooning [37].

A meta-analysis of 25 studies showed that sarcopenia was more common in MASLD than in controls (OR 1.25; 95% CI, 1.08–1.44) and was associated with a greater risk of fibrosis (OR 1.49; 95% CI, 1.03–2.14) [38]. Another meta-analysis of 29 studies (63,330 patients) reported a prevalence of 23.5% sarcopenia in MASLD, especially in Asian males. Sarcopenia was associated with a higher risk of MASLD (adjusted OR [aOR] 2.08) and increased all-cause mortality (HR 1.59), cancer-specific mortality (HR 1.65), and diabetes-specific mortality (HR 4.94) [39].

Finally, a Korean study examined the association of the quantity and quality of skeletal muscle and steatotic liver diseases (SLD) in 18 154 participants found that sarcopenia and myosteatorsis were significantly in those with MASLD than in those without SLD (aOR, 2.62 for sarcopenia and 1.75 for myosteatorsis) [40].

Psoriasis and metabolic dysfunction-associated steatotic liver disease

Psoriasis, a chronic inflammatory skin disease, is also closely related to MASLD. An Italian study comparing 130 patients with plaque-type psoriasis with 260 age, sex, and BMI-matched healthy controls reported a significantly higher prevalence of MASLD among psoriasis patients, diagnosed by ultrasound. In addition, psoriasis severity, as assessed by the Psoriasis Area and Severity Index (PASI), was positively correlated with the prevalence – patients with severe psoriasis (PASI ≥ 10) had a notably higher risk compared to those with milder skin disease [41].

A 2019 meta-analysis that included nine studies and more than 3 million participants confirmed these findings, reporting an OR of 1.95 (95% CI: 1.49–2.55) for MASLD in patients with psoriasis. Those with more severe psoriasis had an even higher risk (OR: 3.58) of developing MASLD. BMI, obesity, PASI score, and elevated ALT levels were identified as significant risk factors for MASLD in this group [42].

Finally, a recent study in China that compared 158 patients with plaque psoriasis and 158 controls undergoing routine physical examinations found that MASLD was 43.67% (69/158) in the plaque psoriasis group and 22.15% (35/158) in controls. Furthermore, plaque psoriasis was an independent risk factor for MASLD with an OR of 1.88 (95% CI: 1.10–3.21) [43].

Surgical and transplant outcomes in metabolic dysfunction-associated steatotic liver disease

Compared to healthy livers, steatotic livers demonstrate reduced regenerative capacity and increased susceptibility to ischemia-reperfusion injury. As a result, patients with MASLD face a higher risk of liver insufficiency and postoperative complications after liver resection.

A Mayo Clinic study of 135 liver resections found that more severe MASLD was associated with higher bilirubin, longer surgeries, greater blood loss, and worse postoperative outcomes [44].

A 2019 review confirmed that steatotic grafts are more prone to reperfusion injury, leading to higher rates of graft dysfunction and complications after LT [45].

A meta-analysis in 2023 of 119,327 LT recipients reported a prevalence of MASH. Although overall survival was similar between MASH and non-MASH recipients, those with high MELD scores and MASH had significantly worse survival [46].

A European study comparing MASLD and hepatitis C virus LT recipients found that MASLD patients had more metabolic and cardiovascular comorbidities before and after LT. They

also had higher rates of recurrent MASLD and cardiovascular events 5 years after transplantation [47].

In a multicenter study of 898 patients with intrahepatic cholangiocarcinoma undergoing partial hepatectomy, those with MASLD had worse 5-year survival (24.0% vs. 48.9%) and higher recurrence rates. MASLD was an independent predictor of poor survival and early relapse (HRs ~2.2, all $P < 0.001$) [48].

CONCLUSION

In March 2024, Resmetirom, a selective thyroid hormone receptor- β agonist, became the first FDA-approved treatment for patients with MASH and fibrosis stages F2/F3 [49]. Meanwhile, several promising agents are under active investigation, such as glucagon-like receptor agonists (e.g., semaglutide) [50] and analogs of fibroblast growth factor 21 (e.g., efruxifermin) [51,52]. Despite these advances, lifestyle modification, including weight management, diet, and exercise, remains the cornerstone of MASLD therapy.

As discussed, extrahepatic diseases have a major impact on the long-term outcomes in MASLD. Thus, beyond managing metabolic and liver factors, a comprehensive approach is essential to address cardiovascular, renal, oncologic, endocrine, and musculoskeletal comorbidities. A multidisciplinary, personalized care strategy that integrates hepatology and systemic disease management is the key to optimizing the results for MASLD patients [Figure 2].

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Data availability statement

The funders had no role in study design, data collection, data analysis, data interpretation, decision to publish, or manuscript preparation. The authors had full access to all the data in the study and had authority over the decision to publish.

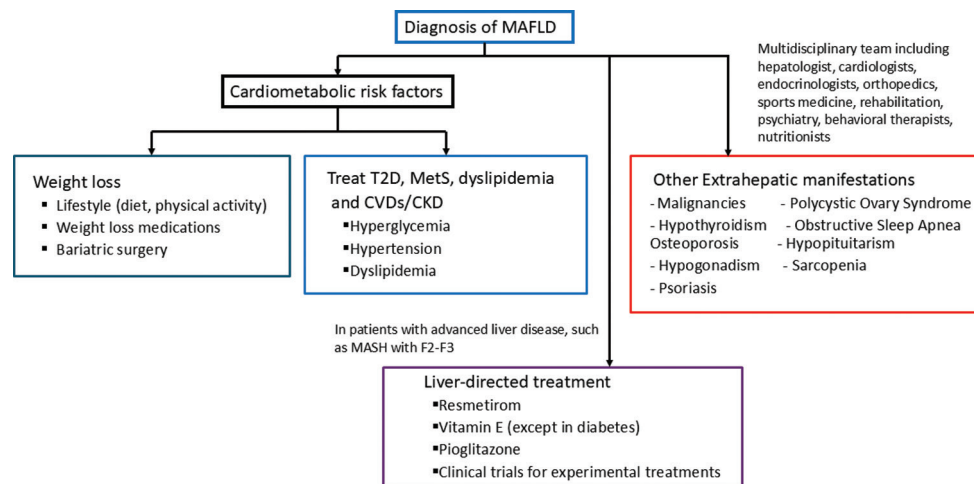


Figure 2: The management algorithm for extrahepatic manifestations of metabolic dysfunction-associated steatotic liver disease. CV: Cardiovascular; CVD: Cardiovascular disease; MASLD: Metabolic dysfunction-associated steatotic liver disease; T2D: Type 2 diabetes

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Conflicts of interest

There are no conflicts of interest.

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