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PHYSICAL ACTIVITY AS A LIFESTYLE INTERVENTION IN METABOLIC DYSFUNCTION-ASSOCIATED STEATOTIC LIVER DISEASE (MASLD): A NARRATIVE REVIEW OF HEPATIC AND CARDIOMETABOLIC OUTCOMES

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ABSTRACT

This narrative review synthesizes current evidence on physical activity and structured exercise in adults with metabolic dysfunction-associated steatotic liver disease (MASLD), with particular emphasis on aerobic exercise, resistance training, and high-intensity interval training (HIIT). The manuscript was prepared as a structured review of guideline documents, systematic reviews, meta-analyses, randomized controlled trials, and selected observational studies identified primarily through PubMed-based searching and full-text source analysis. Because the overlap between historical non-alcoholic fatty liver disease (NAFLD) and current MASLD populations is nearly complete, earlier NAFLD exercise studies were treated as directly relevant to present-day MASLD. The reviewed literature shows that exercise consistently reduces liver fat, improves cardiorespiratory fitness, enhances insulin sensitivity, and favorably modifies body composition and selected cardiovascular risk markers, often without clinically significant weight loss. Aerobic exercise remains the best-studied modality, but resistance training also appears effective and may be especially valuable in patients with low fitness or concern about muscle loss. HIIT seems feasible and potentially beneficial in selected patients when appropriately supervised. Evidence for direct histological or fibrosis-specific benefit is promising but less robust than the evidence for steatosis and cardiometabolic outcomes. Overall, the findings support physical activity as a central lifestyle intervention in MASLD and highlight the importance of individualized prescription, adherence support, and technology-assisted delivery in future practice.

KEYWORDS

Metabolic Dysfunction-Associated Steatotic Liver Disease, Physical Activity, Exercise Therapy, Lifestyle Intervention, Hepatic Steatosis, Insulin Resistance

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1. Introduction

Metabolic dysfunction-associated steatotic liver disease (MASLD) is the contemporary term used for steatotic liver disease occurring in the setting of metabolic dysfunction and the presence of at least one cardiometabolic risk factor. The transition from NAFLD/NASH to MASLD/MASH was intended to better align the nomenclature with disease biology and to replace terminology that many groups considered exclusion-based and stigmatizing (Rinella et al., 2023).

MASLD now represents one of the most prevalent chronic liver disorders worldwide and is closely intertwined with obesity, insulin resistance, type 2 diabetes, dyslipidemia, central adiposity, and impaired fitness. It should not be viewed only as a hepatic condition, because affected individuals also carry substantial cardiovascular and metabolic risk, making its clinical burden broader than progressive liver injury alone (Duell et al., 2022; Younossi et al., 2024).

Lifestyle modification remains the cornerstone of treatment, especially in non-cirrhotic disease. Contemporary guidelines consistently place nutritional optimization, body-weight management, and regular physical activity at the center of care. Yet the role of exercise extends beyond supporting a calorie deficit. In recent years, the evidence base has shifted toward the view that physical activity exerts direct metabolic and hepatic effects that are not fully mediated by total body-weight loss (Babu et al., 2021; Stine, DiJoseph, et al., 2023; Stine, Long, et al., 2023). This distinction is clinically important because many patients do not achieve or sustain the classic 7–10% body-weight reduction commonly associated with histological improvement.

From a broader health-and-well-being perspective, the topic is also shaped by social and organizational factors. Physical inactivity, sedentary behavior, limited health literacy, poor access to structured counselling, and weak adherence support all influence MASLD outcomes. In addition, telehealth coaching, remote supervision, wearable activity tracking, and digital self-monitoring may help translate exercise recommendations into sustainable real-world behavior change (Stine, Soriano, et al., 2021; Stine, Long, et al., 2023).

The present paper therefore focuses on physical activity as a lifestyle intervention in MASLD. The purpose was not only to summarize hepatic outcomes such as steatosis and fibrosis-related changes, but also to integrate cardiometabolic, behavioral, and implementation-oriented evidence that may be useful when adapting exercise recommendations to routine care.

2. Methodology

This manuscript was prepared as a structured narrative review. The working literature set was based on guideline documents, systematic reviews, meta-analyses, randomized controlled trials, and selected observational studies addressing physical activity, exercise training, or lifestyle intervention in adults with MASLD or the earlier NAFLD/NASH nomenclature. PubMed-based searching formed the main backbone of study identification, and backward reference screening from review papers, position statements, and clinical guidance documents was used to identify additional key trials.

The review focused on publications that addressed one or more of the following domains: (a) disease definitions and guideline-based management; (b) aerobic, resistance, combined, or interval exercise interventions; (c) hepatic outcomes such as liver fat, aminotransferases, controlled attenuation parameter, liver stiffness, or histology; (d) cardiometabolic outcomes including insulin resistance, glucose metabolism, cardiovascular biomarkers, body composition, or quality of life; and (e) practical exercise prescription, adherence, barriers, and technology-supported implementation.

Priority was given to recent consensus and guideline papers, especially those by Rinella et al. (2023), the 2024 EASL–EASD–EASO MASLD guideline, the 2023 AASLD practice guidance, and the ACSM international multidisciplinary roundtable report on physical activity and fatty liver disease. These sources were supplemented by key interventional studies, including Hallsworth et al. (2011), Bacchi et al. (2013), Keating et al. (2015), Zhang et al. (2016), Houghton et al. (2017), O'Gorman et al. (2020), Charatcharoenwitthaya et al. (2021), Stine et al. (2022), and Keating et al. (2023), together with systematic reviews and meta-analyses focused on exercise and lifestyle management (Baker et al., 2021; Babu et al., 2021; Chai et al., 2023; Medeiros et al., 2025; Stine, DiJoseph, et al., 2023).

Because current guideline documents explicitly state that evidence generated under the NAFLD framework can generally be extrapolated to MASLD, earlier NAFLD exercise studies were retained in the narrative synthesis. Pediatric-only studies, purely basic-science animal papers without immediate clinical relevance, and studies not related to lifestyle or exercise management were not incorporated into the core analysis. The final synthesis was organized around exercise modality, the strength of evidence for particular outcomes, and implications for clinical and public-health implementation.

3. Results

The literature synthesis showed that physical activity in MASLD can be organized around several major themes: the transferability of NAFLD evidence to MASLD, the physiologic rationale for exercise, modality-specific intervention effects, weight-loss-independent benefit, fibrosis-related uncertainty, extrahepatic cardiometabolic gains, and implementation issues such as barriers, adherence, and technology-assisted support.

3.1. Current definitions and relevance of earlier NAFLD exercise literature

A recurring question in recent reviews is whether studies performed under the older NAFLD/NASH terminology remain informative after the shift to MASLD/MASH. Current consensus documents indicate that they do. The nomenclature change reclassified the disease more explicitly around metabolic dysfunction, but it did not invalidate the intervention trials that shaped the evidence base (Rinella, Lazarus, et al., 2023).

The 2024 EASL–EASD–EASO guideline emphasizes that historical NAFLD populations and current MASLD populations overlap to a very large extent, with broadly similar clinical profiles and comparable performance of non-invasive assessment tools. In practical terms, this means that the earlier exercise literature remains central to contemporary MASLD synthesis rather than being treated as obsolete (European Association for the Study of the Liver [EASL], European Association for the Study of Diabetes [EASD], & European Association for the Study of Obesity [EASO], 2024).

Accordingly, many of the landmark trials that still anchor clinical recommendations were conducted in participants labelled as having NAFLD or NASH. This continuity is a strength of the field: it allows present-day MASLD reviews to build on a mature interventional literature instead of starting from scratch after a nomenclature change.

3.2. Why physical activity matters in MASLD: mechanistic and clinical rationale

Physical activity is relevant in MASLD because it influences several processes that lie at the core of disease pathogenesis. Proposed benefits include greater insulin sensitivity, more efficient skeletal-muscle glucose disposal, lower hepatic de novo lipogenesis, enhanced fatty-acid oxidation, reduced visceral fat burden, and more favorable myokine and adipokine signaling. These effects make exercise biologically meaningful even when changes in total body mass are modest (Heinle et al., 2023; Marjot et al., 2025).

The muscle–liver relationship is especially important. Reduced strength, low cardiorespiratory fitness, and sarcopenia appear to worsen both fatty liver severity and cardiometabolic vulnerability. For that reason, resistance exercise is not simply an adjunct to aerobic training; in some patients it may address a clinically important component of the MASLD phenotype that would otherwise remain undertreated (Marjot et al., 2025; Medeiros et al., 2025).

From a public-health perspective, these mechanisms matter because they reshape how exercise can be explained to patients. Rather than being framed only as a way to spend calories, physical activity can be presented as a targeted intervention that improves metabolic regulation, vascular health, and liver-related risk in parallel.

3.3. Aerobic exercise and hepatic steatosis

Aerobic exercise is the most extensively studied modality in MASLD/NAFLD. Across randomized trials and secondary syntheses, it consistently reduces hepatic steatosis, improves insulin sensitivity, reduces visceral adiposity, and increases cardiorespiratory fitness. This consistency makes aerobic exercise the best-supported starting point for many patients (Baker et al., 2021; Fernández et al., 2022; Smart et al., 2018; Stine et al., 2023).

One of the most informative studies is the dose-response trial by Keating et al. (2015), which compared different aerobic prescriptions that varied in intensity, duration, and frequency. All active intervention arms reduced liver fat and visceral adiposity, without clear evidence that the highest intensity program was universally superior. This finding aligns with later work by Zhang et al. (2016), who showed comparable benefits of moderate- and vigorous-intensity exercise on NAFLD in a randomized clinical trial.

These findings have practical value. They suggest that the total weekly dose of aerobic activity may be more important than insisting on vigorous intensity in every patient. Review-level evidence summarized in current MASLD lifestyle guidance indicates that approximately 150–240 minutes per week of at least moderate-intensity aerobic exercise is usually sufficient to achieve clinically meaningful reductions in liver fat (EASL et al., 2024; Heinle et al., 2023).

Other clinical trials broaden the picture. Cheng et al. (2017) demonstrated benefit from aerobic exercise combined with diet in pre-diabetic NAFLD, while Houghton et al. (2017) reported reductions in liver lipids and visceral adiposity in biopsy-proven NASH. Oh et al. (2017) additionally found that high-intensity aerobic exercise improved both hepatic fat content and stiffness in sedentary obese men with NAFLD. Together, these studies support the view that aerobic exercise is an effective hepatic and cardiometabolic intervention across multiple risk profiles.

The 2023 meta-analysis by Stine, DiJoseph, et al. provides especially strong support for this conclusion. Across 14 randomized studies including 551 adults, exercise training markedly increased the likelihood of achieving a clinically meaningful MRI-based liver-fat response. Although the pooled analysis included different exercise modalities, the review emphasized that aerobic training remains the most extensively represented and most consistently beneficial modality (Stine, DiJoseph, et al., 2023).

3.4. Resistance training and the muscle–liver axis

The evidence base for isolated resistance training is smaller than that for aerobic exercise, but it has become increasingly important. The classic study by Hallsworth et al. (2011) demonstrated that 8 weeks of resistance exercise in sedentary adults with NAFLD reduced liver fat by approximately 13% and improved HOMA-IR and glucose handling without significant changes in body weight. This remains one of the clearest demonstrations of a weight-loss-independent benefit of exercise on hepatic outcomes.

Head-to-head evidence reinforces the relevance of resistance exercise. In the RAED2 randomized trial, Bacchi et al. (2013) showed that both aerobic and resistance training reduced hepatic fat in type 2 diabetic adults with NAFLD. In a later randomized clinical trial, Charatcharoenwitthaya et al. (2021) found that both moderate-intensity aerobic and resistance exercise, when paired with dietary modification, reduced hepatic steatosis and improved insulin resistance. These data argue against viewing resistance exercise as a merely supportive or secondary option.

Review-level evidence points in the same direction. Hashida et al. (2017) concluded that aerobic and resistance exercise both improve clinically relevant outcomes in fatty liver disease. More recently, the systematic review by Medeiros et al. (2025) focused specifically on resistance training in MASLD and concluded that resistance-based interventions can improve liver fat, aminotransferases, and insulin resistance while demonstrating very good adherence across trials.

Clinically, resistance exercise may be particularly useful for individuals with obesity-related orthopedic limitations, low cardiorespiratory fitness, sarcopenia, or concern about preserving lean body mass. These characteristics are common in real-world MASLD populations. As a result, resistance training has special value not only because it can improve liver-related outcomes, but also because it may be easier to adopt and maintain in certain patients than traditional continuous aerobic programs.

Table 1. Selected clinical studies on exercise interventions in MASLD/NAFLD.

Study	Population	Intervention	Main outcomes	Key conclusion
Hallsworth et al. (2011)	Sedentary adults with NAFLD	8-week resistance training, 3×/week	Liver fat, HOMA-IR, glucose handling	Resistance training reduced liver fat and improved insulin sensitivity without major weight loss.
Bacchi et al. (2013)	Adults with type 2 diabetes and NAFLD	Aerobic vs. resistance training	Hepatic fat, metabolic outcomes	Both aerobic and resistance training reduced hepatic fat content.
Keating et al. (2015)	Adults with NAFLD	Different aerobic exercise doses	Liver fat, visceral adiposity	Multiple aerobic prescriptions improved liver fat; total dose mattered more than one fixed intensity.
Zhang et al. (2016)	Adults with NAFLD and obesity	Moderate vs. vigorous exercise	Hepatic steatosis, metabolic parameters	Moderate and vigorous exercise both reduced steatosis.
Houghton et al. (2017)	Biopsy-proven NASH	Structured exercise program	Liver lipids, visceral adiposity	Exercise reduced liver lipids and visceral adiposity in NASH.
O'Gorman et al. (2020)	Biopsy-confirmed MAFLD	12-week aerobic exercise	Histology, CAP, body composition, fitness	Aerobic exercise improved fibrosis and ballooning in a small non-randomized study.
Charatcharoenwitthaya et al. (2021)	Adults with NAFLD	Aerobic vs. resistance exercise plus diet	Steatosis, insulin resistance	Both modalities improved hepatic steatosis and metabolic outcomes.
Stine et al. (2022)	Sedentary adults with biopsy-proven NASH	20-week supervised aerobic exercise (NASHFit)	MRI-PDFF, PAI-1, glycemia, QoL	Exercise improved liver-fat response and several cardiometabolic outcomes.
Keating et al. (2023)	Biopsy-proven NASH	Supervised HIIT	Feasibility, insulin sensitivity, fitness	HIIT was safe and feasible and improved fitness and insulin sensitivity.

3.5. High-intensity interval training

High-intensity interval training (HIIT) has attracted attention because of its time efficiency and its strong effects on fitness. Meta-analytic synthesis suggests that HIIT and moderate-intensity continuous training generally produce similar reductions in liver fat, although HIIT may be particularly appealing for selected individuals who prefer shorter but more demanding sessions (Sabag et al., 2022).

The most directly relevant biopsy-confirmed NASH study in the current corpus is the randomized trial by Keating et al. (2023). In that trial, supervised HIIT was safe and feasible, improved exercise capacity, and improved peripheral insulin sensitivity. However, the study was small and not designed to provide definitive evidence on fibrosis regression, which means the hepatic implications of HIIT still require cautious interpretation.

Comparative studies such as Abdelbasset et al. (2020) also support interval-based exercise in obese diabetic individuals with NAFLD. Taken together, current data support HIIT as a viable option in selected, screened, and appropriately supervised patients, rather than as a universal first-line choice for all individuals with MASLD.

3.6. Weight-loss-independent effects of exercise

One of the most clinically useful messages from the current literature is that exercise can improve relevant hepatic and metabolic endpoints even when body weight changes little. This is important in everyday care, because patients often equate treatment success with the number on the scale and may undervalue exercise if weight loss is slow.

The ACSM international roundtable concluded that established benefits of physical activity in NAFLD include lower liver fat, better physical fitness, and improvement in body-composition measures, even when major weight reduction is not achieved (Stine, Long, et al., 2023). This position helps separate the therapeutic value of exercise from the narrower goal of substantial weight loss.

The strongest pooled quantitative support comes from the meta-analysis by Stine, DiJoseph, et al. (2023), which showed that exercise training increased the likelihood of a clinically meaningful MRI-PDFF response independently of more than 5% body-weight loss. The same study suggested that a weekly dose of about 750 MET-minutes may represent a practical threshold associated with treatment response.

This framing may also improve adherence. When patients understand that exercise can enhance hepatic steatosis, insulin sensitivity, vascular function, and fitness without requiring rapid visible weight change, sustained participation may feel more achievable and more rewarding.

3.7. Histological and fibrosis-related outcomes

Compared with steatosis reduction, the evidence for histological improvement or fibrosis regression remains less certain. This is one of the clearest limitations of the current exercise literature. Most trials are small, of short duration, and use non-invasive surrogate outcomes rather than paired biopsies. Consequently, guideline documents remain cautious when making statements about direct fibrosis benefit (EASL et al., 2024; Stine, Long, et al., 2023).

The most important exercise-alone histology study in the current source set is the work by O'Gorman et al. (2020). In adults with biopsy-confirmed MAFLD, 12 weeks of moderate-to-vigorous aerobic exercise improved fibrosis by one stage in 58% of participants and improved hepatocyte ballooning in 67%, while not significantly changing steatosis, lobular inflammation, or the overall activity score. The authors interpreted these findings cautiously because the study was small, non-randomized, and not powered for definitive histological conclusions.

Indirect evidence further supports the plausibility of liver-tissue benefit. The MRI-based literature indicates that a ≥30% relative decline in liver fat can serve as a useful surrogate threshold associated with histologic response in NASH studies. Tamaki et al. (2022) and Stine, Munaganuru, et al. (2021) showed that MRI-PDFF changes are clinically informative and linked to fibrosis-related outcomes in broader NASH research. This strengthens the relevance of the MRI-response threshold achieved in exercise trials, but it still does not replace direct histological evidence.

Emerging biomarker studies offer additional support. Harris et al. (2024) showed improvement in serum biomarkers of liver fibroinflammation after exercise training in MASH, while Stine, Welles, et al. (2023) reported marked decreases in FGF21 after exercise in biopsy-proven NASH. These findings suggest biologic activity consistent with disease modification, but they remain supportive rather than definitive. Overall, the evidence for fibrosis-related benefit is best described as promising but incomplete.

3.8. Cardiometabolic outcomes, body composition, and quality of life

The extrahepatic benefits of physical activity are especially important in MASLD because the disease is strongly embedded in systemic metabolic dysfunction. Exercise improves insulin sensitivity, fasting glucose, HbA1c, visceral adiposity, endothelial function, and cardiorespiratory fitness across multiple studies and meta-analyses (Babu et al., 2021; Duell et al., 2022; Smart et al., 2018).

The NASHFit trial provides one of the best examples of this broader benefit profile. Stine et al. (2022) found that 20 weeks of supervised aerobic exercise in sedentary adults with biopsy-proven NASH improved MRI-PDFF response, lowered serum PAI-1, improved glucose metabolism, and improved selected health-related quality-of-life outcomes. Because cardiovascular disease and thrombotic risk are major contributors to morbidity and mortality in fatty liver disease, these extrahepatic gains are clinically meaningful.

Body composition changes are also relevant. Aerobic exercise consistently reduces visceral adipose tissue, while resistance training may preserve or improve muscle-related outcomes. This is particularly important given the increasing recognition of sarcopenia and low muscle quality as negative prognostic markers in MASLD (Marjot et al., 2025). In practice, the integration of aerobic and resistance exercise may therefore help address both hepatic steatosis and the broader metabolic-functional phenotype of the patient.

3.9. Sedentary behavior, barriers, and adherence

A lifestyle intervention is only effective if patients can adopt and maintain it. For that reason, the literature on barriers and adherence has direct practical importance. Population-based work by Gerber et al. (2012) showed that NAFLD is associated with lower physical activity levels, suggesting that inactivity is a disease-related reality rather than a marginal issue.

Stine, Soriano, et al. (2021) examined barriers to physical activity in patients with NAFLD and emphasized that fatigue, limited confidence, competing responsibilities, poor exercise counselling, and physical discomfort may all interfere with the adoption of structured exercise. These factors are especially relevant in a social-science-oriented interpretation of MASLD management, because they remind us that behavior change is not determined by biomedical knowledge alone.

Adherence data from clinical trials are nonetheless encouraging when programs are structured and supervised. Hallsworth et al. (2011), Stine et al. (2022), and Keating et al. (2023) all reported good to excellent adherence or feasibility. This suggests that the main challenge may not be the impossibility of exercise in MASLD, but rather how health systems organize counseling, support, supervision, and personalization.

3.10. Technology-supported and telehealth approaches

Digital and technology-assisted models of exercise delivery may help close the gap between what clinical trials show and what routine care can realistically provide. The ACSM roundtable noted that telehealth and mobile-health approaches are emerging as feasible ways to support physical activity in people with fatty liver disease, particularly when frequent in-person supervision is difficult (Stine, Long, et al., 2023).

Direct MASLD-specific implementation data remain limited, but the overall direction is clear. Remote coaching, wearable-based feedback, app-supported self-monitoring, and hybrid supervision models may reduce access barriers and improve continuity for patients who cannot rely on repeated visits to specialist centers.

3.11. Practical implications for lifestyle-oriented exercise prescription

The most consistent practical message from the literature is that adults with MASLD should be encouraged to perform regular physical activity tailored to their abilities, preferences, and comorbidities. Current guidance supports at least 150 minutes per week of moderate-intensity activity or 75 minutes per week of vigorous activity, with graded progression for inactive individuals (EASL et al., 2024; Stine, Long, et al., 2023).

For many patients, a sensible starting point is walking, cycling, or similar moderate-intensity aerobic activity, gradually expanded to meet weekly targets. Resistance training should be added when possible because it may improve insulin resistance, support body composition, and address the muscle-related dimension of MASLD. In patients with low functional capacity, obesity-related joint pain, frailty, or concern about sarcopenia, resistance training may deserve early emphasis.

HIIT can be considered for selected patients who prefer short, more intensive sessions and who have been appropriately screened for cardiovascular and musculoskeletal risk. However, current evidence still favors individualized prescription rather than a single standard model for all patients. The literature repeatedly shows that no universally optimal frequency, intensity, time, and type prescription has yet been established.

Equally important is the need for behavioral support. Referral to exercise specialists, use of graded goals, motivational interviewing, remote monitoring, and periodic follow-up may all improve adherence. In other words, successful exercise prescription in MASLD is not simply about telling patients to move more; it is about building a sustainable lifestyle plan that fits the patient's health status, social context, and access to support.

Table 2. Lifestyle-oriented exercise prescription framework for adults with MASLD.

Clinical situation	Suggested starting approach	Progression target	Practical notes
Previously inactive adult with MASLD	Low- to moderate-intensity walking or cycling 3–5 days/week	≥150 min/week of moderate activity	Use a graded staircase approach; focus on consistency before intensity.
Adult with low fitness or obesity-related pain	Short aerobic sessions plus early resistance work	Progress toward combined aerobic + resistance training	Resistance exercise may be easier to tolerate than prolonged continuous aerobic activity.
Adult with type 2 diabetes or marked insulin resistance	Aerobic exercise plus resistance training	Regular weekly aerobic target plus 2–3 resistance sessions	Combined programs address glycemia, body composition, and hepatic fat.
Selected motivated patient seeking time-efficient training	Supervised HIIT after appropriate screening	Individualized HIIT or mixed program	Suitable only when clinically safe and behaviorally acceptable.
Patient struggling with adherence	Remote coaching, self-monitoring, simple home-based program	Maintain regular weekly activity over time	Telehealth and wearable monitoring may support motivation and continuity.

4. Discussion

This review shows that physical activity and structured exercise should be considered central components of MASLD management. The strongest and most consistent evidence concerns reduction of liver fat, improvements in insulin sensitivity, increases in cardiorespiratory fitness, and favorable changes in body composition. These effects are clinically important because MASLD is not only a liver disease but also a broader metabolic and cardiovascular-risk condition.

Aerobic exercise remains the best-studied modality, and current evidence supports its role as the default recommendation for many adults with MASLD. However, the literature also makes it clear that resistance training should not be treated as a secondary or optional extra. It may reduce liver fat, improve insulin resistance, and offer special advantages in patients with poor fitness, orthopedic limitations, or concern about sarcopenia. This is particularly relevant in real-world care, where the most effective intervention is often the one a patient can sustain rather than the one that appears most elegant in theory.

HIIT appears promising, especially as a time-efficient strategy, but the evidence base remains smaller and less definitive than that for standard aerobic training. Accordingly, HIIT should currently be viewed as an individualized option rather than a universal prescription. More broadly, the literature suggests that total exercise dose, program structure, and adherence support may matter more than choosing one perfect modality for all patients.

A particularly important conclusion is that exercise should not be communicated to patients solely as a strategy for body-weight reduction. If that is the only message, the broader therapeutic value of physical activity may be underestimated, especially by those who do not experience rapid changes in weight. A more effective message is that exercise can modify liver fat, metabolic control, and fitness even when weight loss is limited.

The field nevertheless has clear limitations. Histologic and fibrosis-related outcomes are still less robustly studied than steatosis, and many trials remain small, short, and heterogeneous in design. Differences in exercise frequency, intensity, duration, modality, supervision, and outcome assessment make direct comparison across studies difficult.

A broader implementation-oriented perspective also adds value. Future work should not only ask whether exercise is biologically effective, but also under what behavioral, social, and technological conditions it can be implemented and maintained. Telehealth-supported programs, remote monitoring, and tailored counseling are therefore not peripheral issues; they are part of the real-world translation problem.

Overall, the literature supports a shift from generic advice toward structured, personalized, and behaviorally supported exercise prescription. In this sense, the management of MASLD is not only a clinical question but also a problem of health communication, adherence, and innovation in delivery systems.

Another implication concerns equity of access. Patients living far from specialist centers, people with low socioeconomic resources, or individuals with caregiving and work burdens may find frequent in-person supervision unrealistic. For these groups, digital follow-up, simpler home-based programs, and community-level support may be more realistic than highly structured hospital-based interventions. Future MASLD research should therefore compare not only biological efficacy but also feasibility, accessibility, and long-term maintenance in everyday settings.

Finally, the results of this review suggest that future intervention studies should move beyond the binary question of whether exercise works. More useful questions are which modalities work best for which phenotypes, how much support is needed to maintain adherence, and how digital tools can be integrated into liver-care pathways without increasing exclusion of less technologically confident patients. Addressing these issues would strengthen the real-world relevance of exercise recommendations in MASLD.

5. Conclusions

Physical activity should be regarded as a core lifestyle intervention in adults with MASLD. Current evidence consistently shows that regular exercise reduces liver fat, improves insulin sensitivity, improves fitness, and favorably modifies several cardiometabolic outcomes. These benefits frequently occur even when body-weight loss is modest, which supports exercise as a treatment strategy in its own right.

Aerobic exercise remains the best-supported modality, but resistance training is also clinically valuable and may be especially relevant in patients with low fitness, reduced muscle health, or difficulty tolerating prolonged aerobic sessions. HIIT appears feasible in selected patients but still requires broader validation.

The evidence for direct histological and fibrosis-specific improvement is encouraging but less robust than the evidence for steatosis and cardiometabolic benefit. Future work should therefore combine longer follow-up, standardized hepatic endpoints, and greater attention to adherence, barriers, telehealth delivery, and other technology-supported implementation models. Such an approach may help translate exercise from a well-supported recommendation into a scalable and durable element of MASLD care.

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