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Impact Of Physical Activity on Metabolic Dysfunction Associated Steatohepatitis Patients: A Scoping Review

Ramya G, Post Graduate[1], Mrs.R.Yogeshwari, MPT[1*], Mrs.S.Sridevi, MPT[3], Dr.T. Senthil Kumar, MPT, Msc, MPhil, PhD [4], Prof. N.Venkatesh, MPT, MSc (FERN), PhD[5]

[1]Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu- 600 116, India.

[2]Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu- 600 116, India.

[3]Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu- 600 116, India.

***Corresponding Author:**

Contact: Mrs.R.Yogeshwari

Affiliation: Faculty of Physiotherapy, Sri Ramachandra institute of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu- 600 116, India.

Email ID: yogeshwaridinakaran@sriramachandra.edu.in

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ABSTRACT

Background: Metabolic Dysfunction Associated Steatohepatitis is a progressive liver condition characterized by excessive liver fat, inflammation, and fibrosis, which can lead to cirrhosis, liver failure, and liver cancer.

Methods: A Systematic search was conducted in PubMed, Scopus, GoogleScholar, and PeDro by using Boolean search with keywords. Studies from 1972 to 2025 were included. Selection criteria required studies to be peer-reviewed and focus on exercise interventions in MASH patients. Exclusion criteria included studies involving animals, non-interventional research, non-English publications, and conference abstracts. The PRISMA approach guided the selection process, and data were analyzed based on exercise type, duration, intensity, and effects on liver function and metabolic markers.

Results: Ten studies were included, in which aerobic and resistance exercise that reduces liver fat, improves insulin sensitivity, and decrease systemic inflammation. Moderate-to-vigorous intensity exercise for at least 150 minutes per week was associated with liver health improvements, even without weight loss. However, inconsistencies in study methodologies and participant characteristics led to mixed findings.

Conclusion: Physical activity plays an important role in managing MASH, offering benefits for liver function and metabolic health. The lack of standardized exercise protocols underscores the need for further research. Future studies should focus on long-term randomized controlled trials to refine exercise recommendations and assess their impact on disease progression.

Keywords: *Metabolic dysfunction associated steatohepatitis, physical activity, exercise therapy, liver disease, aerobic exercise*

1. INTRODUCTION

Metabolic dysfunction associated steatohepatitis is a progressive liver disease. With its emerging incidence, MASH has become a major public health concern, contributing to mortality, morbidity, and healthcare costs worldwide.[1] It involves buildup of fat in the liver, inflammation and varying levels of scarring of the liver. If not managed it can lead to severe liver damage, including cirrhosis, liver cancer and eventually it may reach to liver failure.[2] MASH is associated with insulin resistance, type 2 diabetes, metabolic syndrome.[3] At present there are minimum pharmacological treatments available for MASH, primary prevention for disease management is lifestyle modifications.[4] Physical activity has emerged as a key therapeutic strategy to improve metabolic health, it also reduces the hepatic fat accumulation, and attenuate disease progression.[5] Multiple studies shows that aerobic and resistance exercises reduce hepatic steatosis, improve insulin sensitivity, and modulate inflammation.[6] The impact of physical activity on MASH is influenced by several factors, including exercise modality, intensity, duration, and patient characteristics such as disease stage and comorbidities.[7] Moderate-to-vigorous intensity at least 150 minutes per week has been linked to improvements in liver health.[8)] Studies states exercise enhances mitochondrial function, improves lipid metabolism, reduces systemic inflammation, and modulates gut microbiota, all of which contributes to its hepatic protective effects.[9] Heterogeneity in study designs, methodologies, and patient populations has led to inconsistencies in findings, underscoring the need for a more comprehensive synthesis of existing literature.[10]

A Scoping review aims to map the current evidence with the role of physical activity on MASH, highlighting key findings and future directions.[11] By examining the effects of exercise on liver function, metabolic parameters, and disease progression, this review provides a clearer understanding of how physical activity can be optimized as a therapeutic approach for MASH patients.[12] Furthermore, identifying barriers to long-term adherence and exploring personalized exercise interventions will be crucial in enhancing patient outcomes and public health strategies.[13] Given the increasing prevalence of MASH and its strong association with metabolic disorders, the need for effective non-pharmacological interventions is more pressing than ever .[14] Exploring the relationship between physical activity and MASH will not only contribute to the development of evidence-based guidelines but also guide clinicians and healthcare professionals in designing interventions that improve patient adherence and long-term liver health.[15] This scoping review aims to bridge the gap between current research and clinical practice, ultimately guiding future studies towards more effective, individualized exercise prescriptions for MASH patients.[16]

2. METHODOLOGY

IDENTIFYING RESEARCH QUESTION:

The scoping review aimed to explore the impact of physical activity on metabolic dysfunction associated steatohepatitis patients. The review sought to identify existing evidence on how physical activity influences the disease progression, symptom recovery, and overall metabolic outcomes.

DATA SOURCES AND SEARCH STRATEGY: A comprehensive literature search was conducted across multiple databases including PubMed, SCOPUS, Google SCHOLAR to identify relevant studies. The search strategy incorporated Boolean operators and MeSH terms to ensure the inclusion of a wide range of studies. For Google Scholar, the search terms used were: "physical activity" OR "acute exercise" OR "isometric exercises" OR "physical" OR "physical activity"[title/abstract] OR "aerobic exercise" OR "exercise training" OR "acute exercise" AND "non-alcoholic fatty liver disease" OR "disease progression" OR "metabolism" OR "fatty liver" OR "metabolic syndrome" OR "complications". For PubMed, the following search strategy was applied using MeSH terms and text words:((((((("PHYSICAL ACTIVITY") OR ("exercise,physical") OR ("Physical Activity"[Title/Abstract])) OR ("Aerobic Exercise")) OR ("Exercise Training"[MeSH Terms])) OR ("Acute Exercises"[MeSH Terms])) AND ("disease progression"[MeSH Terms])) OR ("Fatty Liver"[MeSH Terms])) OR ("Metabolic Syndrome / complications"[MeSH Terms])) OR ("Non-alcoholic Fatty Liver Disease / complications"[MeSH Terms])) OR ("Non-alcoholic Fatty Liver Disease / metabolism"[MeSH Terms])).

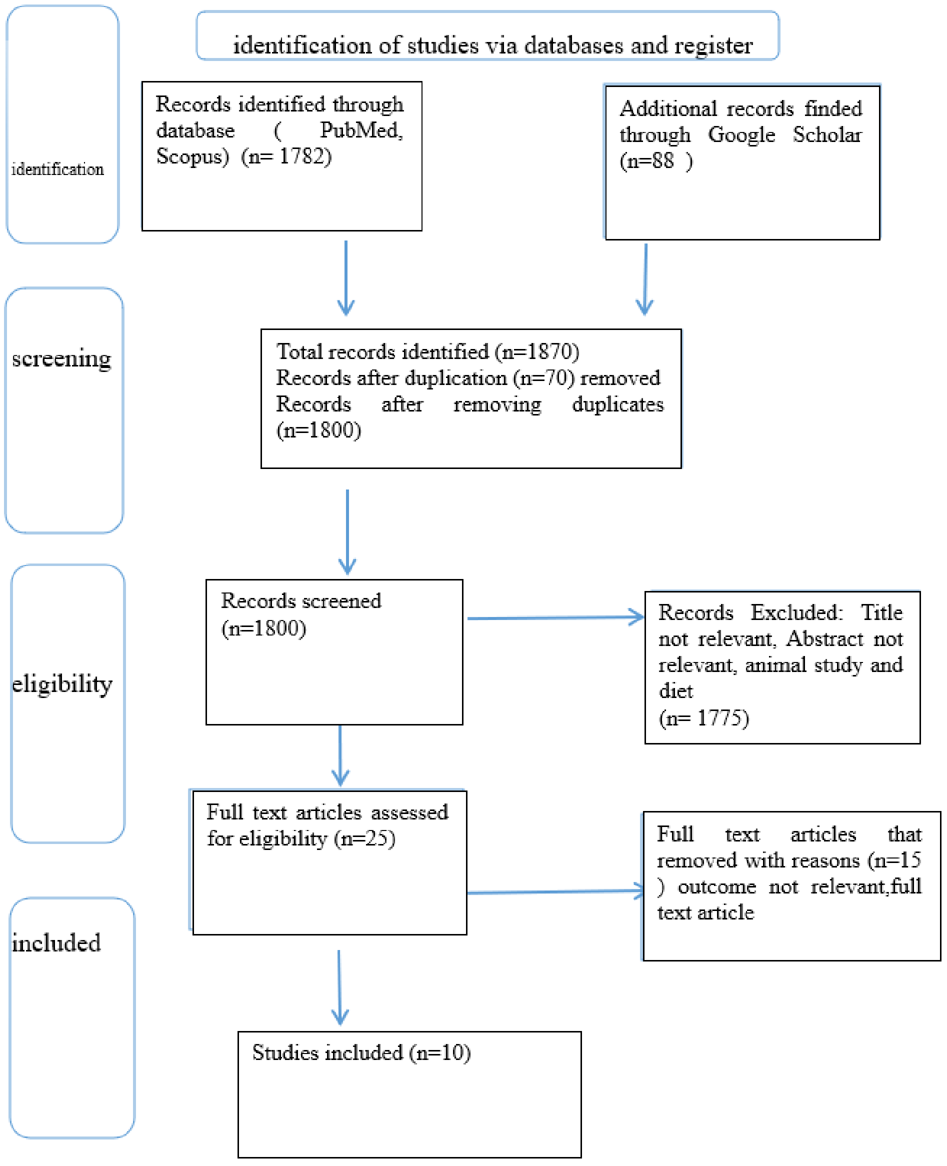
ELIGIBILITY CRITERIA:

This review included studies published between 1972 and 2025 that focused on physical activity interventions in Metabolic Dysfunction-Associated Steatohepatitis (MASH) patients. Only peer-reviewed journal articles were considered, and studies had to be published in English. The review incorporated quantitative, qualitative, and mixed-methods research to ensure a comprehensive analysis of the available evidence. Studies were excluded if they focused solely on animal models, were non-interventional, or lacked relevant outcomes. Research specifically related to Non-Alcoholic Fatty Liver Disease (NAFLD) without addressing MASH was also excluded. Additionally, non-English publications, conference abstracts, editorials, and commentaries without full data were not considered for inclusion.

STUDY SELECTION:

Following database searches, Mendeley desktop was used to check for duplicate citations in the gathered citations. All paper titles and abstracts were independently checked by two reviewers in the first round. Full-text evaluation is the second step, and additional articles were separated to meet the study's goals. The unanimity and consistency of the studies that were part of the systematic review were finalized by a third expert reviewer who also cross-checked. Data from the chosen research was gathered using a data extraction table which included the authors' year, title, and highlights. The Reviewers cross-checked the data entries to ensure accuracy. Lastly, an experienced reviewer examined the data table. The data extraction process was followed by descriptive synthesis of the gathered articles. Overall, this must describe the evidence that is currently available and point out any gaps in the body of current literature.

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework was employed to systematically identify, screen, and include eligible studies. (fig 1)



(Fig 1) PRISMA Flow diagram for the Scoping Review

DATA ANALYSIS:

Quantitative and qualitative analyses support exercise, particularly resistance training, as an effective non-pharmacological strategy for managing NAFLD. While structured exercise interventions have shown significant improvements in liver fat and metabolic parameters, long-term randomized controlled trials (RCTs) are necessary to determine optimal exercise prescriptions and gain a deeper understanding of the underlying physiological mechanisms.

ETHICAL CONSIDERATIONS:

Since this study is a review of published material, ethical approval is not required. However, all sources will be properly represented and cited.

RESULTS:

The characteristics of the studies included in this scoping review are presented in the following study selection. The 10 most relevant studies have been included in the review and are described in Table 1.

Author, year	**Sample size**	**Study design**	**Treatment**	**Outcome**	**Results**	**Limitation**
Kating et al,. 2015	48 NAFLD patients	RCT (12 week duration)	1 Moderate-intensity contiuous training for 30-50 minutes per session, 3 sessions per week;High intensity exercise training interspersed with 3mints of rest, repeated 4times per session per week. Control group: no exercise	MRI, VO2max and body composition	Both MICT and HITT shows reduction in liver fat contentcompare d to the control group	Samll sample size, short intervention duration, lack of long term followup to assess sustainability of results.
Shajaee-Moradie et al., 2016.	20 NAFLD patients	RCT (16 week duration)	Supervised moderate-intensity aerobic exercise: 45-60mintutes/session,5 sessions/week Vs control group: no exercise	MRI, insulin resistivity and body composition	Significant reduction in liver fat content in exercise group compared to control group, improvement in insulin resistivity and no significant changes in body composition	Small sample size, short duration, lack of long term follow-up.
Kate hallswort h et. al., 2011.	21 sedentar y adults	RCT	Assigned to resistance exercise or standard care exercise involved on 8week program -3 Session per week.	Intrahepatic lipid, glucose tolerance, fat oxidation and body composition were measured pre and post intervention.	13% reduction in liver fat. No significant changes in visceral adiposity or overall fat mas	Small sample size short duration of treatment session
Oh et al., 2015	48 NAFLD	RCT	Aerobic exercise: 40-60 mints per seesion per week Vs control group no exercise	MRI, ALT and AST, insulin resistance(HOMA -IR)	significant reduction in liver fat count and improvement in insulin resistance in the exercise group. No significant reduction inliver enzymes	Small sample size, short intervention duration.

AIsabella Franco, et. al., 2024	1,269	Cross-sectional analysis.	Time Spent Sitting (TSS), and the likelihood of developing and progressing non-alcoholic fatty liver disease	International Physical Activity Questionnaire (IPAQ-LF) for LTPA and TSS.	Increased LTPA and reduced TSS were associated with a lower likelihood of NAFLD development and progression. Significant reductions in NAFLD severity were observed in individuals with high LTPA and less than 35 hours of weekly sitting.	Self-reported sedentary behavior and physical activity data may introduce bias. Cross-sectional design prevents causal inferences.
St George et al., 2009	19 NAFLD	RCT	Aerobic exercise: 30-60mints per session, 3 sesssion per week Vs control group no exercise	MRI, Body weight, VO2max	Significant reduction in liver fat and improvemnet in VO2max	No significant reduction in body weight, small sample size, short intervention duration and predominantly male participants.
Hougton et al., 2017	24 NAFLD	RCT.	Combined aerobic and resistance exercise: 3 seesion per week Vs standard care (no structured exercise)	MRI, body composition, insulin resistivity, and Cardio-respiratory fitness	Significant reduction in liver fat content (3.2% absolute reduction) and improvement in cardio-respiratory fitness.	Sample sample size, short intervention duration, predominantly male participants
Shira Zelber-Sagi, et al, 2014	82	RCT	Exercise group performed three supervised sessions weekly for three months, including exercises like leg press and seated rowing, following ACSM guidelines. Control group performed home-based stretching exercises.	Liver fat assessed by hepatorenal-ultrasound index (HRI). Body composition via dual-energy X-ray absorptiometry (DEXA). Blood tests for liver enzymes, cholesterol, and serum ferritin.Dietary intake and physical activity assessed using validation questionnaire.	Liver Fat: HRI decreased significantly in the RT group compared to the control group Body Composition: exercise group showed reduced total, trunk, and android fat and increased lean body mass. Metabolic Parameters: Exercise group reduced serum	Short study duration (3 months). Lack of liver biopsy or advanced imaging to assess inflammation and fibrosis. Small sample size limits generalizability . Exclusion of patients with diabetes, reducing applicability to

					ferritin and total cholesterol significantly.	this subgroup
Mark Ezpeleta, Kelsey Gabel, et al. 2023	80 adults with obesity and NAFLD	Methods: Design: 3-month randomized, controlled, parallel-arm trial.	Exercise: Moderate intensity aerobic exercise, 5 sessions per week, 60 minutes per session.Combination: Both alternate day fasting and exercise.	Primary outcome: MRI. Secondary outcomes: Body weight, fat mass, liver enzymes, insulin sensitivity, and other metabolic risk factors.	Combination therapy showed significant reductions among Body weight, fat mass, waist circumference, ALT levels, and insulin resistance compared to controls. No significant improvements in lean mass, HbA1c, or lipid profiles among the groups.	Short duration (3 months), limiting conclusions on long-term effects. Participants were predominantly at an early stage of NAFLD, limiting generalizability to more severe cases.
Authors: Joanne B. et al 2011	37	Cross-sectional study.	Patients with NAFLD exhibited suboptimal HRF and low PA levels across all disease severities.	Cardiorespiratory fitness (CRF) via VO2peak. Muscle strength using quadriceps peak torque. Body composition via dual-energy X-ray absorptiometry.PA assessed via current self-report and a historical 10-year survey.	CRF: VO2peak was significantly lower in more severe NAFLD groups. Muscle Strength: Moderate steatosis group had higher quadriceps strength compared to mild steatosis. Body Composition: 97% of patients	Limitations: Small sample size limits generalizability. Cross-sectional design precludes causal inference. Lack of severe NAFLD cases might have influenced the results.

					had excessive body fat, indicating high cardiovascular and metabolic risk. Physical Activity: Less than 20% of patients met recommended PA levels. Historical PA was significantly lower in the mild steatosis group than in moderate or severe groups.	

STUDY DESIGN AND PARTICIPANTS:

The included studies consisted of randomized controlled trials (RCTs) that investigated the effects of structured aerobic, resistance, and combined exercise interventions on liver health and metabolic parameters. Additionally, the review incorporated previously published systematic reviews and meta-analyses that synthesized findings from multiple trials on exercise and MASH/NAFLD progression. Cohort studies included in the review focused on longitudinal observations, tracking physical activity patterns and their association with liver fat, fibrosis, and metabolic dysfunction. Cross-sectional studies analysed physical activity levels, sedentary behaviourur, and liver disease severity within a specific population at a single point in time. Some studies also included non-randomized clinical trials that were interventional but not randomized, evaluating the impact of supervised exercise regimens on hepatic and metabolic outcomes. The interventions examined varied across aerobic exercise, resistance training, and combined exercise regimens, with some incorporating dietary modifications. Structured exercise programs ranged from moderate to high intensity and included protocols such as high-intensity interval training (HIIT), moderate-intensity continuous training (MICT), and resistance exercises performed for at least 150 minutes per week. Studies assessed the effects of exercise on hepatic fat accumulation, liver enzymes, metabolic markers, insulin sensitivity, and cardiovascular fitness. Additionally, some trials explored the combination of exercise with alternate-day fasting to evaluate potential synergistic effects. While significant improvements were observed in liver fat reduction, metabolic health, and physical fitness, the review emphasizes the need for standardized exercise prescriptions tailored specifically for MASH patients.

PARTICIPANT CHARACTERISTICS:

Adults aged 18–65 years, with some studies including older individuals. Patients with diagnosed NAFLD, NASH, or MASH, confirmed through biochemical markers, imaging (MRI, ultrasound, FibroScan), or liver biopsy. Overweight or obese individuals (BMI >25 kg/m²), with varying degrees of hepatic fat accumulation, fibrosis, and insulin resistance. Many participants had metabolic comorbidities, including type 2 diabetes, dyslipidemia, hypertension, and metabolic syndrome.

OUTCOME MEASURES:

Liver health was assessed by using intrahepatic fat content mesaured via MRI or ultrasound, liver enzyme levels ALT,AST,GGT), and median liver stiffness through FibroScan report. Metabolic parameters included insulin sensitivity, free fatty acid levels, blood glucose and lipid profilesLDL,HDL,triglycerides). Body composition analysis were measured through BMI, waist circumference, and DEXA scans for fat and lean body mass. Cardiorespiratory Fitness was evaluated through VO2max and oxygen uptake while doing exercise. although limited, some studies included liver biopsy data also to assess inflammation and fibrosis progression.

3. RESULTS

The structured analysis highlights the comprehensive approach to evaluate the impact of exercise interventions on liver health, metabolic function, Body composition, and overall fitness in MASH patients.

DISCUSSION: Resistance exercise reduces liver fat and also improves metabolic parameters. However, further research is needed to evaluate its long-term benefits and sustainability.[18] Exercise remains a key component in the management of NAFLD by improving hepatic fat content, metabolic health, and cardiovascular function .[19] NAFLD patients exhibits poor health-related fitness (HRF) and low physical activity (PA) levels, exhibiting the need for exercise interventions to diminish the disease progression .[20] Resistance training shows reduction in liver fat by improving body composition in NAFLD patients without diabetes, making it a suitable option for individuals struggling with aerobic exercise adherence.[21] Long term trails are necessary to assess its impact on inflammation and fibrosis.[22] Meta-analyses support exercise as a non-pharmacological approach in the NAFLD management resulting in decreased intrahepatic lipid content thus improving liver enzymes level .[23] Higher leisure-time physical activity and reduced sedentary lifestyle are closely associated with lower risk of NAFLD progression.[23] These findings reinforce the role of structured exercise in NAFLD management.

4. CONCLUSION

Exercise interventions like resistance training plays an important role in the management of non-alcholic fatty liver disease .[17] Resistance training reduces liver fat and improve metabolic parameters making them a viable alternative to aerobic exercise due to their lower cardiovascular demands.[18] The higher prevalence of suboptimal health-related fitness and low physical activity levels among NAFLD patients, inttegrating structured exercise programs are essential to slowing disease progressions.[19] However, further long-term studies are needed to determine optimal exercise prescriptions and to fully understand the mechanisms underlying these weight-independent benefits.[20]

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Nil

6. CONFLICT OF INTEREST

The Authors declare no potential conflict of interest.

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