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Effect of Mobile App based Lifestyle Intervention on Metabolic Dysfunction - Associated Steatotic Liver Disease (MASLD)

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Abstract: ***The escalating prevalence of metabolic dysfunction - associated steatotic liver disease (MASLD) underscores an urgent need for innovative healthcare solutions, particularly in regions like India where obesity and diabetes fuel its rise. This narrative review thoughtfully examines the role of nurse - led mobile health (mHealth) interventions in addressing MASLD, a condition increasingly linked to cardiovascular risks and chronic liver complications. It is evident that mobile apps, by offering real - time monitoring, personalized lifestyle guidance, and nurse - driven support, empower patients to sustain critical behavioral changes, such as weight loss and improved dietary habits. These interventions not only enhance patient engagement but also bridge gaps in care, especially in underserved areas, fostering trust and continuity in healthcare delivery. This suggests that integrating nurse - led mHealth into routine practice could transform MASLD management, though challenges like digital access and long - term efficacy warrant further exploration. By weaving technology with human - centered care, this approach holds promise for scalable, equitable solutions to a growing public health crisis.***

Keywords: MASLD, mobile health, nurse - led interventions, lifestyle modifications, chronic liver disease

Abbreviations Used:
MASLD: Metabolic dysfunction associated steatotic liver diseases
NAFLD: non - alcoholic fatty liver diseases
SLD: Steatotic liver diseases
CVD: cardiovascular diseases

1. Introduction

Metabolic dysfunction - associated steatotic liver disease (MASLD), formerly known as non - alcoholic fatty liver disease (NAFLD), represents an increasingly prevalent public health issue. In June 2023, the nomenclature and diagnostic criteria for steatotic liver diseases (SLD), including MASLD, were formally established through an international, multi - society - guided Delphi consensus process (Rinella et al., 2023) . In light of this updated terminology, existing evidence related to NAFLD has been extrapolated to the MASLD population, and the terms are used interchangeably throughout this manuscript.

MASLD is defined as Steatotic liver diseases (SLD) occurring in the presence of one or more cardiometabolic risk factors, in the absence of significant alcohol consumption or other identifiable causes of liver disease.

Table 1: Cardiometabolic risk factors in the definition of MASLD (Rinella et al., 2023)

Metabolic risk factor	Adult criteria
Overweight or Obesity	• Body mass index >−25 kg/m2 (>−23 kg/m2 in people of Asian ethnicity) • Waist circumference >−94 cm in men and >−80 cm in women (Europeans) >−90 cm in men and >−80 cm in women (South Asians and Chinese) >−85 cm in men and >−90 cm in women (Japanese)
Dysglycaemia or type 2 diabetes	• Prediabetes: HbA1c 39 - 47 mmol/mol (5.7 - 6.4%) or • Fasting plasma glucose 5.6 - 6.9 mmol/L (100 - 125 mg/dl) or • 2 - h plasma glucose during OGTT 7.8 - 11 mmol/L (140 - 199 mg/dl) or • Type 2 diabetes: HbA1c >−48 mmol/mol (>−6.5%) or fasting plasma glucose >−7.0 mmol/L (>−126 mg/dl) or 2 - h plasma glucose during OGTT >−11.1 mmol/L (>−200 mg/dl) or • Treatment for type 2 diabetes
Plasma triglycerides	>−1.7 mmol/L (>−150 mg/dl) or lipid - lowering treatment
Plasma HDL cholesterol	< 40 mg/dL (< 1.0 mmol/L) for men and < 50 mg/dL (< 1.3 mmol/L) for women or lipid lowering treatment
Blood pressure	· >−130/85 mmHg or treatment for hypertension

Metabolic dysfunction - associated steatotic liver disease (MASLD) is a growing health concern. With the increasing incidence of unhealthy or sedentary lifestyle, various factors contribute to chronic liver diseases making it one of the important issues that need to be addressed.

A higher prevalence is usually associated with individuals who are overweight, obese, and diabetic (type 2 diabetes mellitus) (Cotter & Rinella, 2020) . The estimated global prevalence of NAFLD in individuals over the age of 18 years is 25.2%. According to a recent meta - analysis, Asia has shown a sharp increase in the prevalence of NAFLD (Wong et al., 2021) .

The prevalence of NAFLD in adults in India has been reported to be between 6.7% and 55.1% (De & Duseja, 2021) . The rising obesity epidemic and increasing diabetes prevalence (1 in 29 individuals are obese, and 1 in 14 are diabetic in India) contribute to the growing burden of NAFLD, which can progress to severe liver diseases, such as non - alcoholic steatohepatitis (NASH), fibrosis, cirrhosis, and liver cancer. Non - alcoholic fatty liver disease is associated with various risk factors, such as diabetes mellitus (insulin resistance type 2 DM), obesity, dyslipidemia, and metabolic syndrome (Shalimar et al., 2022) .

Steatotic liver disease (SLD) contributes significantly to the burden of chronic liver disease. Cardiovascular disease is the leading cause of death among NAFLD, and NAFLD acts as an independent cause of the increased risk of heart disease (Kasper et al., 2021) . A recent 2022 American Heart Association (AHA) Scientific Statement recognized that MASLD is an often - unappreciated independent risk factor for atherosclerotic cardiovascular disease (E. Cho et al., 2024)

NAFLD is often asymptomatic, but significantly increases liver - related morbidity and mortality. Its association with metabolic syndrome, obesity, and diabetes can strain healthcare systems if not addressed early (E. Cho et al., 2024) . Early diagnosis and following preventive measures for lifestyle modifications, have the potential to improve the health outcomes in the patients with MASLD. Lifestyle modifications including proper diet, daily exercise, and weight management or reduction is the key to improve the MASLD. (Kwon et al., 2024)

Clinical guidelines recommend at least 5% weight loss to improve NAFLD outcomes, and various studies support exercise and diet as effective interventions. A study showed that lifestyle intervention could result in the resolution of SLD in up to 97% of patients. Weight loss can lead to improvements in blood pressure, glycaemic and lipid profiles, and a reduction in cardiovascular diseases (CVD) risk, among other benefits (Kwon et al., 2024) .

With the advancement in the technology and innovations; has aided the accessibility to various health related information and enriched the quality of health care. Mobile health technology aids disease management by providing tailored lifestyle interventions beyond clinical settings, allowing the distribution of health related interventions via unconventional routes at the unprecedented speeds (Vilar - Gomez et al., 2015) . Previous studies has reported the effect of mobile app based lifestyle interventions on MASLD has proven effective in reducing complications, preventing the progression of diseases, reduction the level of triglyceride level, insulin resistance and thus improving the quality of life (Kwon et al., 2024)

Mobile - based health tools provide real - time, personalized lifestyle guidance through text messaging, videos, goal - setting features, and interactive content. These platforms enable patients to track dietary habits, physical activity, weight, and clinical parameters, facilitating the early detection of complications and timely interventions (Vilar - Gomez et al., 2015) . Evidence suggests that mobile apps improve engagement, reinforce behavior change, and support long - term adherence, all of which are crucial for managing chronic diseases such as MASLD (S. M. J. Cho et al., 2020) .

Nurse - led mobile health (mHealth) interventions represent a promising and scalable solution for supporting patient self - management and behavioral changes. This may enhance patient engagement and adherence to lifestyle modifications, potentially improving health outcomes. Nurses play pivotal roles in patient education, motivation, and adherence to lifestyle changes. Integrating their expertise into mobile app platforms enhances the continuity of care and fosters trust between patients and the healthcare system (Aida et al., 2020)

Importantly, a nurse - led mHealth approach addresses barriers to care, especially in underserved or rural areas, by bridging the gap between patients and health care providers. These interventions also allow for ongoing monitoring, individualized feedback, and psychosocial support, which are vital for sustaining lifestyle changes. With the growing digital health infrastructure and increasing smartphone penetration, integrating nurse - led mHealth interventions into routine care could significantly improve MASLD outcomes, reduce complications, and reduce the economic burden on healthcare systems.

2. Significance of the Study

Metabolic dysfunction - associated steatotic liver disease (MASLD) has become a significant public health concern in India, primarily due to the rising prevalence of sedentary lifestyles, obesity, and type 2 diabetes mellitus.

Effective management of MASLD relies heavily on sustained lifestyle modifications including dietary changes, increased physical activity, and weight reduction. However, existing healthcare delivery models in India often lack the infrastructure and continuity required to support long - term behavioral changes. There is a critical need for comprehensive care approaches that go beyond clinical consultations and empower patients to manage their health actively.

Nurses play a pivotal role in health education, behavioral counseling, and chronic disease management. Integrating their roles into digital health platforms can significantly enhance the quality and accessibility of care. The increasing penetration of smartphones and digital literacy across India provide an opportunity to leverage mobile health (mHealth)

technology to support self - management and improve health outcomes. When integrated into nurse - led interventions, mobile applications can provide personalized guidance, real - time monitoring, and continuous support to patients beyond the clinical setting.

While international evidence supports the effectiveness of mHealth interventions for chronic disease management, there is a paucity of research within the Indian context, particularly on nurse - led mobile app - based interventions for the MASLD. Therefore, this study aimed to evaluate the effectiveness of a nurse - led mobile health application in delivering comprehensive care to patients with MASLD. These findings will contribute to evidence - based nursing practice and support the development of scalable, technology - enabled care models tailored to the Indian healthcare system.

3. Methodology

The present study is a narrative review of effects of mobile app - based lifestyle interventions on MASLD. Literature from 2018 to 2025 was searched using electronic databases from PubMed, Cochrane, Research gate, SCOPUS, Google Scholar, and the Elsevier clinical library.

Electronic database search was done to extract the articles related to the theme of research problem and related terms using the keywords “Nurse - led mobile app” OR “Telehealth nursing” AND “Comprehensive preventive care” OR “Preventive care” AND “Quality of life” AND “Metabolic dysfunction associated liver steatotic liver diseases” OR “MASLD” OR “Non - alcoholic fatty liver diseases” NOT “Alcohol related fatty liver diseases” AND “Adult patients. ”

A total of 12 articles were reviewed, that includes cross sectional surveys (incidence and prevalence studies), Randomized controlled trials and prospective randomized clinical trials and conclusion was drawn based on the review of articles findings.

PREVALENCE OF MASLD

The global incidence of metabolic dysfunction - associated steatotic liver disease (MASLD) is rising, with an estimated incidence rate of 46.9 cases per 1, 000 persons annually (Kwon et al., 2024) . A comprehensive meta - analysis by (Riazi et al., 2022) , which included data from 72 studies encompassing over one million individuals (n = 1, 030, 160), reported a global prevalence of non - alcoholic fatty liver disease (NAFLD) in adults at 32%. The prevalence was significantly higher in males compared to females (40% vs.26%, $P < 0.0001$). Notably, the prevalence of NAFLD increased from 26% in studies conducted before 2005 to 38% in those published from 2016 onward (Teng et al., 2023) .

In the Asian population, multiple studies have reported an overall NAFLD prevalence of approximately 30% (Le et al., 2022) . Given the influence of various biological and lifestyle factors, the prevalence of MASLD demonstrates considerable regional variation (Anton et al., 2023) . For instance, a cross - sectional study reported an NAFLD prevalence of 61.5% based on ultrasound findings (Teng et al., 2023) . In India, estimates suggest that between 9% and 32% of the general population is affected by NAFLD, with a particularly high prevalence of 49.8% reported in a population - based study conducted in southern coastal regions (Singhai et al., n. d.)

Major risk factors associated with NAFLD include obesity, elevated fasting blood glucose, and dyslipidemia. In Asia, prevalence estimates range widely from 8.7% to 57.37%. Among India’s urban population, NAFLD affects approximately 16.6% to 32%, with a strong correlation observed between increased waist circumference and disease occurrence (Anton et al., 2023) . According to a study by Shalimar et al. (2022), the pooled prevalence of NAFLD among adults was estimated at 38.6% (95% CI: 32–45.5%). Stratified analysis showed prevalence rates of 28.1% (95% CI: 20.8–36%) in average - risk groups and 52.8% (95% CI: 46.5–59.1%) in high - risk populations. Furthermore, NAFLD prevalence was higher in hospital - based datasets (40.8%, 95% CI: 32.6–49.3%) compared to community - based data (28.2%, 95% CI: 16.9–41%).

IMPACT OF MOBILE APP - BASED LIFESTYLE INTERVENTIONS ON MASLD:

Findings from the reviewed randomized controlled trials underscore the increasing relevance and clinical value of mobile application–based interventions and tele - nursing in the prevention and management of non - alcoholic fatty liver disease (NAFLD) and metabolic dysfunction - associated steatotic liver disease (MASLD). These digital health strategies have consistently demonstrated significant improvements in both physiological and behavioral outcomes, including reductions in liver enzyme levels, body weight, hepatic steatosis, and liver stiffness, along with enhancements in quality of life, fatigue levels, and self - management behavior (S. M. J. Cho et al., 2020) .

Mobile health applications—such as Noom Weight, Fitbit - integrated platforms, and custom - designed tools like *Dr. Coach*—have facilitated lifestyle coaching and self - monitoring of dietary habits, physical activity, and clinical metrics. These platforms support real - time data sharing and feedback between patients and healthcare professionals, particularly nurses, enabling tailored goal setting, behavioral counselling, and motivational support (*Fitbit - Based Interventions for Healthy Lifestyle Outcomes: Systematic Review and Meta - Analysis - PMC*, n. d.; *Mobile Application for Digital Health Coaching in the Self - Management of Older Adults with Multiple Chronic Conditions: A Development and Usability Study - PMC*, n. d.; Sysko et al., 2022)

A study by (Ghodsbin et al., 2018) demonstrated that structured telephonic follow - ups by nurses led to significant improvements in ultrasound liver findings and liver size, highlighting the potential of tele - nursing to reinforce sustained behavioral change. Similarly, (Kwon et al., 2024) reported significant improvements in clinical and psychological parameters among NAFLD patients who received mobile lifestyle coaching over six months. Additional studies by (E. Cho et al., 2024; Tincopa et al., 2024) , further affirmed that digital interventions are particularly effective among high - risk subgroups, including younger individuals and those with type 2 diabetes, underscoring the need for adaptive, targeted digital tools. Even short - duration interventions, such as that by (E. Cho

et al., 2024) , which incorporated high - protein meal replacements and app - based coaching, yielded significant improvements in liver enzyme profiles, suggesting that mobile health solutions can achieve measurable clinical benefits in a relatively short timeframe.

Despite certain limitations—such as limited generalizability due to homogeneous study populations and disparities in access to digital technology—these interventions were generally safe, feasible, and well - accepted by participants.

Overall, the evidence supports the integration of mobile health technologies into clinical practice as scalable, cost - effective, and accessible tools to promote sustained lifestyle changes, enhance patient engagement, and improve long - term outcomes in NAFLD and MASLD care. Future research should prioritize diverse study populations, assess long - term effectiveness and economic viability, and explore integration into existing healthcare infrastructures to ensure continuity and equity of care.

4. Limitations

The majority of the reviewed studies targeted specific demographic groups, which limits the generalizability of their findings across diverse ethnicities, age ranges, and socioeconomic strata. Moreover, it remains unclear whether improvements in liver function were primarily attributable to mobile app–based coaching, telehealth education, or a combination of both. A common limitation among these studies was the exclusion of individuals without access to smartphones or those with limited literacy, which may inadvertently exclude populations from lower socioeconomic backgrounds. Although smartphone ownership continues to rise globally, it remains closely linked to education level and household income, potentially restricting the reach of digital health interventions.

Furthermore, the cost - effectiveness of mobile application–based interventions remains underexplored, which is a critical factor for their integration into standard clinical practice. Questions surrounding user acceptance, accessibility, and adherence also persist, particularly regarding concerns about data privacy and information security. Another limitation is the relatively short duration of most clinical trials, which may not fully capture the long - term effectiveness or sustainability of these interventions.

Consequently, there is a clear need for more comprehensive interventional studies that assess the long - term impact, scalability, and generalizability of mobile app–based lifestyle interventions for individuals with MASLD. Such research should aim to include diverse populations and address barriers related to access, literacy, and digital inclusion to ensure broader applicability and real - world effectiveness.

5. Conclusion

Recent studies indicate a rising global prevalence of non - alcoholic fatty liver disease (NAFLD), increasing from 26% in 2005 or earlier to 38% in studies conducted from 2016 onward (Teng et al., 2023) . This trend closely mirrors the global escalation in obesity rates. In India, the prevalence of NAFLD among adults has been reported at 38.6%, which is notably higher than the global average of approximately 25%, with both males and females affected at similar rates (Shalimar et al., 2022) .

Telemedicine, particularly through mobile - based applications, offers an integrated platform for delivering healthcare services by enabling virtual communication between patients and healthcare providers. These digital tools facilitate remote monitoring of key health parameters—including body weight, dietary intake, physical activity, and biochemical markers—while also delivering education on self - management practices. Mobile applications can improve accessibility to care, reduce the need for in - person visits, and help decrease out - of - pocket healthcare expenses, particularly in resource - limited settings.

The feasibility and acceptability of mobile health interventions in managing metabolic dysfunction - associated fatty liver disease (MASLD) are increasingly supported by emerging evidence. For instance, a study by Sato et al. (2023) demonstrated that 68.4% of patients showed improvement in non - alcoholic steatohepatitis (NASH) after 48 weeks of digital treatment via a mobile application. The intervention was well tolerated, with no serious adverse events attributed to the mobile app. Similarly, nurse - led mobile app–based lifestyle coaching has shown effectiveness in reducing complications and promoting early recovery in patients with NAFLD (Stine et al., 2023) .

6. Scope for Further Research

More studies can be carried out for the wider group enrolment and generalizability of the study findings. Randomized controlled trials or clinical trials needs to be carried out in order to have a comparison of the output findings with the conventional health care interventions to have better result output. Randomization, thoughtful control arms, and enrolment of sufficient power to detect meaningful effects are needed. Recruitment methods must be designed for inclusivity, support for enrolment, including download and set - up, are needed, and technological support should be provided

Integrating comprehensive health care related data can help promote the better outcome findings instead of focusing on the weight reduction and dietary modifications only. Mobile apps should ideally be acceptable to patients with limited literacy, easy to use, and allow two - sided communications between patient/caregiver and provider. Liver cirrhosis self - care programs can improve selfcare in cirrhotic patients by providing education, symptom tracking, medication management, and lifestyle guidance. Overall, these applications help empower patients to actively participate in their care and improve their quality of life. Mobile apps fill multiple important needs in the management of Chronic liver diseases.

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