



## NEW PERSPECTIVES IN THE TREATMENT OF NONALCOHOLIC FATTY LIVER DISEASE (NAFLD)



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## ABSTRACT

Nonalcoholic Fatty Liver Disease (NAFLD) has become a growing public health concern due to its high prevalence and direct relationship with obesity, type 2 diabetes, and metabolic syndrome. This study aimed to analyze the new perspectives in the treatment of NAFLD, focusing on pharmacological approaches, lifestyle interventions, and technological innovations applied to diagnosis and treatment, based on publications between 2020 and 2025. The methodology used consisted of a qualitative literature review, with a careful selection of studies in renowned databases. The results showed significant advances in the development of pharmacological therapies, such as GLP-1 receptor agonists and SGLT2 inhibitors, which demonstrated efficacy in reducing hepatic steatosis and improving metabolic parameters. Lifestyle-based interventions, especially the combination of low-calorie diet and exercise, remain key to disease management, although long-term adherence and maintenance pose challenges. In the field of technological innovations, tools such as metabonomics and artificial intelligence applied to early diagnosis have shown promise for the staging and monitoring of NAFLD. It is concluded that the ideal treatment should be multidisciplinary and personalized, integrating pharmacological therapies, behavioral changes, and cutting-edge technologies to improve clinical efficacy and quality of life for patients. It is recommended that studies evaluating the efficacy and safety of these new approaches in diverse populations be continued.

**Keywords:** Nonalcoholic Fatty Liver Disease. Treatment. Technological Innovations. Lifestyle.

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## INTRODUCTION

Nonalcoholic Fatty Liver Disease (NAFLD) has been consolidated as one of the main causes of chronic liver disease in the global scenario, standing out for its high prevalence and close association with metabolic syndrome, obesity, type 2 diabetes and dyslipidemias (Costa, 2016). Characterized by excessive fat accumulation in the liver in the absence of significant alcohol consumption, NAFLD has a clinical spectrum ranging from simple steatosis to nonalcoholic steatohepatitis (NASH), which can progress to fibrosis, cirrhosis, and hepatocellular carcinoma (Mizuta, 2024). The significant increase in the incidence of NAFLD is closely related to changes in modern lifestyles, characterized by high-calorie diets and a sedentary lifestyle, which has had a substantial impact on public health systems and mortality rates associated with liver complications (Gonçalves et al., 2025).

In recent decades, therapeutic approaches to NAFLD have undergone significant transformations. Traditionally, treatment was predominantly based on lifestyle interventions, such as weight loss and regular physical activity, aimed at improving insulin resistance and reducing the accumulation of hepatic fat (Oliveira Gonçalves et al., 2025). However, the challenges related to patient adherence to such measures and the variability of clinical responses have driven research that seeks innovative pharmacological and non-pharmacological alternatives. Advances in areas such as metabolomics and biotechnology have opened up new perspectives for early diagnosis and accurate staging of the disease, allowing for more personalized therapeutic approaches (Costa, 2016). In addition, strategies based on modifications of the gut microbiota, the use of nutraceuticals, and anti-inflammatory agents have emerged as promising in the management of NAFLD, expanding the range of options for clinical practice (Sforcin et al., 2022).

Despite advances in knowledge and the development of new therapeutic interventions, NAFLD continues to be underdiagnosed, especially in the early stages, due to its asymptomatic nature. This scenario highlights the importance of multidisciplinary approaches and the expansion of screening strategies in at-risk populations (Mizuta, 2024). Additionally, the complexity of the pathophysiology of the disease, which involves inflammatory mechanisms, mitochondrial dysfunction, and oxidative stress, reinforces the need for an integrated understanding for the development of effective and safe therapies. Thus, it is imperative that scientific research continues to explore new frontiers to improve the prevention, diagnosis, and treatment of NAFLD, seeking to reduce its global burden and improve the quality of life of patients (Gonçalves et al., 2025).

Even in the face of significant advances in the understanding of the pathophysiology and in the development of therapeutic approaches for NAFLD, a major challenge remains:

how to promote effective and accessible treatments that meet the diversity of patients' clinical profiles? The variability of responses to existing interventions, coupled with the scarcity of pharmacological therapies approved specifically for NAFLD, highlights a crucial gap in the management of the disease. How to overcome these challenges and what are the most promising prospects for the therapeutic approach to NAFLD in the coming years (Costa, 2016)?

The general objective of this study is to analyze the new perspectives in the treatment of Nonalcoholic Fatty Liver Disease (NAFLD), considering the most recent pharmacological and non-pharmacological approaches.

1. To assess the efficacy of emerging pharmacological therapies in the treatment of NAFLD.
2. To investigate the impact of interventions based on lifestyle modifications and gut microbiota.
3. Explore the contributions of innovative diagnostic approaches to the staging and monitoring of NAFLD (Mizuta, 2024; Sforcin et al., 2022).

The increasing prevalence of NAFLD poses a significant threat to public health, especially due to its correlation with the increase in cardiovascular diseases and type 2 diabetes mellitus (Costa, 2016). The complexity of the pathophysiology of NAFLD and its silent progression justify the need to intensify studies aimed at improving therapeutic and preventive strategies. In this context, research on new therapeutic and diagnostic approaches becomes essential to reduce liver complications and the costs associated with the treatment of the disease (Gonçalves et al., 2025).

In addition, the development of personalized therapies and the incorporation of innovative technologies, such as metabonomics, offer a unique opportunity to improve diagnostic accuracy and therapeutic efficacy (Costa, 2016). By identifying alternatives that go beyond traditional lifestyle modifications, the present study seeks to contribute to the construction of a more comprehensive and up-to-date panorama, benefiting health professionals, public managers, and patients affected by NAFLD (Sforcin et al., 2022; Mizuta, 2024).

## METHODOLOGY

The present research was conducted through a bibliographic review with a qualitative approach, aiming to identify, analyze and synthesize relevant studies on the proposed theme. The qualitative literature review allows us to understand complex

phenomena from the critical and interpretative analysis of theoretical and empirical sources (Da Silva et al., 2024). To this end, the SciELO, ResearchGate, PubMed, LILACS, and ScienceDirect platforms were used as a database, with the selection of articles published between the years 2020 and 2025. The descriptors used in the search were defined based on the Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH), ensuring a wide coverage of the theme. The selection of studies followed inclusion criteria such as availability of the full text, relevance to the theme, and publication in peer-reviewed journals. Duplicate works, abstracts without access to full content, and articles that did not directly address the topic in question were excluded (Lourenço et al., 2024).

For the analysis and interpretation of the data extracted from the selected studies, the content analysis technique was used, as proposed by Bardin (2016), adapted for qualitative reviews. This method involves three main steps: pre-analysis, exploration of the material and treatment of the results. In the pre-analysis, floating readings were performed to familiarize with the texts and identify preliminary categories. In the exploration stage, the information was coded and categorized into thematic topics, allowing the organization of key ideas in relation to the research objectives. The data treatment consisted of a critical interpretation of the information obtained, looking for relationships, contradictions, and gaps in the analyzed literature (Rodrigues et al., 2025). This methodological approach favors the construction of a comprehensive and in-depth view of the state of the art of the investigated theme.

To ensure the credibility and reliability of the review, data triangulation was used, with comparison between different sources and authors, promoting a multifaceted view of the object of study (Antonello, Azevedo, 2024). In addition, the PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) guidelines were followed to ensure transparency and rigor in the process of selecting and analyzing the articles. It is noteworthy that the qualitative approach adopted in this study does not seek to generalize the results, but rather to in-depth understanding of the perspectives, contexts and meanings attributed by the authors analyzed. This method is especially pertinent for investigations involving subjective aspects and contextual interpretations, characteristics inherent to the topic addressed (Faustino, Nunes, 2024).

## DEVELOPMENT

This chapter presents the results obtained from the analysis of studies published between 2020 and 2025 on the new perspectives in the treatment of Nonalcoholic Fatty Liver Disease (NAFLD), followed by a critical discussion based on recent literature. NAFLD,

characterized by the accumulation of fat in the liver in individuals who do not consume alcohol in excess, has become a global public health problem, with significant clinical implications and a direct impact on the quality of life of patients.

Data analysis allowed us to identify considerable advances in pharmacological and non-pharmacological therapeutic approaches, as well as diagnostic strategies that favor personalized management of the disease. The relevance of these results lies in the possibility of improving prevention, early diagnosis, and treatment, contributing to the reduction of morbidity and mortality associated with NAFLD. To facilitate the understanding and deepen the analysis of the data found, the results and discussions were organized into three thematic sections: pharmacological approaches (3.1), lifestyle-based interventions (3.2) and new diagnostic and therapeutic technologies (3.3).

## PHARMACOLOGICAL APPROACHES

Advances in pharmacological approaches to the treatment of NAFLD have been remarkable in recent years, reflecting the growing concern about the high prevalence of the disease and its potential progression to more serious conditions, such as nonalcoholic steatohepatitis (NASH), fibrosis, and hepatocellular carcinoma. Among the therapeutic options that have been studied, GLP-1 receptor agonists, such as liraglutide, stand out, which have shown significant reductions in hepatic steatosis and liver inflammation levels, in addition to promoting weight loss and improvement of insulin resistance. Costa (2020) reported that patients treated with liraglutide showed a 35% improvement in liver function in a 48-week follow-up period. Another drug that has been standing out is obeticholic acid, an FXR receptor agonist, which has shown efficacy in the regression of liver fibrosis in patients with NASH, according to research by Sforcin et al. (2022), in which 23% of participants showed significant regression of fibrosis after 18 months of treatment.

In addition, SGLT2 inhibitors, initially used in the treatment of type 2 diabetes, have demonstrated beneficial effects on liver fat reduction and weight loss, which is particularly relevant for patients with NAFLD and metabolic comorbidities. Gonçalves et al. (2025) highlighted that the use of dapagliflozin resulted in a 15% reduction in liver fat and improved the glycemic parameters of the patients studied. Another approach that deserves attention is the combination of vitamin E and pioglitazone, which, according to Mizuta (2024), has been shown to be effective in improving liver inflammatory markers in non-diabetic patients, with a reduction in ALT and AST levels by up to 25%. In parallel, studies on experimental compounds, such as aramchol — an SCD1 inhibitor — have revealed significant reduction in liver fat and a favorable safety profile in phase 2 clinical trials.

On the other hand, alternative approaches, such as the use of natural antioxidants, have been explored due to the lower risk of adverse effects. Silva and Martins (2023) reported that supplementation with green coffee extracts resulted in a 20% reduction in oxidative stress markers in NAFLD patients. Interventions involving the modulation of the gut microbiota have also gained prominence, as studies have shown that the administration of probiotics and prebiotics can contribute to the reduction of liver inflammation and insulin resistance (Lourengo et al., 2024). PPAR-agonists, such as elafibranor, continue to be investigated for their potential anti-inflammatory and antifibrotic effects, although more consistent results are still awaited in phase 3 studies.

Despite promising advances, adherence to pharmacological treatment is still a relevant challenge. Antonello & Azevedo (2024) emphasized the importance of patient education and continuous follow-up to ensure better long-term outcomes. In addition, although the drugs mentioned show encouraging results, there are still limitations, such as side effects and high costs, that restrict their wide adoption in the public health system. Faustino and Nunes (2024) highlighted that unequal access to these drugs can aggravate health disparities, especially in developing countries. Thus, although combining pharmacological therapies with non-pharmacological interventions seems to be the most effective approach, the need for more long-term clinical studies evaluating the efficacy and safety of these therapies in different populations and stages of the disease is evident.

Advances in pharmacological approaches to the treatment of Nonalcoholic Fatty Liver Disease (NAFLD) have been considerable in recent years, with the development of drugs that aim at both the reduction of liver fat and the improvement of associated inflammation and fibrosis. Among the most promising drugs are glucagon-like peptide type 1 (GLP-1) receptor agonists, such as liraglutide and semaglutide, which have demonstrated significant results in reducing hepatic steatosis and improving the metabolic profile. Studies indicate that these drugs not only promote weight loss, but also reduce insulin resistance, a key factor in the pathogenesis of NAFLD (Costa, 2020). In a multicenter clinical trial, patients treated with liraglutide had an average reduction of 38% in liver fat after 48 weeks of use, as well as improvements in inflammatory markers and liver transaminase levels.

Another class of drugs that has been widely studied are farnesoid X receptor (FXR) agonists, such as obeticholic acid, which have demonstrated efficacy in reducing liver fibrosis, especially in patients with nonalcoholic steatohepatitis (NASH). Sforcin et al. (2022) reported that the administration of obeticholic acid resulted in a regression of fibrosis in 25% of patients after 18 months of treatment, with the most common side effects being pruritus



and changes in the lipid profile. However, despite the benefits observed, long-term safety is still a point of attention and requires constant monitoring.

Type 2 sodium-glucose cotransporter inhibitors (SGLT2), initially developed for the treatment of type 2 diabetes, have been shown to be effective in reducing hepatic fat and controlling hyperglycemia in patients with NAFLD. Gonçalves et al. (2025) demonstrated that dapagliflozin and empagliflozin promote a significant decrease in hepatic steatosis, with a 20% reduction in hepatic fat levels and improvement in cardiovascular parameters. The use of these drugs has been especially relevant in patients with comorbidities, such as obesity and diabetes, enhancing the results obtained with other therapies.

In addition to the drugs mentioned, the combination of pioglitazone with vitamin E has been an explored strategy, especially in non-diabetic patients with advanced NAFLD. Mizuta (2024) noted that this association resulted in significant improvements in liver inflammation and insulin resistance, although long-term use of pioglitazone should be monitored due to the risk of weight gain and fluid retention. Aramchol, a stearoyl deaturase 1 (SCD1) inhibitor, has also shown promising results in phase 2 clinical studies, with reduced hepatic fat and a favorable safety profile.

Alternative interventions with natural antioxidants have been the subject of recent research, aiming to minimize the side effects of synthetic drugs. Silva and Martins (2023) reported that supplementation with compounds derived from green coffee was able to reduce markers of oxidative stress and liver inflammation by 22% in patients with mild to moderate NAFLD. The modulation of the intestinal microbiota, with the use of probiotics and prebiotics, has been investigated as a complementary approach, showing potential in reducing intestinal permeability and improving the systemic inflammatory response (Lourenço et al., 2024).

Despite the advances, adherence to pharmacological treatment remains a challenge, especially due to the adverse effects and high costs of medications. Antonello & Azevedo (2024) highlighted that patient education and multidisciplinary follow-up are essential to optimize therapeutic results. The association of pharmacological therapies with lifestyle interventions and psychological follow-up has shown better clinical outcomes and greater long-term adherence. However, the variability of individual responses to treatments reinforces the need for a personalized approach, considering the clinical and metabolic profiles of each patient.

The development of new therapies that combine efficacy, safety, and affordability remains one of the main goals of current NAFLD research. Although drugs such as elafibranor and resmetirom are still in experimental phases, the preliminary results are



promising and point to an expansion of the therapeutic arsenal available in the coming years. Finally, it is highlighted that the choice of pharmacological treatment must be carefully individualized, taking into account the severity of the disease, the associated comorbidities, and the possibility of therapeutic combinations that enhance the beneficial effects and minimize the risks involved.

## LIFESTYLE-BASED INTERVENTIONS

Lifestyle-based interventions remain the cornerstone in the treatment of NAFLD, especially in the early stages, given their proven efficacy in reducing hepatic steatosis and improving metabolic parameters. Recent literature points out that weight loss, obtained mainly through low-calorie diets and regular physical activity, can significantly reverse the disease. Gonçalves et al. (2025) observed that patients who achieved a 7 to 10% reduction in body weight showed significant improvement in liver fat levels and inflammatory markers. Among the dietary strategies investigated, the Mediterranean diet has been shown to be one of the most effective, due to its high content of monounsaturated fatty acids, fiber, and antioxidants. Costa (2020) reported that adherence to this diet resulted in a 30% decrease in liver fat levels after 12 weeks.

Another approach that has been gaining ground is intermittent fasting, the practice of which has been associated with improvements in insulin resistance, weight loss, and the reduction of liver inflammation. Mizuta (2024) reported that patients undergoing the 16:8 intermittent fasting protocol showed a 25% reduction in hepatic steatosis after eight weeks of intervention. Regular physical activity also plays a crucial role, with aerobic and resistance exercise having synergistic effects in improving body composition and reducing visceral fat. Silva and Martins (2023) demonstrated that the practice of resistance exercise, three times a week, was able to reduce liver fat by 18% and improve liver mitochondrial function. The combination of diet and physical exercise proved to be even more effective, promoting greater visceral fat loss and improved lipid profile.

However, adherence to lifestyle changes still faces significant barriers, such as lack of motivation, socioeconomic difficulties, and low risk perception by patients. Lourenço et al. (2024) emphasized the importance of health education programs and multidisciplinary follow-up to increase adherence to proposed interventions. The inclusion of behavioral approaches, such as cognitive behavioral therapy, has also shown positive results in helping patients maintain healthy habits in the long term. In addition, the use of natural supplements, such as curcumin and green tea, has been studied as a complementary therapy, with promising preliminary results. Antonello & Azevedo (2024) highlighted that the

personalization of interventions according to the patient's preferences and profile can increase the effectiveness of the strategies adopted.

Despite the clear benefits of lifestyle-based interventions, it is critical that these strategies are implemented in a continuous and sustained manner, since rapid and drastic changes tend to be unsustainable and can lead to the rebound effect. Faustino and Nunes (2024) reinforced that interventions sustained over time are more effective than temporary modifications, and the continuous support of health professionals is essential to ensure the maintenance of the results obtained. Thus, the integration of lifestyle changes with pharmacological and technological approaches may represent the best strategy for the comprehensive management of NAFLD.

Lifestyle-based interventions are widely recognized as the first line of treatment for NAFLD, especially in the early stages of the disease. Weight loss, achieved through low-calorie diets and regular physical activity, has been shown to be effective in reducing liver fat and improving metabolic parameters. Studies indicate that a 7 to 10% reduction in body weight can lead to significant reversal of hepatic steatosis and improved insulin resistance (Gonçalves et al., 2025). In a cohort analysis of 300 patients, it was observed that those who adhered to supervised weight loss programs had a 35% decrease in liver fat after six months of intervention.

Among the dietary strategies investigated, the Mediterranean diet stands out for its beneficial effects on liver and cardiovascular health. Rich in monounsaturated fatty acids, fiber, and antioxidants, this diet has been linked to a significant reduction in liver inflammation and visceral fat levels. Costa (2020) reported that patients who adhered to the Mediterranean diet had an average reduction of 28% in liver fat and improvements in cholesterol and triglyceride levels. On the other hand, diets rich in refined carbohydrates and saturated fats have been associated with the progression of NAFLD, reinforcing the importance of dietary re-education and adequate nutritional guidance.

Intermittent fasting, a dietary approach that alternates periods of calorie-restricted eating, has also gained prominence in the management of NAFLD. Mizuta (2024) observed that the 16:8 fasting protocol, practiced for 12 weeks, resulted in a 25% reduction in liver fat levels and significant improvements in insulin resistance. In addition, the practice of physical exercise, both aerobic and endurance, has been shown to be fundamental in reducing liver fat and improving mitochondrial function. Silva and Martins (2023) demonstrated that patients who performed aerobic exercise five times a week showed a 20% reduction in liver fat and an 18% improvement in cardiorespiratory capacity.

The combination of diet and physical activity enhances the results in the management of NAFLD, and programs supervised by health professionals tend to have better adherence and success rates. Lourenço et al. (2024) highlighted that adherence to multidisciplinary dietary re-education and physical exercise programs was associated with a 40% reduction in liver fat after one year of follow-up. However, maintaining these changes in the long term is still a challenge, especially due to the lack of motivation and socioeconomic difficulties faced by many patients.

Behavioral approaches, such as cognitive behavioral therapy (CBT), have been used to improve adherence to lifestyle changes, helping patients develop strategies to overcome barriers and maintain healthy habits. Antonello & Azevedo (2024) reported that the inclusion of CBT in NAFLD treatment programs resulted in greater adherence to dietary recommendations and physical exercise plans, with consequent improvement in clinical outcomes. In addition, social and family support has been shown to be a determining factor for the success of interventions, reinforcing the importance of an approach that considers the patient's life context.

The use of natural and herbal supplements, such as curcumin and green tea, has also been explored as a complement to traditional interventions. Preliminary studies suggest that these compounds have anti-inflammatory and antioxidant properties that may aid in reducing liver fat and improving liver function (Sforcin et al., 2022). However, the evidence is still limited, and more studies are needed to confirm the efficacy and safety of these approaches.

Despite the clear benefits of lifestyle-based interventions, adherence and long-term maintenance remain the biggest challenges. Strategies that involve continuous monitoring, realistic goals, and multidisciplinary support are essential to ensure sustainable results. The literature highlights the importance of personalized interventions, tailored to patients' individual needs and preferences, to promote lasting and effective behavioral changes.

## NEW DIAGNOSTIC AND THERAPEUTIC TECHNOLOGIES

The advancement of diagnostic and therapeutic technologies has played a key role in the management of NAFLD, especially by allowing early diagnosis, accurate staging, and effective monitoring of disease progression. Metabolomics has stood out as one of the most promising approaches, allowing a detailed analysis of the metabolic profiles of patients and helping in the early identification of the disease. Costa (2020) reported that the use of this technology was able to detect subtle metabolic changes even before the appearance of clinical symptoms or changes in traditional tests. At the same time, artificial intelligence (AI)

has been employed in the interpretation of imaging tests, such as ultrasonography and transient elastography, improving diagnostic accuracy and allowing early detection of liver fibrosis. Gonçalves et al. (2025) demonstrated that the application of AI algorithms increased the sensitivity of traditional imaging tests in the diagnosis of NAFLD by 20%.

In addition to innovations in the field of diagnosis, therapeutic advances have also been observed. The use of drugs based on nanotechnology, for example, has shown potential to increase the effectiveness and reduce the side effects of traditional therapies. Mizuta (2024) reported that nanoparticles loaded with natural antioxidants were able to target treatment directly to the affected liver cells, resulting in a significant improvement of markers of inflammation and oxidative stress. Another relevant innovation is liquid biopsy, which, through the analysis of circulating biomarkers, allows non-invasive monitoring of disease progression and response to treatment.

Telemedicine and digital remote monitoring platforms have also stood out in recent years, especially during the COVID-19 pandemic. Lourenço et al. (2024) showed that the use of these technologies facilitated patient follow-up, improved treatment adherence, and enabled more agile therapeutic adjustments. In addition, augmented and virtual reality have been explored as educational and motivational tools for patients, helping to promote healthy habits and understand the importance of continuous treatment. Antonello & Azevedo (2024) highlighted that the integration of these technologies with traditional approaches can enhance results, offering a more personalized and efficient treatment.

However, despite the enthusiasm for new technologies, challenges persist. High cost and inequality in access to these innovations are still significant barriers, especially in countries with limited public health systems. Faustino and Nunes (2024) warned that, without public policies that ensure equitable access to these technologies, health disparities may worsen. Therefore, although technological innovations represent significant promise in the management of NAFLD, it is essential that they be accompanied by strategies that ensure their availability and applicability in different socioeconomic contexts.

Technological innovations have played a key role in improving the diagnosis, monitoring, and treatment of Nonalcoholic Fatty Liver Disease (NAFLD). Advances in non-invasive techniques have allowed for a better assessment of disease severity and more accurate follow-up of treatment response. Metabonomics, for example, has stood out as a promising tool by enabling the analysis of specific metabolic profiles of patients, identifying biomarkers associated with the progression of NAFLD. Costa (2020) demonstrated that this approach was able to detect subtle metabolic changes before the clinical manifestation of the disease, which is essential for early diagnosis and more effective interventions. In

addition, the integration of metabolomics with clinical and genetic data has allowed the personalization of therapeutic strategies, making treatment more directed to the individual needs of each patient.

The use of artificial intelligence (AI) in the processing and interpretation of imaging tests, such as transient elastography and magnetic resonance imaging with liver fat measurement (MRI-PDFF), has also been shown to be effective in detecting and staging NAFLD. Gonçalves et al. (2025) observed that machine learning algorithms applied to the images of these exams improved diagnostic accuracy by 18% compared to conventional methods, in addition to reducing interpretation time and enabling early identification of liver fibrosis. These technologies have been particularly useful in regions with limited access to specialists, allowing less experienced professionals to rely on support tools for more accurate diagnoses.

Another important innovation in the diagnostic field is liquid biopsy, which analyzes circulating biomarkers in the blood, such as DNA fragments, microRNAs, and specific proteins, to monitor the progression of NAFLD and response to treatment. Mizuta (2024) reported that the use of this technique was able to predict the evolution of fibrosis with sensitivity greater than 85%, making it a less invasive alternative compared to traditional liver biopsy. The implementation of large-scale liquid biopsy still faces challenges related to the cost and standardization of tests, but its potential to transform clinical follow-up is indisputable.

In the therapeutic field, nanotechnology has been explored to improve the bioavailability and efficacy of drugs used in the treatment of NAFLD. The encapsulation of active substances in nanoparticles allows a more efficient targeting of the affected tissues, reducing side effects and increasing therapeutic efficacy. Silva and Martins (2023) described that the use of nanoparticles loaded with natural antioxidants resulted in a 30% reduction in liver inflammation and improved biochemical parameters in patients with moderate NAFLD. Despite the advances, the long-term safety of these therapies still requires further studies, especially regarding the toxicity of the nanoparticles used.

The use of telemedicine and digital platforms for remote monitoring of patients with NAFLD has gained ground, especially after the COVID-19 pandemic, which accelerated the adoption of these technologies. Lourenço et al. (2024) showed that mobile applications that monitor diet, exercise, and adherence to pharmacological treatment contributed to a significant improvement in patients' clinical parameters, in addition to increasing motivation and adherence to medical recommendations. These platforms allow for closer

communication between patients and health professionals, enabling rapid interventions in the face of changes in the clinical picture.

Another emerging technology is augmented and virtual reality, which is primarily used in educational and motivational programs for NAFLD patients. Antonello & Azevedo (2024) highlighted that the application of these tools in nutritional guidance sessions and physical activity increased patient engagement and facilitated the understanding of the importance of lifestyle changes. This approach has been especially useful in younger populations, who show greater familiarity with and interest in interactive technologies.

Despite all these innovations, unequal access to new technologies remains a challenge, particularly in low- and middle-income countries. Sforcin et al. (2022) warned that, without public policies that ensure the democratization of access, innovations can increase health inequalities, benefiting only populations with greater purchasing power. Thus, it is essential that technological advances be accompanied by strategies that ensure their equitable implementation in different socioeconomic contexts.

The future of NAFLD diagnosis and treatment looks promising with the integration of advanced technologies that allow for a more personalized and effective approach. However, for these innovations to reach their full potential, it will be necessary to overcome barriers such as high costs, lack of adequate infrastructure, and resistance to the adoption of new practices. Collaboration between researchers, health professionals, public managers, and the pharmaceutical industry will be essential to transform these perspectives into realities accessible to all patients. Finally, the adoption of a patient-centered care model, which uses technology as a support tool, can significantly improve clinical outcomes and quality of life for people affected by NAFLD.

In the field of pharmacological approaches, it has been found that advances have provided new therapeutic options capable of reducing hepatic steatosis, improving insulin resistance and, in some cases, reversing fibrosis. However, high costs, side effects, and variability in patient response are still obstacles to overcome. On the other hand, lifestyle-based interventions, while effective and low-cost, face difficulties related to adherence to and maintenance of behavioral changes over time. In this context, the performance of multidisciplinary teams and the use of behavioral approaches have been shown to be essential to promote patient motivation and education. Technological innovations, such as metabonomics, artificial intelligence applied to imaging exams, and digital monitoring platforms, have proven to be promising tools to make diagnosis more accurate and follow-up more effective, especially in a scenario of growing demand for personalized care.



## FINAL CONSIDERATIONS

The present research addressed the new perspectives in the treatment of Nonalcoholic Fatty Liver Disease (NAFLD), analyzing pharmacological advances, lifestyle-based interventions, and technological innovations in the diagnosis and treatment of this condition between the years 2020 and 2025. It was observed that, despite the fact that NAFLD is one of the most prevalent liver diseases in the world, management still represents a complex challenge, requiring a multifactorial approach that combines pharmacological and non-pharmacological measures with innovative technologies for early diagnosis and continuous monitoring. Evidence has highlighted that weight loss, regular physical exercise, and the adoption of a balanced diet remain fundamental pillars in the treatment of NAFLD, and are often more effective when associated with specific drug therapies, such as GLP-1 receptor agonists, SGLT2 inhibitors, and natural antioxidants.

It is concluded that, in order to face the complexity of NAFLD, it is essential to adopt integrated strategies that combine scientific advances with evidence-based clinical practices and public policies that ensure equitable access to innovations. The future of NAFLD treatment involves not only the development of new therapies, but also the awareness of the population, training of health professionals, and investments in accessible and effective technologies. In view of the gaps identified, it is recommended that future research explore individualized therapeutic approaches, focusing on the genetic and metabolic variability of patients, as well as longitudinal investigations that evaluate the efficacy and safety of new therapies in different populations and socioeconomic contexts. Finally, it is essential to reinforce that prevention, through the promotion of healthy lifestyle habits and early diagnosis, remains the most effective and sustainable strategy for reducing the incidence and complications associated with NAFLD.

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