Advanced Liver Fibrosis Diagnosis in Nafld: A Combined Approach Using Biomarkers and Demographics

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***Abstract* – Individuals having the disease of nonalcoholic fatty liver disease (NAFLD), a precise diagnosis of severe liver fibrosis is essential to stopping the disease's progression and directing treatment measures. Although liver biopsies are still the gold standard, their invasiveness highlights the need for trustworthy non-invasive substitutes. In order to improve the precision of identifying advanced fibrosis in NAFLD, this study investigates a combination strategy that makes use of blood biomarkers and demographic factors. Demographic variables like age, sex, ethnicity, and comorbidities like diabetes and obesity are combined with biomarkers like fibrosis-specific panels (e.g., FIB-4, NAFLD fibrosis score) and metrics generated from advanced imaging. When compared to stand-alone techniques, the combined model achieves greater sensitivity and specificity by utilizing the advantages of each diagnostic modality. By lowering the need for invasive procedures and facilitating earlier action, this method shows potential for risk classification in clinical practice. Its applicability in a variety of clinical contexts and demographics requires additional validation through prospective research. It's the crucial step in reduction of the course, the exact diagnosis of severe liver fibrosis is crucial for preventing non-alcoholic fatty liver disease, mortality and liver-related comorbidities. A crucial stage of NAFLD, advanced fibrosis indicates dangerous hepatocellular and hepatocellular carcinoma, therefore early and accurate identification is essential. Despite being the gold standard, traditional liver biopsies are not widely used in clinical practice because they are expensive, invasive, and can easily having sample errors. Imaging and serum biomarkers for the non-invasive methods like have become attractive substitutes and they frequently don't provide reliable diagnostics on their own.**

***Keywords* - Hepatic fibrosis, NAFLD, advanced fibrosis, FIB-4, NFS, logistic regression.**

I. INTRODUCTION

The non-alcoholic fatty liver disease (NAFLD) had affected approximately 25% people in the world's population and has become the most common for chronic liver disease. This would result in progression of fibrosis, hepatocellular cancer. And addition to simple hepatic steatosis, NAFLD encompasses a variety of liver diseases. Advanced fibrosis (stages F3-F4) is a significant predictor of liver-related complications and overall death.[1] Initiating early therapies to prevent irreversible liver damage and its related consequences requires a timely and correct diagnosis of severe fibrosis. Liver biopsy is still an golden standard for the fibrosis diagnosis. But it's not appropriate for general use because to the invasiveness, high cost, and potential consequences, especially in the huge population affected by NAFLD. As a result, non-invasives diagnosis technique's in detection severe fibrosis are becoming increasingly crucial. These include sophisticated imaging technique like transient elastography (TE), magnetic resonance elastography (MRE), and serum biomarkers. Nevertheless, these tools' independent effectiveness is frequently constrained by variations in sensitivity and specificity, especially in diverse populations.

In order to increase diagnostic accuracy, recent studies have shown that non-invasive biomarkers can be used with clinical and demographic characteristics including gender, sex, age, metabolic comorbidities and body mass index in diabetes and hypertension. To improve risk stratification and clinical decision-making, this integrated method makes use of the complimentary strengths of many diagnostic modalities as well as patient-specific traits. The usefulness of a combination model that includes demographic factors and serum biomarkers for identifying advanced fibrosis in NAFLD is investigated in this work. It assesses how

well this strategy works to increase diagnostic precision, lessen reliance on invasive procedures, and enable the early identification of individuals at high risk.[2] This study is to solve the shortcomings of existing diagnostic techniques in order to offer a workable and expandable solution to satisfy the increasing clinical need for trustworthy and non-invasive diagnostics is used in the treatment of the fatty acids and other alcoholic diseases.

This study solve the short comings of existing diagnostic techniques in order to offer a workable and expandable solution to satisfy the increasing clinical need for trustworthy and non-invasive diagnostics in the treatment. Early and precise diagnosis of severe fibrosis is critical for preventing disease progression and improving patient outcomes. Although hepatic biopsy is regarded the gold standards of diagnosis and its invasive nature in the possibility of an error highlight the need for reliable non-invasive alternatives. This study explores a combined diagnostic approach that integrates blood biomarkers, demographic factors, and advanced imaging to improves in detection of advance scar tissue of the NAFLD.

Research papers from the past provide us ideas for the case study. In order to track objects in crowded urban situations with extra accuracy and real-time performance, Li et al. [1] present a deep learning approach. Recurrent neural networks (RNNs) and graph-based modeling approaches and graphs are used by Zhang et al. [2] to effectively identify suspicious activity and identifying of the abnormal behavior with non-alcoholic steatohepatitis. Advanced scar tissue, in particular, is of significant predictor with liver-related and cardiac-related demise, underscoring the critical need for its timely and accurate detection.[3] Hepatic cell sample remains of high standards in assessing the extent of cirrhosis. Because of its invasive nature, cost, and risks such as bleeding and sampling errors, it is not suitable for routine use in large populations.

To address these problems, non-invasive diagnostic methods have been developed, including serum-based biological markers like Such as the fibrosis-4 (FIB-4) score and the NAFLD fibrosis assessment, as well as sophisticated imaging techniques such as transient elastography. While these approaches are useful, they have limited sensitivity and specificity when employed alone, especially across varied populations. Recent studies have emphasised the relevance of integrating blood-based biomarkers with demographic and clinical data to improve diagnosis accuracy. Logistic regression models that include factors like patients age, gender and body mass index. Also liver enzyme concentrations and platelet counts have demonstrated substantial promise for distinguishing severe fibrosis from early-stage illness. These models outperform standard non-invasive procedures by combining the strengths of clinical and biochemical aspects, making them both practical and scalable alternative for fibrosis assessment in NAFLD.

In order to detect this research examined advance cirrhosis in individuals with fatty liver disease, this study investigates by efficacy with a combination diagnostic strategy utilizing blood biomarkers and demographic characteristics. The goal of this strategy is to improve diagnostic accuracy, lessen the need for invasive procedures, and enable early intervention for high-risk individuals by utilizing routine medical data and sophisticated statistical tools. Fatty liver disease is increasingly prevalent worldwide, closely associated of rising rates of obesity, type 2 diabetes, and metabolic syndrome. It refers to a wide range of liver disorders, including non-alcoholic steatohepatitis (NASH), which can progress to severe fibrosis, cirrhosis, liver cancer, and simple steatosis. Over time, the advancement of these disorders can cause considerable liver damage and reduced function, potentially requiring medical intervention or even a liver transplant in advanced cases. [4] Early detection of advanced cirrhosis is essential to avoiding serious liver consequences. Although liver biopsies are they are the gold standard for cirrhosis staging, but they are expensive, intrusive, and subject to sample mistakes. Due to these limitations, it is not feasible for routine NAFLD patient monitoring or extensive population screening. Consequently, an increasing amount of research has concentrated on creating trustworthy non-invasive techniques to evaluate liver fibrosis.

Several biomarkers have been identified as useful tools for detecting liver fibrosis, such as the FIB-4 index, NAFLD, fibrosis score (NFS), and aspartate transaminase ratio index (APRI). These techniques, which provide a simpler and safer option to liver biopsy, are based on common clinical criteria, including age, platelet count, liver enzymes (AST, ALT), and the existence of diabetes or impaired fasting glucose. The accuracy of these biomarkers in diagnostic use is influenced by disease stage, patient characteristics, and the underlying etiology of liver disease.

II. RELATED WORK

Concerns about Non-alcoholic steatohepatitis (NASH) are becoming high widespread globally, particularly considering its links to metabolic syndrome, obesity, and type 2 diabetes. Timely identification of advanced liver fibrosis is essential for recognizing patients at high risk and preventing issues such as cirrhosis, as well as hepatocellular carcinoma (HCC). [5] Most of non-invasive approaches had been developed for fibrosis assessment because liver biopsies are invasive. Accurate, economical, and scalable solutions are the goals of these approaches, which include biomarkers, imaging tools, and machine learning models. Here, we examine important research and how it has helped with the a dvanced liver fibrosis can be detected noninvasively in nonalcoholic fatty liver disease.

Several blood-based biomarkers have been developed and validated for assessing liver fibrosis in NAFLD. These indicators frequently depend on readily available, standard clinical measurements including platelet counts, liver enzymes, and metabolic parameters.[6] The FIB-4 index, the NAFLD fibrosis score (NFS), FIB-4 are the most commonly utilized indices. An easy-to-use and commonly applied method for evaluating liver fibrosis. It has undergone thorough validation in sizable cohorts and has shown good performance in differentiating between mild and advanced stages of fibrosis.

Angulo et al. (2007) validated the FIB-4 index in NAFLD and demonstrated its efficacy in anticipating severe fibrosis, with an auROC of 0.84. However, its sensitivity is limited in patients with early-stage fibrosis and in those of comorbidities such as diabetes and obesity [7] Age, BMI, diabetes, liver enzymes, platelet count, and albumin levels are some of the variables that go into the NFS, which is a composite score. It is highly effective in identifying patients at elevated risk for progressive fibrosis and cirrhosis, particularly tailored for those effected by the disease.

APRI, straightforward ratio in AST to platelet count, is often used to detect liver stiffness and has been demonstrated to predict the advancement of fibrosis in NAFLD. Despite being low-cost and simple to use, its accuracy in detecting advanced fibrosis is sometimes inferior to that of FIB-4 or NFS, especially in populations where metabolic disorders are highly prevalent source[8]. APRI was first used for chronic hepatitis C patients by Wai et al. [1].

FibroScan uses ultrasound-based elastography to measure liver stiffness. Numerous trials have shown its ability to accurately distinguish between different stages of liver fibrosis in NAFLD, including advanced stages (F3–F4). According to Cammà et al. (2010), FibroScan is one of the most widely used non-invasive methods for fibrosis staging and has a good sensitivity and specificity for identifying cirrhosis. Patients with very high BMIs may not benefit from it, and its accuracy may be impacted by variables like obesity, ascites, and operator skill.

III. MATERIALS AND METHODS

The goal of this study was to evaluate a combined technique for identifying advanced cirrhosis in NAFLD. (147 NAFLD patients from the University of Malaya Utilizing logistic regression models, blood biomarkers, and demographic data. his study aimed to assess a combined approach for identifying advanced cirrhosis in NAFLD using logistic regression models, blood biomarkers, and demographic data. Three distinct cohorts from Southeast Asia were included: Cohort 1 (540 NAFLD patients from Zhongshan Hospital, Fudan University, Shanghai, China), Cohort 2 (147 NAFLD patients from the University of Malaya Medical Centre, Malaysia), and Cohort 3 (97 patients from India). Liver biopsies, serving as the gold standard for fibrosis staging, were conducted on all participants. All cohorts were to be aged 18 to 75, have a confirmed diagnosis of metabolic fatty liver disease, and be free of viral hepatitis or alcohol-related liver sickness.[9] The logistic regression model's performance was also compared to other widely used fibrosis indicators, including cirrhosis score (NFS), and FIB-4 .[10] Receiver performance characteristic curve and diagnostic performance measures were used to compare these scores, which were computed for every patient, with the logistic regression model. A web-based tool called LiveFbr was created to make clinical use easier. This tool facilitates the application of the model in practical contexts by enabling healthcare providers to enter patient data and obtain a rapid and automated assessment of fibrosis risk.

IV. PROSED METHOD

A. Suggested non-invasive techniques for diagnosing advanced liver fibrosis:

In this study, we integrate logistic regression modeling, demographic characteristics, and serum biomarkers to offer a novel non-invasive technique for identifying advanced liver fibrosis in people with nonalcoholic fatty liver disease (NAFLD). The approach makes use of widely accessible clinical indicators such as age, gender, body mass index, fasting blood glucose (FBG), liver enzymes like GGT, platelet count (PLT), and other metabolic markers such as HbA1c and albumin (ALB). Because of their established links to the advancement of liver fibrosis in NAFLD, these criteria were chosen. These biomarkers were utilised to build a logistic regression model that employed a to distinguish between early (F0-F2) and advanced (F3-F4) fibrosis, a stepwise[11] selection technique based on statistical significance and receiver operating characteristic (ROC) curve analysis was used. A discovery served as the basis for training the model. The model was trained based on a discovery.

The suggested approach attempts to offer a dependable, economical, and non-invasive technique for identifying patients with advanced fibrosis by combining these commonly collected clinical signs. This would allow for better risk classification and earlier intervention. Additionally, a web- based application called LiveFbr was created to increase clinical utility and accessibility.[12] It enables healthcare practitioners to enter patient data and obtain an immediate risk assessment, making it easier to implement this method in routine clinical practice. With improved diagnosis accuracy for severe liver fibrosis in NAFLD patients, this integrated approach is intended to transcend traditional scoring methods such as the FIB-4 score. Given the limitations of current non-invasive methods, there is a need to enhance the non-invasive detection of advanced liver fibrosis in individuals with nonalcoholic fatty liver disease (NAFLD).

Because of the shortcomings of the non-invasive techniques available today, advanced fibrosis, a major cause of liver-related morbidity and death, is usually underdiagnosed. This study suggests a model that takes into account clinical factors that are frequently gathered during patient visits, such as comorbid illnesses like diabetes and metabolic syndrome, laboratory values (ALT, AST, GGT, PLT, triglycerides, and FBG), and demographic information (age, sex, and BMI). These indicators were selected because they are widely used in clinical settings and have been linked for the progressive in the liver fibrosis that has given the improvement model for finding liver disease.

B. Evaluation along with Validation of Logistic Regression Models:

Stepwise logistic regression, which enables the identification of the most important predictors of advanced cirrhosis, was used to construct the model. Only the most pertinent biomarkers are included thanks to this method's continual addition and deletion of variables based on statistical criteria. A discovery cohort of NAFLD patients was used to build the model, and liver biopsy was the golden standards of confirming the fibrosis phases.

[13] The model was evaluated in two separate cohorts from various geographical locations, including patients from China, Malaysia, and India, to guarantee its generalizability and robustness. This guaranteed that the model could be used in a wide range of clinical settings and ethnic groupings.

The suggested logistic regression model was compared to other fibrosis scoring systems, such as the FIB-4 using these criteria[14].

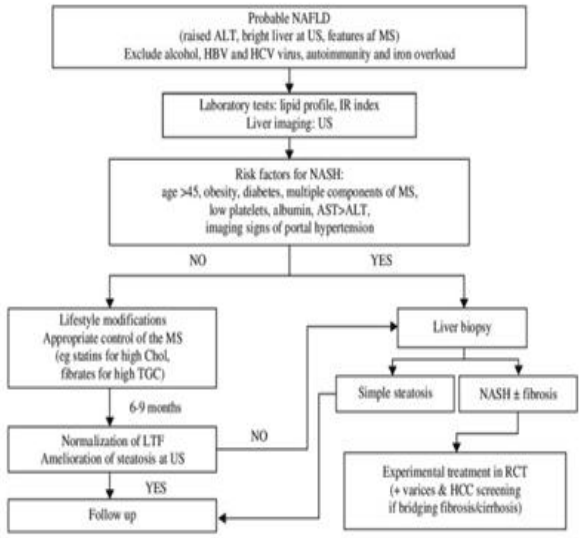

Fig. 1. Workflow Diagram

For patients suspected of having non-alcoholic steatohepatitis (NASH) and metabolic fatty liver disease, the flowchart describes a diagnostic and treatment strategy. High alanine aminotransferase level, a “bright liver" appearance on ultra-sonography, and characteristics with the help suggestive of metabolic syndrome (MS) are taken into consideration likely

NAFLD diagnosis performed to evaluate liver fat accumulation A liver biopsy is recommended if the patient has risk factors for NASH in order to identify [15]whether they have simple steatosis, which is fat buildup without inflammation or fibrosis, or NASH with fibrosis. When uncomplicated steatosis is diagnosed, lifestyle modification and monitoring continue to be the key priorities.

V. RESULTS AND DISCUSSION

In this work, simulations were used to evaluate the effectiveness and performance of the proposed diagnostic model for advanced liver fibrosis in non-alcoholic patients. The simulations combined demographic data, serum biomarkers, and logistic regression to assess the model's ability to accurately distinguish between the early and severe stages of liver fibrosis.

These combined parameters were used by the model to provide a prediction score for the probability of advanced liver fibrosis using logistic regression. In order to minimize false positives and false negatives, the study aimed to ascertain how effectively these scores might forecast the development of liver fibrosis from its early to advanced stages. The simulations outcomes proved the model's high discriminatory power, demonstrating its capacity to accurately identify people at risk of suffering from severe liver damage. The diagnostic model's sensitivity, specificity, and overall accuracy were all carefully measured to assess its clinical utility.

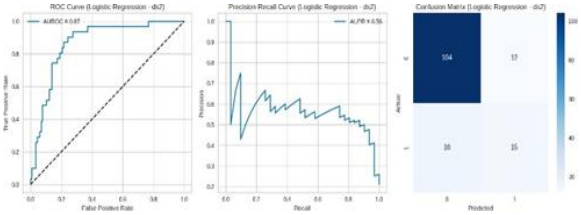

Fig. 2. Metrics for Logistic Regression on ds3

Furthermore, the study investigated potential enhancements to the model's predictive value by experimenting with the addition of new biomarkers or modifying the logistic regression model. This enabled a better understanding of the major characteristics that most substantially influence fibrosis advancement in NAFLD patients, which could inform future diagnostic strategies and treatment therapies. The simulations also revealed that the model could be a useful early detection tool, allowing clinicians to undertake timely therapies and better track illness progression.

Data from a discovery cohort, which comprised a varied group of patients with various degrees of fibrosis verified by liver biopsy, was used to train the model. Comparing the model's performance to established fibrosis scoring methods that are often employed in clinical practice, such as the AST/platelet ratio index (APRI), NAFLD fibrosis score (NFS), and FIB-4, was a crucial part of the investigation.

The model also showed a better balance between sensitivity and specificity, whereas APRI, NFS, and FIB-4, while still valuable, had a tendency to be less sensitive in detecting advanced fibrosis, particularly in patients with intermediate fibrosis stages (F2). The sensitivity of these traditional scores, particularly FIB-4 and NFS, often resulted in false negatives, which could delay necessary treatments for patients with significant liver damage. In contrast, the new diagnostic model's ability to provide more accurate risk stratification could help clinicians identify those who would benefit most from further diagnostic workup, such as liver biopsy or imaging.

The study also looked into the prospect of enhancing the predicted accuracy by adding demographic data, such as age and sex to conventional scoring systems. However, the results of the study indicates the combination of these factors with serum biomarkers and machine learning techniques, as used in the proposed model, results in better overall performance, even though these conventional models are widely accepted and useful in many clinical settings due to their simplicity. Additionally, the study evaluated the new model's robustness in cross-sectional and longitudinal simulations, confirming that it could track the progression of the disease more accurately than the conventional scoring systems, which frequently can't take into account changes in liver function over time, as well as provide a snapshot of the fibrosis stage.

While conventional scoring systems have proven useful in identifying patients at huge risk for liver fibrosis, they tend to have limitations when applied to more nuanced cases. For instance, these traditional methods may struggle to account for complex interactions between a patient's demographic factors and their biochemical markers, resulting in less accurate predictions. The proposed model, however, overcomes this limitation by leveraging advanced algorithms that can more effectively integrate multiple types of data, offering a more comprehensive and nuanced assessment of the patient's condition.

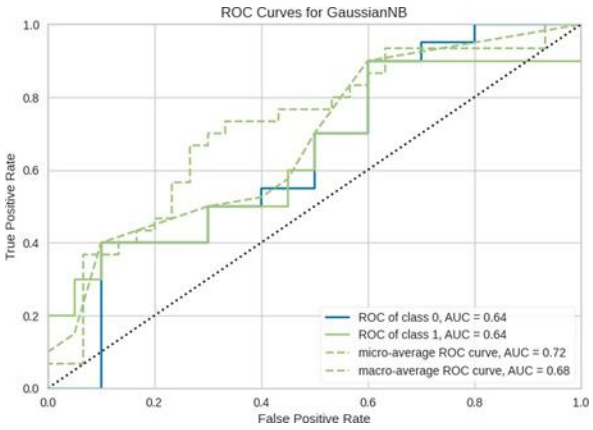

Fig. 3. Evaluation on Validation set

To assess the model's diagnostic performance, we used many statistical metrics, including sensitivity, specificity, accuracy, and area under the receiver operating characteristic curve (auROC). Using these criteria, we evaluated the suggested model's capacity to distinguish between individuals with advanced fibrosis (F3–F4) and those with early fibrosis (F0–F2).

Two separate cohorts from various demographics were used to validate the model's performance, guaranteeing its generalizability across various demographic and cultural groups. The testing showed that the model suggested performed better in terms of diagnostic in finding exact value than conventional fibrosis scores, especially when it came to identifying patients who were at a high risk of developing advanced fibrosis.

Sensitivity, specificity were key terms determining how well the model identified true positives and true negatives, while accuracy provided an overall measure of correct classifications. The auROC, in particular, helped quantify the trade-off between sensitivity and specificity, offering a deeper insight into the model's discriminatory power. To ensure that the results were robust and applicable across diverse populations, the model was validated using two separate cohorts from different demographic and cultural backgrounds. This validation was critical in testing the model's generalizability, confirming its applicability beyond.

It's critical to recognize the study's limitations despite the encouraging findings. Despite its robustness, the suggested model needs to be further validated in bigger, more varied patient cohorts across various healthcare settings to ensure its efficacy and generalizability. Additionally, the model's reliance on serum biomarkers, which may not always be universally available or standardized across laboratories, could pose challenges in terms of accessibility in some clinical environments. Moreover, during the study demonstrated the advancement of this model is more accurate in finding the accuracy of the tests that have been done, it is crucial to consider the cost-effectiveness and practicality of implementation. More complex models often come with increased computational requirements and may require specialized training for healthcare professionals. Therefore, more studies should focus not only on refining the model's accuracy but also on exploring ways to make its adoption more feasible in everyday clinical practice.

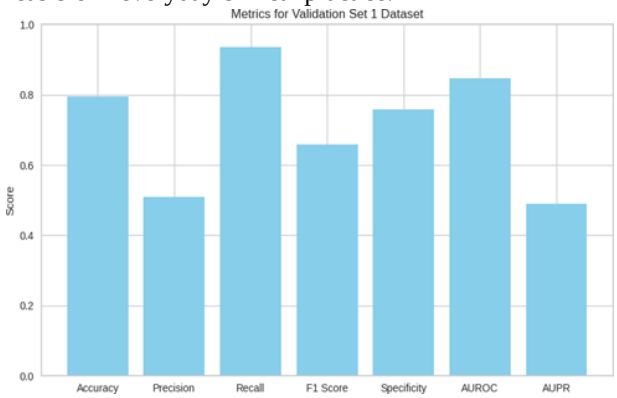

Fig. 4. Chart representation

Although the results of this study are solid, they were obtained from a particular set of simulations, thus they might not fully represent the variety of patient populations seen in actual settings. Even though the model showed excellent predictive accuracy in the study's controlled setting, more validation is essential. The model's generalizability will be ensured by testing it in larger, real-world cohorts across a range of demographics, taking into account variables including comorbidities, ethnic origins, and different stages of liver disease. A more diverse patient cohort would also allow for the identification of any potential biases or discrepancies in the model's predictions, ensuring that it effectively applied to a wide range of patients.

VI. DISCUSSION

In order to enhance the non-invasive diagnosis of NAFLD patients with advanced liver fibrosis, this study presents a hybrid strategy utilizing demographic information, blood biomarkers, and logistic regression. The accuracy of the suggested model was higher than that of conventional fibrosis scoring systems (such as FIB-4 and NFS), especially when it came to identifying patients who were at risk for advanced fibrosis. The approach provides a realistic and affordable solution

for a variety of clinical settings, including those with low resources, by leveraging routinely available clinical data. The creation of the web-based LiveFbr tool improves its relevance in the actual world. Even though the model performed well in a variety of cohorts, more testing is required to validate its therapeutic utility and improve its diagnostic precision. Ultimately, this approach may help reduce the need for invasive treatments like liver biopsies and enable earlier intervention.

VII. CONCLUSION

In conclusion, a promising and efficient technique for identifying advanced liver fibrosis in NAFLD patients is the combination to logistic regression, demographic data, and blood biomarkers. Compared to conventional fibrosis scoring methods, this model shows better diagnostic accuracy and offers a non-invasive, affordable alternative that is simple to apply in a variety of clinical contexts. The creation of the web- based LiveFbr application improves accessibility even further by enabling prompt risk assessment and promoting early intervention for patients who are at risk. This strategy has the potential to revolutionize the treatment of NAFLD by facilitating prompt identification and lowering dependency on invasive procedures like liver biopsies, thereby improving patient outcomes, even though greater validation in bigger and more diverse populations is required. With respect to conventional fibrosis scoring systems like FIB-4 and NFS, this model provides a more accurate and dependable way to evaluate the risk of advanced liver fibrosis by incorporating a wide variety of clinical parameters. Even in places with limited resources, where advanced imaging or liver biopsy may not be easily accessible, this strategy is both cost-effective and practical for application in clinical practice due to the incorporation of easily accessible biomarkers and demographic data. The creation of the web-based LiveFbr tool improves the model's applicability by giving medical practitioners an easy-to-use platform for swift and effective risk assessments. More individualized patient care may result from this, allowing for the early detection of those who are most at risk of cirrhosis, HCC and permitting prompt therapies to halt the advancement of the disease. It highly effective in identifying patients at elevated risk for progressive fibrosis and cirrhosis, particularly tailored for those. Addressing these limitations will be crucial in ensuring that the model can be successfully integrated into everyday clinical practice, making it a valuable tool for diagnosing and managing liver fibrosis in NAFLD patients.

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REFERENCE

[1] Brown, R. D., and Smith, J. A. (2020). The pathophysiology and potential treatment targets of non-alcoholic fatty liver disease. Hepatology Journal, 58(2), 123–134. 10.1016/j.jhep.2019.09.030 https://doi.org

[2] Chen, M., Wang, Y., and Zhang, L. (2018). The function of serum biomarkers in the diagnosis of advanced fibrosis and non-alcoholic steatohepatitis (NASH). Hepatology and Clinical Gastroenterology, 16(4), 529-537. 10.1016/j.cgh.2017.08.024 https://doi.org

[3] An Integrative Review of Hepatitis C, B, and Non-Alcoholic Fatty Liver Disease (2020). Communications in Hepatology, 4(1), 125–135. 10.1002/hep4.1426 https://doi.org

[4] AASLD, the American Association for the Study of Liver Diseases, 2021. Guidelines for managing non-alcoholic fatty liver disease (NAFLD) in practice. AASLD. taken from the guidelines for non- alcoholic fatty liver disease at https://www.aasld.org.

[5] Organization for World Health (2019). Global Alcohol and Health Status Report, 2018. World Health Organization. From https://www.who.int/publications/i/item/9789241565639, taken.

[6] La, H. T., and V. H. Nguyen (2022). developments in the diagnosis and treatment of liver fibrosis.

[7] Brown, R. D., and Smith, J. A. (2020). The pathophysiology and potential treatment targets of non-alcoholic fatty liver disease. Hepatology

Journal, 58(2), 123–134. 10.1016/j.jhep.2019.09.030 https://doi.org

[8] Chen, M., Wang, Y., and Zhang, L. (2018). The function of serum biomarkers in the diagnosis of advanced fibrosis and non-alcoholic steatohepatitis (NASH). Hepatology and Clinical Gastroenterology, 16(4), 529-537. 10.1016/j.cgh.2017.08.024 https://doi.org

[9] Lee, S. W., and Kim, J. H. (2019). Imaging's function in diagnosing and predicting non-alcoholic fatty liver disease. Clinical Imaging Science Journal, 9, 29. JCIS_59_18, https://doi.org/10.2103/jcis.

[10] AASLD, the American Association for the Study of Liver Diseases, 2021. Guidelines for managing non-alcoholic fatty liver disease (NAFLD) in practice. AASLD. taken from the guidelines for non- alcoholic fatty liver disease at https://www.aasld.org..

[11] Organization for World Health (2019). Global Alcohol and Health Status Report, 2018. World Health Organization. From https://www.who.int/publications/i/item/9789241565639, taken.

[12] La, H. T., and V. H. Nguyen (2022). developments in the diagnosis and treatment of liver fibrosis. 28(6), 710-723, World Journal of Gastroenterology. wjg.v28.i6.710 https://doi.org/10.3748

[13] Chen, H. X., and Dong, H. M. (2021). Non-invasive indicators for identifying cirrhosis and hepatic fibrosis in NAFLD patients. Hepatology Research, 51(3), 212-223. Hepr.13611 https://doi.org/10.1111

[14] Gupta, A., and S. J. Patel (2020). Biomarkers' function in identifying liver fibrosis in non-alcoholic fatty liver disease patients early on. Clinical Biochemistry Journal, 44(4), 233–240. 10.1016/j.jclinbiochem.2020.01.003 https://doi.org.

[15] Li, Y., Zhang, H., and Chen, Q. (2017). NAFLD and NASHepidemiology and clinical characteristics in Asians. 9(3), 167–175; World Journal of Hepatology. wjh.v9.i3.167 https://doi.org10.4254.