

## Research Article

# CORRELATION OF FIBROSCAN FINDINGS WITH FIB-4 AND NAFLD FIBROSIS SCORE IN PATIENTS WITH NAFLD

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**Abstract:** **Introduction:** Non-alcoholic fatty liver disease (NAFLD) is the most prevalent chronic liver disease worldwide and is characterized by excessive hepatic fat accumulation that may progress to advanced fibrosis, cirrhosis, and hepatocellular carcinoma. Liver fibrosis is the strongest predictor of liver-related morbidity and mortality. Although liver biopsy remains the reference standard for fibrosis assessment, its invasive nature limits routine clinical use. Consequently, non-invasive modalities such as transient elastography (FibroScan), Fibrosis-4 (FIB-4) Index, and NAFLD Fibrosis Score (NFS) have become valuable tools for evaluating fibrosis severity. Assessing the correlation among these methods may improve diagnostic accuracy and facilitate early identification of patients with advanced fibrosis. **Aim:** To evaluate the correlation between FibroScan findings, Fibrosis-4 (FIB-4) Index, and NAFLD Fibrosis Score (NFS) in patients with non-alcoholic fatty liver disease. **Materials and Methods:** A hospital-based cross-sectional observational study was conducted among 63 adult patients with ultrasonographically diagnosed NAFLD. Clinical assessment, anthropometric measurements, and laboratory investigations including liver function tests, platelet count, and serum albumin were performed. Liver stiffness was measured using FibroScan, while FIB-4 and NFS were calculated using validated formulas. Patients were categorized according to FibroScan fibrosis stage, FIB-4 risk category, and NFS classification. Correlation between FibroScan findings and non-invasive fibrosis scores was analyzed using Pearson's correlation coefficient, Chi-square test, and one-way ANOVA. A p-value of <0.05 was considered statistically significant. **Results:** Among the 63 patients, 49.2% had mild fibrosis (F0–F1), 27.0% had significant fibrosis (F2), 15.9% had advanced fibrosis (F3), and 7.9% had cirrhosis (F4) according to FibroScan. FIB-4 classified 55.6% of patients as low risk, 31.7% as intermediate risk, and 12.7% as high risk, while NFS identified 41.3% as low fibrosis, 36.5% as indeterminate, and 22.2% as advanced fibrosis. Mean FIB-4 and NFS values increased significantly with advancing FibroScan stage ( $p < 0.001$ ). A strong positive correlation was observed between FibroScan liver stiffness measurements and both FIB-4 and NFS, demonstrating good agreement among the three non-invasive fibrosis assessment methods. **Conclusion:** FibroScan findings show a significant positive correlation with both Fibrosis-4 Index and NAFLD Fibrosis Score in patients with non-alcoholic fatty liver disease. The combined use of these non-invasive modalities provides an accurate, practical, and cost-effective approach for identifying advanced liver fibrosis, improving risk stratification, and reducing the need for invasive liver biopsy in routine clinical practice.

**Keywords:** Non-alcoholic fatty liver disease, FibroScan, Liver fibrosis, FIB-4, NAFLD Fibrosis Score, Transient elastography, Non-invasive assessment.

## INTRODUCTION

Non-alcoholic fatty liver disease (NAFLD) is the most common chronic liver disease worldwide and has emerged as a major public health concern due to the increasing prevalence of obesity, type 2 diabetes mellitus, insulin resistance, and metabolic syndrome. The disease encompasses a broad spectrum ranging from simple hepatic steatosis to non-alcoholic steatohepatitis (NASH), progressive fibrosis, cirrhosis, and hepatocellular carcinoma. Liver fibrosis is the strongest predictor of liver-related complications and mortality, making early identification of fibrosis an essential component of NAFLD management. Younossi et al. estimated that nearly one-quarter of the global population is affected by NAFLD, emphasizing the growing burden of the disease and the need for effective, non-invasive diagnostic strategies.(1)

Traditionally, liver biopsy has been regarded as the gold standard for assessing hepatic fibrosis. However, its invasive nature, sampling variability, procedural risks, and high cost limit its routine clinical use. Consequently, there has been increasing emphasis on developing reliable non-invasive methods for fibrosis assessment. The American Association for the Study of Liver Diseases (AASLD) recommends the use of validated non-invasive fibrosis assessment tools to identify patients at risk of advanced fibrosis before considering liver biopsy. These approaches facilitate early diagnosis while minimizing unnecessary invasive procedures.(2)

Among the available non-invasive modalities, transient elastography (FibroScan) has become one of the most widely accepted techniques for evaluating liver fibrosis. FibroScan measures liver stiffness by assessing the

propagation velocity of shear waves through hepatic tissue, providing a rapid, painless, and reproducible estimate of fibrosis severity. Castera et al. demonstrated that FibroScan possesses excellent diagnostic accuracy for detecting significant fibrosis and cirrhosis in patients with NAFLD and has become an important component of routine hepatology practice.(3)

Current European Association for the Study of the Liver (EASL) guidelines also recommend a stepwise non-invasive approach for fibrosis evaluation. The guidelines advocate the use of simple biochemical fibrosis scores followed by transient elastography for patients with indeterminate or high-risk results. This sequential strategy improves diagnostic efficiency, reduces unnecessary referrals, and minimizes dependence on liver biopsy while maintaining high sensitivity for detecting advanced fibrosis.(4)

Several biochemical fibrosis scoring systems have been developed using routinely available clinical and laboratory parameters. Among these, the NAFLD Fibrosis Score (NFS) is one of the most extensively validated tools. It incorporates age, body mass index, diabetes status, serum albumin, platelet count, and AST/ALT ratio to estimate fibrosis severity. Angulo et al., who developed the NFS, demonstrated that the score reliably differentiates patients with advanced fibrosis from those with minimal disease and possesses a high negative predictive value, making it particularly useful for excluding advanced fibrosis in clinical practice.(5)

Similarly, the Fibrosis-4 (FIB-4) Index, calculated using age, AST, ALT, and platelet count, has gained widespread acceptance as an initial screening tool because of its simplicity, low cost, and good diagnostic performance. Kaya et al. reported that simple non-invasive fibrosis scores such as FIB-4 are especially useful for excluding advanced fibrosis, although their ability to predict advanced fibrosis is comparatively limited. These findings support their role as first-line screening tests that identify patients requiring further assessment with imaging modalities such as FibroScan.(6)

More recently, growing evidence has demonstrated strong agreement between FibroScan and biochemical fibrosis scores. Zhang et al. found that non-invasive fibrosis markers, including FIB-4 and NFS, showed significant associations with advanced fibrosis identified by transient elastography. Their findings suggest that combining biochemical scores with FibroScan improves diagnostic accuracy and enables more effective identification of patients with clinically significant fibrosis.(7)

Further supporting this concept, Ding et al. demonstrated that the FIB-4 Index showed excellent agreement with FibroScan in detecting advanced liver fibrosis and may serve as an effective screening tool for early

identification of high-risk patients with NAFLD. The authors concluded that sequential use of FIB-4 followed by FibroScan improves risk stratification while reducing unnecessary invasive investigations, thereby providing a practical and cost-effective approach to fibrosis assessment.(8)

Therefore, the present study was undertaken to evaluate the correlation between FibroScan findings, Fibrosis-4 (FIB-4) Index, and NAFLD Fibrosis Score (NFS) in patients with non-alcoholic fatty liver disease. Establishing the relationship among these validated non-invasive modalities may improve early detection of advanced fibrosis, optimize patient risk stratification, and reduce the need for liver biopsy in routine clinical practice.

## MATERIALS AND METHODS

### Study Design

A hospital-based cross-sectional observational study was conducted to evaluate the correlation between FibroScan findings, Fibrosis-4 (FIB-4) score, and NAFLD Fibrosis Score (NFS) in patients with non-alcoholic fatty liver disease.

### Study Setting

The study was carried out in the Department of Gastroenterology of a tertiary care teaching hospital.

### Study Duration

The study was conducted over **18 months** after obtaining approval from the Institutional Ethics Committee.

### Study Population

Adult patients diagnosed with NAFLD attending the outpatient department or admitted to the gastroenterology unit were enrolled consecutively.

### Sample Size

A total of **63 patients** with confirmed NAFLD were included in the study.

### Inclusion Criteria

- Adults aged 18–75 years.
- Ultrasonographic evidence of fatty liver.
- Diagnosis of NAFLD after exclusion of secondary causes.
- Patients willing to provide written informed consent.

### Exclusion Criteria

- Significant alcohol consumption.
- Viral hepatitis.
- Autoimmune liver disease.
- Drug-induced liver disease.
- Wilson disease or hemochromatosis.
- Pregnancy.
- Malignancy.
- Previous liver transplantation.

## Clinical Assessment

Detailed demographic characteristics, anthropometric measurements, history of diabetes, hypertension, medication use, and metabolic risk factors were recorded.

## Laboratory Investigations

The following investigations were performed:

- Complete blood count
- AST
- ALT
- Serum albumin
- Platelet count
- Lipid profile
- Fasting blood glucose

## FibroScan Assessment

Transient elastography (FibroScan) was performed using the FibroScan device after overnight fasting. At least ten valid measurements with an interquartile range less than 30% were obtained. Liver stiffness measurements (kPa) were categorized into:

- **F0–F1:** Mild fibrosis
- **F2:** Significant fibrosis
- **F3:** Advanced fibrosis
- **F4:** Cirrhosis

## FIB-4 Score Calculation

FIB-4 score was calculated using the standard equation:

$$\text{FIB-4} = (\text{Age} \times \text{AST}) / (\text{Platelet count} \times \sqrt{\text{ALT}})$$

Patients were classified as:

- **<1.45:** Low fibrosis risk
- **1.45–3.25:** Intermediate risk
- **>3.25:** High fibrosis risk

## NAFLD Fibrosis Score (NFS)

NFS was calculated using the validated equation incorporating:

- Age
- BMI
- Diabetes status
- Platelet count
- Albumin
- AST/ALT ratio

Patients were categorized as:

- **<-1.455:** Low fibrosis
- **-1.455 to 0.675:** Indeterminate fibrosis
- **>0.675:** Advanced fibrosis

## Outcome Measures

### Primary Outcome

- Correlation between FibroScan liver stiffness and FIB-4 score.

### Secondary Outcomes

- Correlation between FibroScan liver stiffness and NFS.
- Agreement among FibroScan, FIB-4, and NFS in identifying advanced fibrosis.

## Statistical Analysis

Data were analyzed using **SPSS version 26.0**. Continuous variables were expressed as mean  $\pm$  standard deviation, while categorical variables were presented as frequencies and percentages. Pearson's correlation coefficient was used to evaluate the relationship between FibroScan, FIB-4, and NFS. Chi-square test and one-way ANOVA were used for group comparisons. A p-value  $<0.05$  was considered statistically significant.

# RESULTS

A total of 63 patients with non-alcoholic fatty liver disease (NAFLD) were included in the present study. Liver fibrosis was assessed using FibroScan (Transient Elastography) and compared with two validated non-invasive fibrosis scoring systems, namely Fibrosis-4 (FIB-4) and NAFLD Fibrosis Score (NFS). The findings demonstrated a significant positive correlation between FibroScan liver stiffness measurements and both fibrosis scoring systems. Patients with advanced fibrosis on FibroScan consistently exhibited higher FIB-4 and NFS values compared with those having mild fibrosis. The correlation was statistically significant, supporting the utility of these non-invasive tools for fibrosis assessment.

**Table 1: Distribution of Patients According to FibroScan Fibrosis Stage (n=63)**

| FibroScan Stage           | Liver Stiffness (kPa) | Number | Percentage (%) |
|---------------------------|-----------------------|--------|----------------|
| F0–F1 (Mild fibrosis)     | <7.0                  | 31     | 49.2           |
| F2 (Significant fibrosis) | 7.0–10.7              | 17     | 27.0           |
| F3 (Advanced fibrosis)    | 10.8–16.7             | 10     | 15.9           |
| F4 (Cirrhosis)            | $\geq 16.8$           | 5      | 7.9            |
| Total                     | —                     | 63     | 100            |

**Interpretation:** Nearly half (49.2%) of the patients had mild fibrosis (F0–F1) on FibroScan, whereas 27.0% showed significant fibrosis (F2). Advanced fibrosis (F3) and cirrhosis (F4) were observed in 15.9% and 7.9% of patients, respectively, indicating that almost one-fourth (23.8%) had advanced liver fibrosis requiring close clinical monitoring.

**Table 2: Correlation of FibroScan Findings with FIB-4 Score**

| FibroScan Stage | Low Risk (<1.45) | Intermediate (1.45–3.25) | High Risk (>3.25) | Total | p value |
|-----------------|------------------|--------------------------|-------------------|-------|---------|
| F0–F1           | 26 (83.9%)       | 5 (16.1%)                | 0                 | 31    |         |
| F2              | 8 (47.1%)        | 8 (47.1%)                | 1 (5.8%)          | 17    |         |
| F3              | 1 (10.0%)        | 6 (60.0%)                | 3 (30.0%)         | 10    |         |
| F4              | 0                | 1 (20.0%)                | 4 (80.0%)         | 5     |         |
| Total           | 35 (55.6%)       | 20 (31.7%)               | 8 (12.7%)         | 63    | <0.001* |

Patients with mild fibrosis predominantly belonged to the low-risk FIB-4 category (83.9%), whereas 80.0% of patients with FibroScan-confirmed cirrhosis were classified as high-risk by FIB-4. The association between FibroScan fibrosis stage and FIB-4 score was highly statistically significant ( $p < 0.001$ ).

**Table 3: Correlation of FibroScan Findings with NAFLD Fibrosis Score (NFS)**

| FibroScan Stage | Low Fibrosis | Indeterminate | Advanced Fibrosis | Total | p value |
|-----------------|--------------|---------------|-------------------|-------|---------|
| F0–F1           | 22 (71.0%)   | 8 (25.8%)     | 1 (3.2%)          | 31    |         |
| F2              | 4 (23.5%)    | 10 (58.8%)    | 3 (17.7%)         | 17    |         |
| F3              | 0            | 5 (50.0%)     | 5 (50.0%)         | 10    |         |
| F4              | 0            | 0             | 5 (100%)          | 5     |         |
| Total           | 26 (41.3%)   | 23 (36.5%)    | 14 (22.2%)        | 63    | <0.001* |

Most patients with FibroScan stage F0–F1 were categorized as low fibrosis by NFS (71.0%), whereas all patients with cirrhosis (F4) were classified as advanced fibrosis by NFS. The correlation between FibroScan staging and NFS was highly significant ( $p < 0.001$ ).

**Table 4: Comparison of Mean FIB-4 and NAFLD Fibrosis Score According to FibroScan Stage**

| FibroScan Stage | Mean FIB-4 $\pm$ SD | Mean NFS $\pm$ SD | p value |
|-----------------|---------------------|-------------------|---------|
| F0–F1           | 1.08 $\pm$ 0.36     | -2.18 $\pm$ 0.54  |         |
| F2              | 1.89 $\pm$ 0.42     | -0.78 $\pm$ 0.61  |         |
| F3              | 2.96 $\pm$ 0.58     | 0.42 $\pm$ 0.68   |         |
| F4              | 4.18 $\pm$ 0.74     | 1.68 $\pm$ 0.59   | <0.001* |

Mean FIB-4 and NFS values increased progressively with advancing FibroScan fibrosis stage. Patients with cirrhosis demonstrated the highest FIB-4 (4.18  $\pm$  0.74) and NFS (1.68  $\pm$  0.59), whereas patients with mild fibrosis had the lowest scores. The differences across fibrosis stages were highly significant ( $p < 0.001$ ).

Overall, the results suggest that FIB-4 and NAFLD Fibrosis Score are reliable, inexpensive, and easily applicable non-invasive tools that correlate strongly with FibroScan findings. Their combined use can improve early detection of significant fibrosis, facilitate risk stratification, and reduce the need for invasive liver biopsy in routine clinical practice.

## DISCUSSION

The present study evaluated the correlation between FibroScan findings and two validated non-invasive fibrosis assessment tools, namely the Fibrosis-4 (FIB-4) Index and the NAFLD Fibrosis Score (NFS), in patients with non-alcoholic fatty liver disease (NAFLD). The findings demonstrated a strong positive correlation between liver stiffness measured by FibroScan and both fibrosis scoring systems. Patients with advanced fibrosis exhibited significantly higher FIB-4 and NFS values than those with mild fibrosis, indicating that these simple

biochemical indices reliably reflect increasing liver stiffness and fibrosis severity. These observations support the use of combined non-invasive assessment strategies for routine evaluation of patients with NAFLD. Recent studies have consistently demonstrated excellent agreement between FibroScan and non-invasive fibrosis scores. Alam et al. compared FIB-4, APRI, and AST/ALT ratio with FibroScan in patients with NAFLD and type 2 diabetes mellitus and reported that FIB-4 showed the strongest correlation with FibroScan-derived liver stiffness measurements. Their findings suggested that FIB-4 is an effective first-line screening tool for

identifying patients requiring further evaluation with transient elastography. Similar to their observations, the present study found that patients with advanced fibrosis on FibroScan predominantly belonged to the high-risk FIB-4 category, while most patients with mild fibrosis were classified as low risk.<sup>(9)</sup>

The present findings are also supported by Cox et al., who compared the performance of FIB-4 and NAFLD Fibrosis Score with FibroScan in patients with NAFLD. They reported that both scoring systems demonstrated good agreement with FibroScan for identifying advanced fibrosis, although FIB-4 showed slightly better diagnostic performance. The authors concluded that combining these readily available biochemical scores with transient elastography improves diagnostic confidence and reduces the need for liver biopsy. Our study similarly demonstrated highly significant associations between FibroScan stage and both FIB-4 and NFS, reinforcing the complementary role of these investigations.<sup>(10)</sup>

Evidence from the Indian population further supports these observations. Choudhary et al. evaluated the diagnostic performance of FIB-4 and NAFLD Fibrosis Score among individuals with type 2 diabetes mellitus and demonstrated that both scores effectively excluded advanced fibrosis but had moderate positive predictive value for confirming severe disease. They recommended sequential use of FIB-4 followed by FibroScan for patients with intermediate or high-risk scores, a strategy that closely aligns with the results of the present study.<sup>(11)</sup> Likewise, Kakar et al. compared FIB-4 with FibroScan in patients with NAFLD and observed a significant positive correlation between both methods. Their study reported that FIB-4 possessed good sensitivity for detecting advanced fibrosis and could serve as a practical screening tool in resource-limited settings where FibroScan may not be readily available. The present findings similarly indicate that FIB-4 reliably reflects increasing liver stiffness measured by transient elastography and may help prioritize patients for specialist evaluation.<sup>(12)</sup>

The findings of the present study are further corroborated by Deng et al., who demonstrated that FIB-4 closely matched FibroScan results for detecting advanced liver fibrosis. Their analysis showed that FIB-4 effectively identified patients with clinically significant fibrosis and may facilitate early recognition of NAFLD before irreversible liver damage occurs. They concluded that combining FIB-4 with FibroScan enhances diagnostic accuracy and supports timely intervention. The progressive increase in mean FIB-4 values observed across FibroScan stages in the present study is consistent with these findings.<sup>(13)</sup>

Obesity presents additional challenges in fibrosis assessment because conventional ultrasonography may underestimate liver fibrosis. Park et al. compared several non-invasive methods before and after bariatric surgery

and reported that FibroScan remained one of the most reliable techniques for evaluating liver fibrosis in obese individuals. They observed that combining FibroScan with biochemical fibrosis scores improved diagnostic accuracy during both preoperative assessment and postoperative follow-up. These findings highlight the importance of integrating imaging-based and laboratory-based methods, particularly in populations with obesity and metabolic syndrome, which constitute the majority of patients with NAFLD.<sup>(14)</sup>

A comprehensive systematic review and meta-analysis by Cao et al. further established the diagnostic accuracy of FibroScan by evaluating controlled attenuation parameter (CAP) and liver stiffness measurement (LSM) in NAFLD. The authors concluded that liver stiffness measurement demonstrated excellent sensitivity and specificity for identifying advanced fibrosis and cirrhosis, while CAP effectively assessed hepatic steatosis. They emphasized that FibroScan represents one of the most accurate non-invasive modalities currently available and recommended its combined use with validated biochemical fibrosis scores to optimize fibrosis assessment. The present study demonstrated similar findings, with excellent agreement between FibroScan, FIB-4, and NAFLD Fibrosis Score across increasing stages of fibrosis.<sup>(15)</sup>

The strengths of the present study include simultaneous evaluation of three validated non-invasive fibrosis assessment methods in the same patient population and comparison of imaging-based liver stiffness with biochemical fibrosis scores. This approach reflects contemporary clinical practice and provides practical information regarding the utility of sequential non-invasive assessment. However, certain limitations should be acknowledged. Liver biopsy, the histopathological gold standard, was not performed because of its invasive nature and associated risks. In addition, the relatively small sample size and single-center design may limit the generalizability of the findings. Future multicenter prospective studies with larger cohorts and histological confirmation are warranted to establish standardized diagnostic algorithms and optimal cut-off values for different populations.

## CONCLUSION

The present study demonstrated a significant positive correlation between FibroScan findings, Fibrosis-4 Index, and NAFLD Fibrosis Score in patients with non-alcoholic fatty liver disease. Increasing liver stiffness measured by FibroScan was consistently associated with progressively higher FIB-4 and NFS values, confirming the reliability of these non-invasive fibrosis assessment tools. The combined use of FibroScan with biochemical fibrosis scores provides an accurate, inexpensive, and clinically practical strategy for identifying patients with advanced fibrosis, facilitating early risk stratification, reducing unnecessary liver biopsies, and improving the overall management of patients with NAFLD.



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