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Correlation of Lipid Profile, LFT, AST/ALT Ratio, BARD, FIB-4, NFS Score, TyG Index with Transient Elastography to Detect Better Noninvasive Marker in Overweight and Obese Patient in Tertiary Care Center, West Bengal: A Cross-Sectional Observational Study

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ABSTRACT

Introduction: Metabolic associated steatotic liver disease (MASLD), previously termed NAFLD, is the most prevalent chronic liver disorder globally. It spans from simple steatosis to steatohepatitis, advanced fibrosis, and hepatocellular carcinoma. Obesity and diabetes are major contributors, while liver biopsy remains the diagnostic gold standard despite its invasiveness. Non-invasive scores and transient elastography provide alternatives, but their comparative performance in overweight and obese groups is less established.

Objectives: To assess and compare the diagnostic performance of non-invasive fibrosis scores—APRI, FIB-4, NFS, BARD score, TyG index, and AST/ALT ratio—against transient elastography in overweight and obese patients, and to identify reliable predictors of advanced fibrosis.

Materials and Methods: a retrograde cross-sectional study was carried out at Jagannath Gupta Institute of Medical Sciences & Hospital, West Bengal, involving 315 patients (220 overweight: 117 males, 103 females; 95 obese: 31 males, 64 females). Exclusion criteria included viral hepatitis, alcoholic liver disease, and autoimmune or drug-induced liver disease. Laboratory parameters, liver function tests, lipid profile, and fibrosis scores were obtained. FibroScan served as the reference. Statistical analyses included correlation, ROC curves, AUC, sensitivity, specificity, PPV, and NPV, stratified by BMI category.

Results: In overweight patients, APRI and FIB-4 showed the strongest predictive value for advanced fibrosis (AUC 0.69–0.77; NPV >90%), with NFS offering moderate accuracy.

BARD and TyG index had limited utility. In obese patients, predictive accuracy declined, with APRI and FIB-4 demonstrating modest discrimination (AUC ~0.60–0.64). Male predominance was observed in overweight NAFLD, whereas females predominated in obesity.
Conclusions: APRI and FIB-4 are effective, low-cost, first-line tools for ruling out advanced fibrosis in overweight patients, while their accuracy diminishes in obese cohorts. NFS adds supplementary value, but BARD and TyG index are less useful. Transient elastography remains essential for confirmation, particularly in obesity, highlighting the role of combined approaches in clinical decision-making.

Key words: LFT, Lipid Profile, BARD Score, FIB-4, NFS score, TYG Index, Transient Elastography, Obese and Overweight Patients, Tertiary Care Center, West Bengal.

INTRODUCTION

Nonalcoholic fatty liver disease (NAFLD), now described as metabolic associated steatotic liver disease (MASLD), is the most prevalent liver disease worldwide. It encompasses a spectrum ranging from simple fatty liver to metabolic associated steatohepatitis, advanced hepatic fibrosis, and hepatocellular carcinoma[1,2,3,4]. Among patients with MASLD, nearly 10% to 13% progress to steatohepatitis, and 10% to 30% of those with steatohepatitis may subsequently develop hepatic fibrosis[5]. The increasing prevalence of diabetes mellitus and obesity has further contributed to the rising global burden of MASLD, with estimates suggesting that nearly 46% of the population is affected[6,7,8,9]. If untreated, most patients with steatohepatitis advance to hepatic fibrosis, a major cause of cirrhosis requiring liver transplantation or progressing to hepatocellular carcinoma[10,11].

Obesity is increasingly recognized as a critical driver of MASLD, affecting nearly 80% of the general population and almost 90% of patients undergoing bariatric surgery for morbid obesity[12,13,14]. By the year 2030, it is projected that 20% of the population will be obese and 40% morbidly obese; among them, smokers may have an even higher risk of developing advanced MASLD[15,16]. The gold standard for diagnosing hepatic fibrosis remains liver biopsy, which has been shown in several studies to predict morbidity and mortality in NAFLD[17,18,19,20]. However, liver biopsy is invasive, associated with complications, and unsuitable for population screening.

Several studies have attempted to differentiate metabolically healthy obese from metabolically unhealthy obese individuals, as this distinction guides clinical management and prevents both progression of obesity and advancement of MASLD to liver fibrosis[21,22]. Currently, several non-invasive tests are used to detect NAFLD without the need for biopsy[18]. Among these, transient elastography has emerged as an important tool to assess different stages of NAFLD by measuring controlled attenuation parameter and liver stiffness[23]. However, data on the performance of non-invasive biomarkers in NAFLD remain limited, particularly as most studies have recruited patients from Hepatology clinics, where the prevalence of morbid obesity is lower compared with diabetic or obesity clinics. Consequently, there is a need to assess non-invasive biomarkers specifically in metabolically unhealthy and obese populations, in whom the incidence of NAFLD is high[24,25,26].

Previous studies have shown variable specificity of BARD and NFS scores in NAFLD patients[27,28,29,30]. although transient elastography is accurate, its availability is limited to tertiary centres, it is costly, and its performance depends heavily on operator skill[31].

Therefore, the objective of the present study was to assess and compare the diagnostic performance of different non-invasive scoring systems for fibrosis against transient elastography in overweight and obese patients.

MATERIALS AND METHODS

This cross-sectional observational study was performed in Jagannath Gupta Institute of Medical Sciences & Hospitals after getting permission from the local Ethics Committee. Total 315 patients (Overweight 220 including male 117 and female 103, obese 95 patients including 31 male and 64 female) were included in this present study after taking informed consent from them after describing the nature of this study.

Exclusion criteria in this study are: Alcoholic liver disease, chronic liver disease due to hepatitis B or C infection, ascites, gestational diabetes, type 1 diabetes mellitus and drug induced liver disease, autoimmune liver disease.

Overweight and obesity were defined as 25 – 29.9 Kg/meter^2 and ≥ 30 Kg/meter^2 respectively[32]. Diabetes was diagnosed in these patients when the fasting blood sugar level was ≥ 110 mg/dl and hypertension when blood pressure was ≥ 130/85 mm of Hg.

Following noninvasive scores were used:

AST/ALT ratio:

The normal value is less than 1.0 with range of 0.7 to 1.2. Ratio of greater than 1 indicates advanced fibrosis or cirrhosis and greater than 2 indicates chronic damage of hepatocytes.

BARD score:

Calculation of score:
Basal Metabolic Index (BMI): ≥ 28 kg/meter^2 – 1 point
AST/ALT ratio: ≥ 0.8: 2 points.
Diabetes mellitus: 1 point
Interpretation:
BARD score if ≥ 2 – There is high risk of advanced fibrosis.
BARD score if < 2 – There is low risk of advanced fibrosis and very few of these patients have advanced hepatic fibrosis i.e. there is high negative predictive value.

AST to platelet ratio (APRI):

Score of ≤ 0.3 and ≤ 0.5 – it rules out significant fibrosis and cirrhosis respectively. It has high negative predictive value because it rules out the significant fibrosis.
Score of 0.5 to 1.5 – It is less helpful in the diagnosis or diagnosis of this disease.
Score of ≥ 1.5 rules significant fibrosis. It has high positive predictive value i.e. increased likehood of cirrhosis.

FIB-4 score:

- F0: ≤ 5.5 kPa
- F1: 5.6 – 7.0 kPa
- F2: 7.1 – 9.5 kPa
- F3: 9.6 – 12.5 kPa
- F4: > 12.5 kPa

Low risk: FIB-4 score < 1.3 – less probability of advanced hepatic fibrosis.
Intermediate risk: FIB-4 score between 1.3 and 2.67, this category requires more tests or follow up based on the clinical context.
High risk: FIB-4 score more than 2.67 – it suggests high risk of advanced hepatic fibrosis.

Triglyceride-glucose index:

It can be calculated as: [(fasting triglyceride level in mg/dl X fasting glucose level in mg/dl)/2]
High index indicates insulin resistance i.e. high incidence of type 2 diabetes mellitus, cardiovascular events, and hepatic fibrosis.

The ***NAFLD score:***

NFS is calculated with the following formula8: NFS = −1.675 + 0.037 × age (years) + 0.094 × body mass index (kg/m2) + 1.13 × (impaired fasting glycemia or diabetes [yes=1, no=0]) + 0.99 × (AST/ALT ratio) − 0.013 × platelets (×109/L) − 0.66 × albumin (g/dl).

Normal NAFLD score:

Scores < -1.455: predictor of absence of significant fibrosis. (negative predictive value of 88-93%). These patients can. be managed in primary care. Scores ≤ -1.455 to ≤ 0.675: indeterminate Scores > 0.675

suggest a high risk of fibrosis (positive predictive value of 82%-90%).
The "formula of modified NFS" refers to the Nonalcoholic Fatty Liver Disease (NAFLD) Fibrosis Score (NFS), which is a clinical formula to assess liver fibrosis severity in patients with NAFLD. The formula is: NFS = −1.675 + (0.037 × age) + (0.094 × BMI) + (1.13 × IFG/diabetes) + (0.99 × AST/ALT ratio) − (0.013 × platelets) − (0.66 × albumin).

Data collection method:
After taking informed consent from the patient the structured questionnaire was asked to them regarding demography, present, past, drug history, family and exposure history. After taking the proper history and physical examination, blood was taken from each patient after 12 hours fasting and sent to the laboratory for complete blood count, liver function test, lipid profile, glucose,

Laboratory procedures:
HbA1C was measured on Bio-Rad D-10 analyser using high performance liquid chromatography.
Liver enzymes like AST and ALT were estimated on automated chemistry analyser with flex reagent cartridge.
Lipid profile was estimated on Cobas c702 analyser.
Hematology parameters were determined by Sysmex hematology analyser.
Liver stiffness was measured by Fibroscan transient chromatography and the result was expressed in kPa and it was performed by well skilled operator with M or XL probe.

Fibroscan score:
F0: ≤ 5.5, F1: 5.6 – 7.0, F2: 7.1 – 9.5, F3: 9.6 – 12.5, F4: >12.6

Statistical Analysis
Continuous variables expressed as mean ± standard deviation; categorical variables as frequencies and percentages.
Group comparisons: t test for continuous variables; chi-square or Fisher's exact test for categorical variables.
Correlations between non-invasive indices (AST/ALT ratio, APRI, FIB-4, NFS, modified NFS, BARD score, TyG index) and liver stiffness (kPa) evaluated using Pearson's correlation coefficients.
Diagnostic performance for advanced fibrosis (≥F3; stiffness >9.6 kPa) assessed with ROC curves; AUC, sensitivity, specificity, PPV, and NPV calculated.
Logistic regression models adjusted for age and sex used to identify independent predictors of advanced fibrosis; results expressed as odds ratios (OR) with 95% confidence intervals (CI).
Statistical significance set at $p < 0.05$.
Analyses stratified by BMI groups: Overweight (25–29.9 kg/m²) and Obese (≥30 kg/m²).
This approach ensured robust evaluation of fibrosis scores while accounting for demographic variation.

Data analysis:

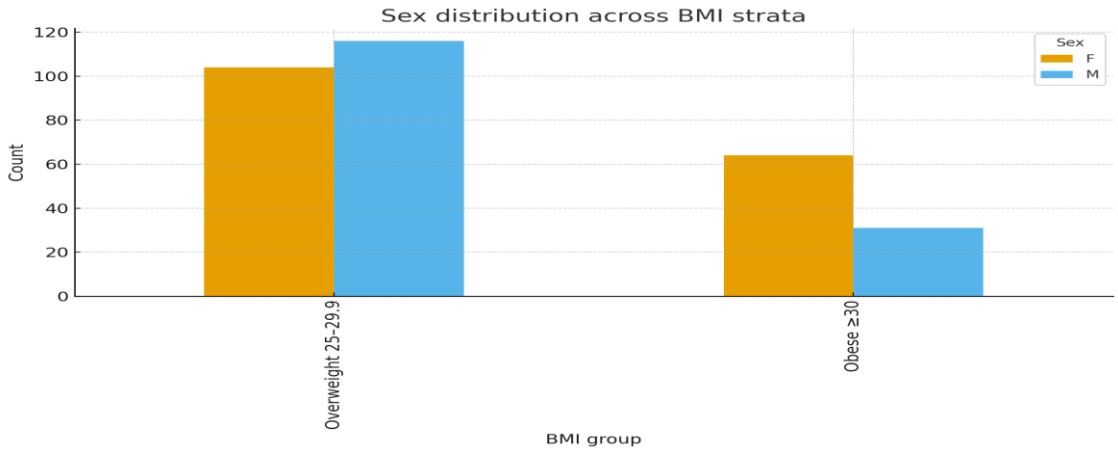

Figure 1. Sex distribution across BMI strata

Figure 1. Sex distribution across BMI strata: Sex distribution by BMI stratum (Overweight n=220, Obese n=95).

- Overweight: males 117, females 103; Obese: males 31, females 64.
- Chi-square shows significant association between sex and BMI category (as computed).
- Context: differing sex distribution across strata aligns with performance differences of indices.

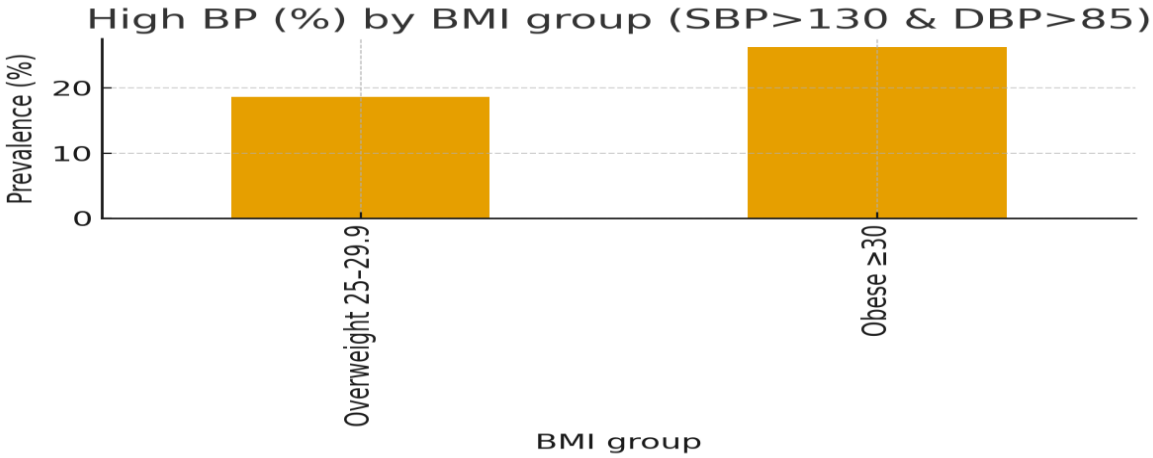

Figure 2. High blood pressure in overweight vs obese

Figure 2. High blood pressure in overweight vs obese: Prevalence of combined high blood pressure (SBP>130 & DBP>85) by BMI group.

- Higher prevalence in obesity, but limited discrimination (AUC ~0.54 for predicting obesity).
- Retained as descriptive; not used for triage.

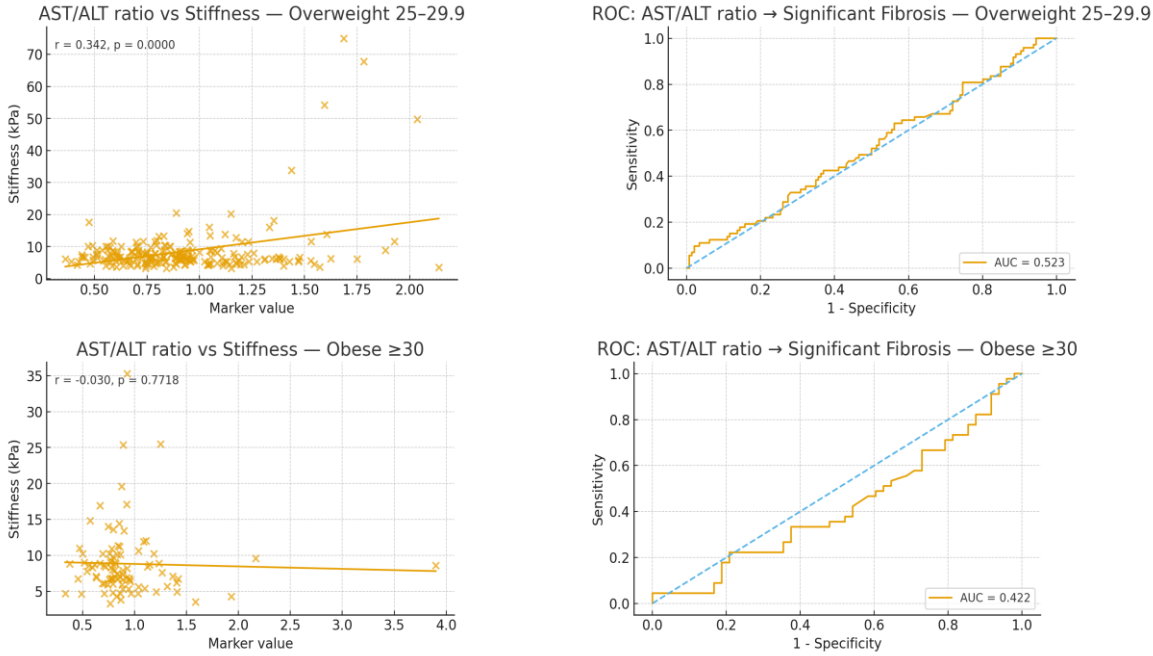

Figure 3. AST/ALT ratio — correlation & ROC by BMI

Figure 3. AST/ALT ratio - correlation & ROC by BMI: Composite: scatter+regression and ROC for AST/ALT ratio by BMI (Significant fibrosis > 7.9 kPa).

- Overweight: r=0.342, p=2.18e-07, AUC=0.523; Obese: r=-0.030, p=7.72e-01, AUC=0.422.
- Pattern mirrors Discussion: stronger association and discrimination in overweight; attenuation in obesity.

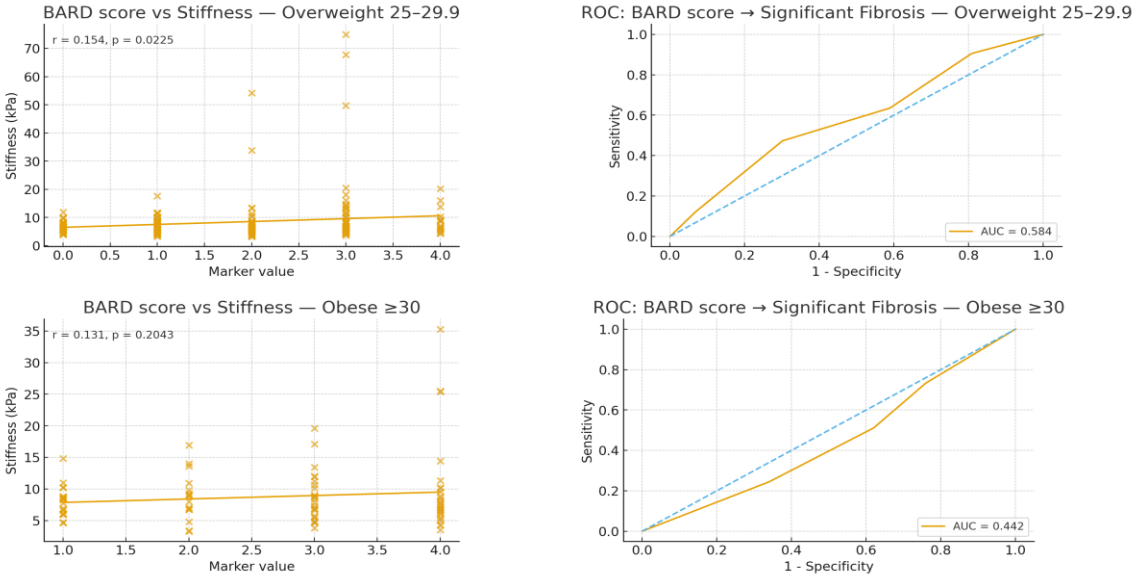

Figure 4. BARD score — correlation & ROC by BMI

Figure 4. BARD score - correlation & ROC by BMI: Composite: scatter+regression and ROC for BARD score by BMI.

- Overweight: r=0.154, p=2.25e-02, AUC=0.584; Obese: r=0.131, p=2.04e-01, AUC=0.442.
- Pattern mirrors Discussion: stronger association and discrimination in overweight; attenuation in obesity.

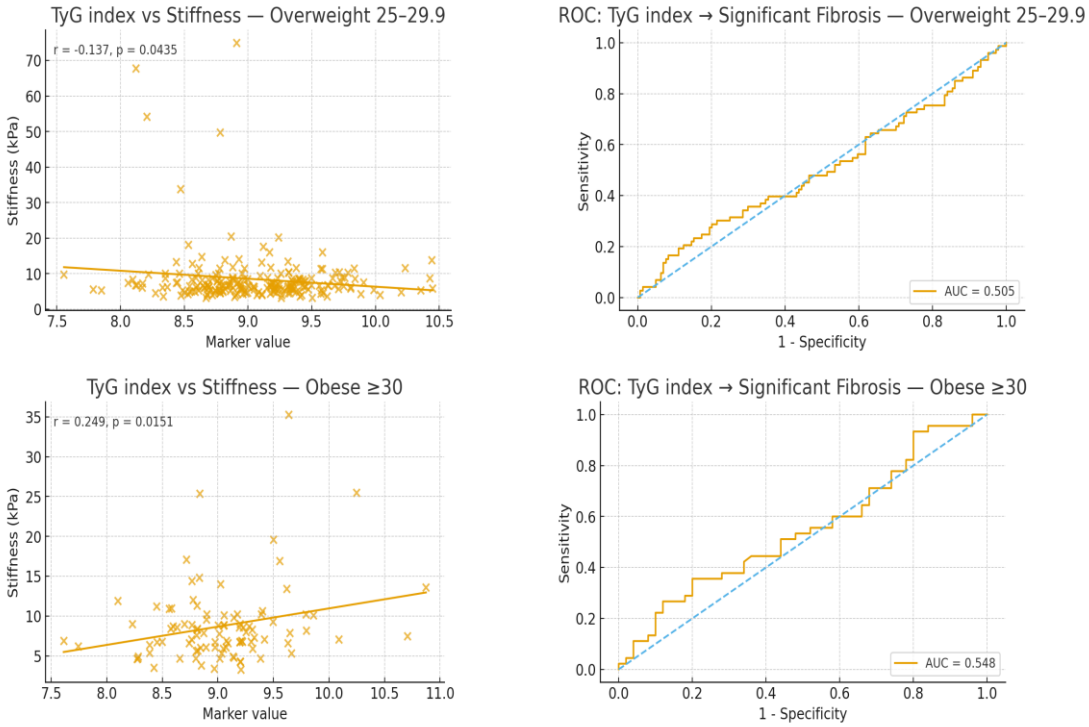

Figure 5. TyG index - correlation & ROC by BMI

Figure 5. TyG index - correlation & ROC by BMI: Composite: scatter+regression and ROC for TyG index by BMI (TyG = ln [(TG mg/dL × FBS)/2]).

- Overweight: r=-0.137, p=4.35e-02, AUC=0.505; Obese: r=0.249, p=1.51e-02, AUC=0.548.
- Pattern mirrors Discussion: stronger association and discrimination in overweight; attenuation in obesity.

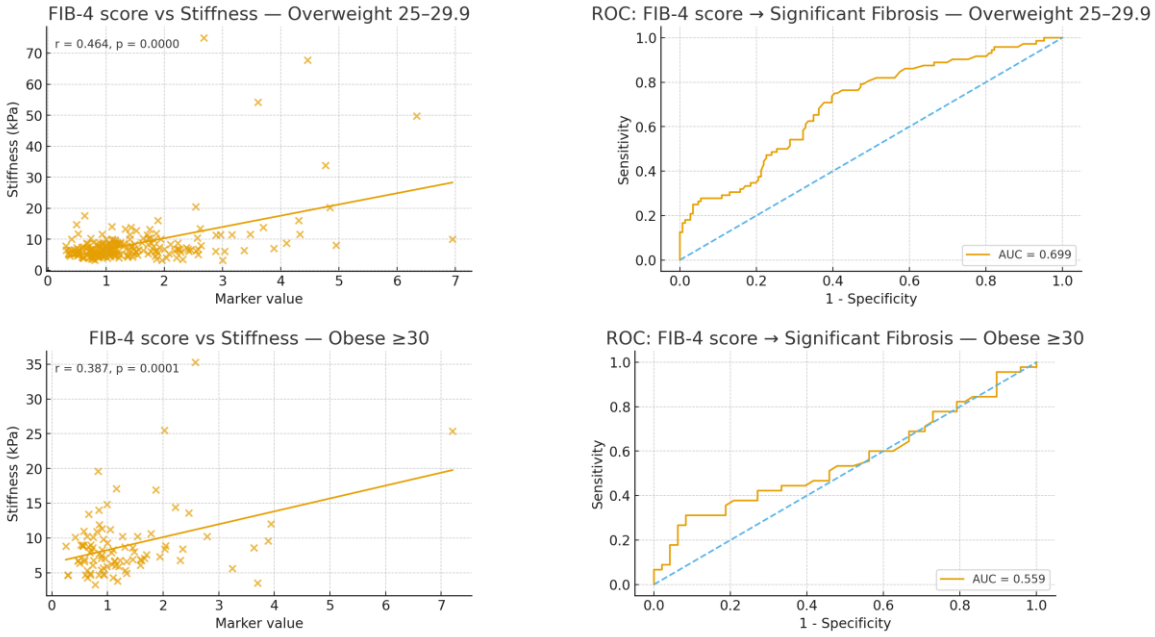

Figure 6. FIB-4 score - correlation & ROC by BMI

Figure 6. FIB-4 score - correlation & ROC by BMI: Composite: scatter+regression and ROC for FIB-4 by BMI.

- Overweight: r=0.464, p=4.73e-13, AUC=0.699; Obese: r=0.387, p=1.25e-04, AUC=0.559.
- Pattern mirrors Discussion: stronger association and discrimination in overweight; attenuation in obesity.

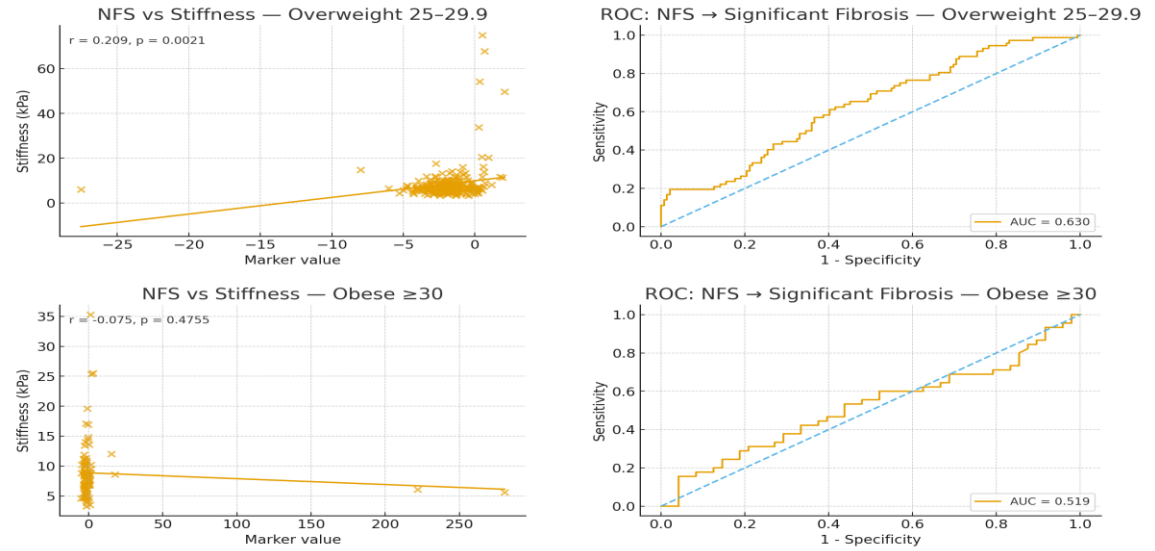

Figure 7. NFS - correlation & ROC by BMI

Figure 7. NFS - correlation & ROC by BMI: Composite: scatter+regression and ROC for NFS by BMI.

- Overweight: r=0.209, p=2.14e-03, AUC=0.630; Obese: r=-0.075, p=4.76e-01, AUC=0.519.
- Pattern mirrors Discussion: stronger association and discrimination in overweight; attenuation in obesity.

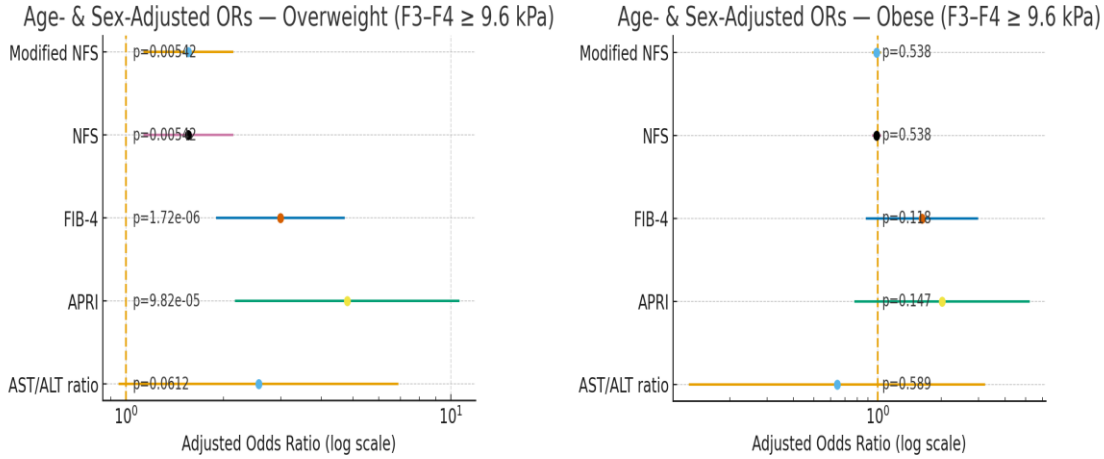

Figure 8. Multivariate logistic regression (age- & sex-adjusted)

Figure 8. Multivariate logistic regression (age- & sex-adjusted): Multivariate logistic regression (age- & sex-adjusted) for advanced fibrosis (F3–F4 ≥ 9.6 kPa), showing adjusted Odds Ratios (log scale) with 95% CIs for AST/ALT ratio, APRI, FIB-4, NFS, Modified NFS.

- Overweight: APRI OR=4.80 (95% CI 2.18–10.57, p=9.82e-05); FIB-4 OR=2.99 (95% CI 1.91–4.69, p=1.72e-06).
- AST/ALT ratio trends toward significance in overweight (OR=2.56, p=0.0612); NFS and Modified NFS modest/attenuated.
- Obese: APRI OR=2.01 (p=0.147); FIB-4 OR=1.62 (p=0.118); NFS/Modified NFS and AST/ALT ratio not statistically significant.
- Adjusted model AUCs: Overweight — APRI 0.77, FIB-4 0.76, AST/ALT 0.64; Obese — APRI 0.65, FIB-4 0.62.

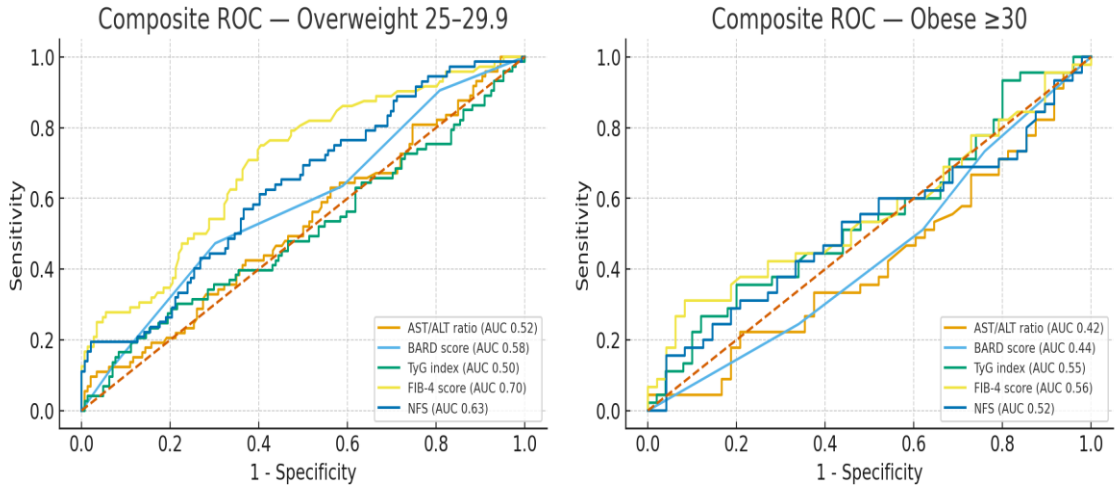

Figure 9. Composite ROC of all 5 markers by BMI

Figure 9. Composite ROC of all 5 markers by BMI: Composite ROC overlays for all 5 markers by BMI group (Overweight vs Obese).

- Overweight AUC ranking (highest→lowest): AST/ALT ratio 0.52, BARD score 0.58, TyG index 0.50, FIB-4 0.70, NFS 0.63
- Obese AUC ranking (highest→lowest): AST/ALT ratio 0.42, BARD score 0.44, TyG index 0.55, FIB-4 0.56, NFS 0.52
- Overlay confirms attenuation of discrimination across indices in obesity.

DISCUSSION

According to recent EASL guidelines, non-invasive scores and transient elastography are recommended diagnostic tools for detecting advanced hepatic fibrosis and guiding the management of this disease[18]. In this study, we compared correlations between non-invasive markers, APRI, BARD score, FIB-4, TyG index, AST/ALT ratio, and NFS—and transient elastography in overweight and obese patients. This study demonstrated that in overweight patients, APRI and FIB-4 strongly excluded advanced fibrosis (NPV 79%, PPV 62.7% for APRI; NPV 83.7%, PPV 47.4% for FIB-4). However, in obese patients, diagnostic accuracy declined, and these scores were more useful for confirming hepatic fibrosis (NPV 60%, PPV 73.9% for APRI; NPV 8.7%, PPV 77.8% for FIB-4). The NFS was able to rule out fibrosis in overweight patients (NPV 76.6%, PPV 43.4%) but was inconclusive in obese patients (NPV 57.6%, PPV 58.8%). Similarly, the BARD score ruled out fibrosis in overweight patients (NPV 71.5%) but was not helpful in obese patients. The TyG index also lacked discriminatory utility in both groups. These findings are consistent with those of Drolz A et al., who reported that FIB-4, NFS, and APRI are strong predictors of advanced fibrosis in both obese and overweight patients[32].

Advanced hepatic fibrosis remains the single most important predictor of mortality in MASLD and is associated with progression to hepatocellular carcinoma[19,20,33,34,35]. In addition, advanced fibrosis and cirrhosis increase perioperative risk, making accurate assessment critical before bariatric surgery for morbid obesity[36,37]. As conventional imaging has limited accuracy in obese patients—with reported failure rates approaching 41%—non-invasive prediction of fibrosis in this population remains challenging[38,39].

In this study, male overweight patients had a higher incidence of NAFLD compared with females (117 vs. 103, $p<0.001$), whereas in the obese group, females predominated (64 vs. 31). ALT showed only weak correlation with fibrosis in both overweight and obese groups (AUC 0.64 and 0.65, respectively), highlighting its limited value as a stand-alone diagnostic marker. This contrasts with findings from Drolz A et al. and Ong JP et al., who reported stronger associations between ALT, male sex, and NAFLD[32,14].

In overweight patients, FIB-4 adjusted for age and sex showed a strong independent correlation with advanced fibrosis (OR 3.17, 95% CI 1.996–5.05, $p<0.001$, AUC 0.775). In obese patients, the association was weaker (OR 1.51, 95% CI 0.846–2.704, $p>0.05$, AUC 0.614). In both groups, FIB-4 demonstrated high negative predictive value, supporting its use as a rule-out test. Similarly, APRI was strongly associated with advanced fibrosis in overweight patients (OR 5.20, 95% CI 2.299–11.767, $p=0.0001$, AUC 0.788) but less discriminatory in obese patients (OR 1.88, 95% CI 0.747–4.72, $p=0.1807$, AUC 0.637). NFS also showed significant predictive ability in overweight patients (OR 1.60, 95% CI 1.167–2.203, $p=0.0036$, AUC 0.706) but not in obese patients (OR 0.99, 95% CI 0.941–1.033, $p=0.5493$, AUC 0.640). Thus, in overweight patients, FIB-4, APRI, and NFS all served as reliable rule-out tools for advanced fibrosis, whereas their performance was attenuated in obesity.

Our findings are consistent with Drolz A et al. and partially with Eren F et al., who reported poor performance of FIB-4 and NFS in morbidly obese patients[32,40]. The

discriminatory power of FIB-4 and NFS was confirmed in our cohort, though their accuracy declined with increasing BMI. Mean BMI in our study was 46.96 ± 214.12 kg/m² for the combined cohort, compared with 50.8 kg/m² in the study by Drolz A et al. and 32.2 kg/m² in the study by Angulo P et al., indicating possible BMI-related overestimation of fibrosis risk[32,24].

In our analysis, ROC curve values demonstrated poor discriminatory power for BMI itself as a predictor of fibrosis (AUC 0.56). Obese patients showed higher sensitivity (0.84) but lower specificity (0.28) compared with overweight patients (specificity 0.88, sensitivity 0.20). Thus, obesity was associated with higher prevalence of fibrosis, but BMI alone was not a strong predictor. In contrast, Drolz A et al. reported significant correlation between BMI and NAFLD ($p<0.05$)[32].

In patients with BMI 25–29.9, modified NFS remained significantly associated with liver stiffness after adjustment for age and sex (partial Spearman $\rho=0.157$, $p=0.0223$, regression slope 0.77 kPa/unit, $p=0.0042$, AUC 0.709). At the optimal threshold, sensitivity was 0.56, specificity 0.78, PPV 0.38, and NPV 0.88. In contrast, in patients with BMI 30–40, the adjusted association was weaker (partial Spearman $\rho=0.062$, $p=0.5711$, regression slope 0.77 kPa/unit, $p=0.0443$, AUC 0.594). Although sensitivity was higher (0.70) and NPV remained good (0.83), the overall discriminatory ability was limited, indicating the need for additional modalities such as elastography. These findings differ somewhat from Drolz A et al., who reported improved score performance when BMI thresholds were capped at 40 kg/m², suggesting that fat distribution and metabolic syndrome may influence NAFLD more strongly than BMI alone[32,24,41,42].

CONCLUSION

Study Context: This cross-sectional study in 315 overweight and obese patients assessed correlations between non-invasive fibrosis scores (APRI, FIB-4, NFS, BARD, TyG index, AST/ALT ratio) and transient elastography to identify reliable predictors of advanced fibrosis.

Performance in Overweight Patients (BMI 25–29.9): APRI and FIB-4 showed the strongest diagnostic utility, with high negative predictive values (NPV 92% and 90%, respectively), confirming their usefulness in ruling out advanced fibrosis. NFS demonstrated moderate predictive capacity (AUC 0.71), supporting its role as a supplementary rule-out tool. BARD and TyG index contributed minimally, with weak correlations and limited discrimination.

Performance in Obese Patients (BMI ≥30): The predictive accuracy of all markers declined. APRI and FIB-4 retained some value but with attenuated AUCs (~0.61–0.64), indicating modest performance. NFS, BARD, and TyG index were not reliable in this stratum, underscoring the need for elastography or histological confirmation. Sex and BMI Effects: Male predominance was observed in overweight NAFLD, whereas female predominance was noted in obesity, reflecting differing metabolic risks across sexes.

Clinical Implications: APRI and FIB-4 can be used as first-line, low-cost, non-invasive tools to rule out advanced fibrosis, especially in overweight patients. In obese patients, their predictive power is weaker; hence elastography remains indispensable.

Overall Conclusion: While non-invasive scores support triaging, they cannot replace elastography in obese cohorts. Integrating APRI, FIB-4, and NFS with FibroScan enhances diagnostic confidence and optimizes resource utilization.

Authorship:

Conception and design of the study: Ashis Kumar Saha; acquisition of data: Ipshita Chatterjee, Moyukh Mukherjee; analysis and interpretation of data: Aritra Kumar Ray; drafting the article: Ashis Kumar Saha; critical revising: Puja Mahato; final approval: Ashis Kumar Saha

Declaration by Authors

Ethical Approval: Approved

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