QUANTIFICATION OF LIVER FAT AND FIBROSIS WITH ULTRASOUND: THE EXPANDING ROLE OF ELASTOGRAPHY

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ABSTRACT

OBJECTIVES

To assess ultrasound-detected fatty liver grade and elastography-based fibrosis stage among adults undergoing liver ultrasound evaluation and to determine their association with selected clinical and metabolic risk factors.

METHODOLOGY

This descriptive cross-sectional observational study was conducted at the Department of Radiology, MTI Bacha Khan Medical College and Mardan Medical Complex, Mardan, from February 2026 to April 2026. A total of 83 adults undergoing liver ultrasound evaluation were recruited through non-probability consecutive sampling. Demographic, clinical, laboratory, ultrasound, and elastography findings were recorded. Significant fibrosis was defined as fibrosis stage ≥F2. Data were analyzed using SPSS version 25. The chi-square test and Cramér's V were used to assess unadjusted associations, while binary logistic regression was used to identify independent factors associated with significant fibrosis.

RESULTS

The mean age of participants was 42.1 ± 13.8 years, and 45 (54.2%) were male. Overweight and obesity were observed in 38 (45.8%) and 22 (26.5%) participants, respectively. Grade II fatty liver was the most common ultrasound finding, observed in 39 (47.0%) participants. Significant fibrosis ≥F2 was present in 51 (61.4%) participants. On unadjusted analysis, BMI category, ALT category, and fatty liver grade were significantly associated with significant fibrosis. On multivariate logistic regression, elevated ALT was associated with higher odds of significant fibrosis (AOR = 5.85, 95% CI: 1.12-30.30, p = 0.036). Fatty liver grade was also independently associated with significant fibrosis (AOR = 15.87, 95% CI: 3.47-72.64, p < 0.001). BMI, diabetes mellitus, age group, and gender were not significant after adjustment.

CONCLUSION

Significant fibrosis was common in this hospital-based sample. Elevated ALT and higher fatty liver grade were independently associated with significant fibrosis ≥F2. Ultrasound-detected fatty liver grade and elastography-based fibrosis staging may support non-invasive risk stratification in patients undergoing liver evaluation.

KEYWORDS: *Elastography, Liver Fibrosis, Ultrasound, Alt, Metabolic Risk Factors*

INTRODUCTION

Non-alcoholic fatty liver disease (NAFLD) is one of the most common chronic liver diseases worldwide and is closely associated with obesity, diabetes mellitus, dyslipidemia, and metabolic syndrome.[1] It represents a spectrum of liver involvement ranging from simple steatosis to non-alcoholic steatohepatitis, fibrosis, and cirrhosis. The rising burden of NAFLD is an important public health concern, particularly in low- and middle-income countries where lifestyle changes, increasing obesity, and metabolic disorders are becoming more common.[2,3] Accurate assessment of hepatic steatosis and fibrosis is important for identifying patients who may require closer clinical evaluation and follow-up.[4] Liver biopsy has traditionally been considered the reference standard for fibrosis assessment; however, it is invasive, costly, and associated with potential complications. These limitations have increased interest in non-invasive imaging methods that can assist in the assessment of liver fat and fibrosis in routine clinical practice.[5,6] Ultrasound is commonly used as a first-line imaging modality because it is widely available, affordable, safe, and acceptable to patients. It is useful for detecting hepatic steatosis, particularly moderate-to-severe fatty liver, but its ability to quantify early steatosis and assess fibrosis is limited.[7] Elastography has therefore gained importance as a non-invasive method for measuring liver stiffness, providing additional information on fibrosis stage.[8] Previous studies have shown that elastography

can support non-invasive assessment of clinically significant fibrosis and cirrhosis, particularly when interpreted in conjunction with clinical and laboratory findings.[9] It is repeatable and may be useful for follow-up assessment in selected patients. However, the combination of conventional ultrasound and elastography is already well established; therefore, the present study does not claim novelty in the technique itself. Instead, its relevance lies in evaluating the association between ultrasound-detected fatty liver grade, elastography-based fibrosis stage, and metabolic factors in a local tertiary-care radiology setting**.** Despite increasing international evidence, local data from Pakistani hospital-based radiology practice remain limited regarding how sonographic fatty liver grade and elastography-based fibrosis stage are associated with metabolic and biochemical risk factors. This local evidence is important because patient profiles, obesity patterns, diabetes burden, referral practices, and access to advanced hepatology services may differ across settings. Therefore, this study was conducted to assess ultrasound-detected fatty liver grade and elastography-based fibrosis stage among adults undergoing liver ultrasound evaluation and to determine whether fatty liver grade and selected metabolic risk factors are associated with significant fibrosis, defined as fibrosis stage ≥F2.

METHODOLOGY

This was a descriptive cross-sectional observational study designed to assess ultrasound-detected fatty liver grade and elastography-based fibrosis stage among adults undergoing liver ultrasound evaluation. The study also aimed to determine the association of fatty liver grade and selected metabolic risk factors with significant fibrosis, defined as fibrosis stage ≥F2. The study was conducted at the Department of Radiology, MTI Bacha Khan Medical College and Mardan Medical Complex, Mardan, over 2 months from February 2026 to April 2026. Ethical approval was obtained from the Institutional Ethical Review Board of Bacha Khan Medical College, Mardan, vide reference number No. 980/BKMC dated 09/02/2026. Written informed consent was obtained from all participants prior to inclusion, and confidentiality of patient information was ensured throughout the study. The study was reported in accordance with relevant STROBE recommendations for cross-sectional observational studies. A non-probability consecutive sampling technique was employed to recruit participants presenting for liver ultrasound evaluation. The sample size was calculated using the WHO formula, with a 95% confidence level, P assumed to be 50% due to variability in reported prevalence across previous studies, and a 10% margin of error (d), yielding a sample size of 83 participants.[10] As the sample size was calculated for estimation purposes, the multivariable association analysis was considered exploratory. All adult patients aged 18 years and above undergoing abdominal ultrasound for suspected fatty liver disease or liver-related clinical evaluation were included in the study. Patients with known chronic liver disease already under treatment, liver malignancy, prior hepatic surgery, pregnancy, significant ascites interfering with elastography measurement, or incomplete clinical or imaging data were excluded. A structured proforma was used to collect demographic, clinical, laboratory, ultrasound, and elastography data. Laboratory parameters were retrieved from hospital records and included alanine aminotransferase, aspartate aminotransferase, AST/ALT ratio, serum bilirubin, and platelet count. ALT was categorized as normal or elevated using 40 U/L as the cut-off value. BMI was recorded as a continuous variable and categorized as normal, overweight, or obese according to standard BMI categories. Each participant underwent conventional abdominal ultrasound followed by elastography using a standardized imaging protocol. Ultrasound was performed to assess liver size, echotexture, and fatty liver grade. Fatty liver was categorized as Grade 0, Grade I, Grade II, and Grade III based on liver echogenicity, visualization of intrahepatic vessels, and posterior beam attenuation. Grade 0 represented normal liver echogenicity, Grade I represented mild steatosis, Grade II represented moderate steatosis, and Grade III represented severe steatosis. Elastography was performed using transient elastography/FibroScan-based liver stiffness measurement on a FibroScan elastography system using the standard adult M probe. The XL probe was used, as required, for overweight or obese participants to obtain reliable measurements. Participants were examined in the supine position with the right arm elevated to improve access to the right intercostal spaces. Liver stiffness measurements were obtained from the right hepatic lobe through an intercostal approach, avoiding large vessels, focal lesions, ribs, and biliary structures. Liver stiffness was recorded in kilopascals (kPa). For each participant, at least 10 valid liver stiffness measurements were obtained, and the median value was used for analysis. Measurements were considered reliable when the interquartile range-to-median ratio was ≤30%. Fibrosis staging was categorized as F0, F1, F2, F3, and F4 according to liver stiffness values. For this study, fibrosis staging was defined as follows: F0–F1 ≤ 7.4 kPa; F2 = 7.5–10.0 kPa; F3 = 10.1–14.0 kPa; and F4 > 14.0 kPa. Significant fibrosis was defined as fibrosis stage ≥F2. All imaging procedures were performed or supervised by trained radiologists using standardized criteria. Where more than one operator was involved, radiologists with comparable experience performed scans, and doubtful cases were reviewed by a senior radiologist to maintain

consistency. Interobserver reliability was not formally calculated, and this was acknowledged as a study limitation. Data were entered and analyzed using SPSS version 25. A p-value ≤0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Clinical Characteristics of Participants (n = 83)

Variable	Category	Frequency (%age)
Age Group	18-30 years	23 (27.7%)
	31-50 years	36 (43.4%)
	>50 years	24 (28.9%)
Gender	Male	45 (54.2%)
	Female	38 (45.8%)
BMI Category	Normal	23 (27.7%)
	Overweight	38 (45.8%)
	Obese	22 (26.5%)
Diabetes Mellitus	Yes	33 (39.8%)
	No	50 (60.2%)
Hypertension	Yes	38 (45.8%)
	No	45 (54.2%)
Dyslipidemia	Yes	22 (26.5%)
	No	61 (73.5%)
Hepatitis B	Yes	5 (6.0%)
	No	78 (94.0%)
Hepatitis C	Yes	11 (13.3%)
	No	72 (86.7%)
Symptoms	Asymptomatic	37 (44.6%)
	Fatigue	26 (31.3%)
	RUQ Pain	20 (24.1%)

Table 2: Components of Continuum of Maternal Care Across Included Studies

Parameter	Mean ± SD (Min–Max)
ALT (U/L)	48.9 ± 14.8 (18.9–83.4)
AST (U/L)	41.6 ± 11.1 (18.3–64.3)
AST/ALT Ratio	0.92 ± 0.36 (0.39–2.36)
Serum Bilirubin (mg/dL)	1.32 ± 0.39 (0.60–2.25)
Platelet Count (×10⁹/L)	196.6 ± 46.6 (80–297)

Table 3: Determinants and Barriers Affecting Continuum of Maternal Care

	Variable	Category	Frequency(%)
Ultrasound Findings: Fatty Liver Grading	Liver Size	Normal	19 (22.9%)
		Enlarged	64 (77.1%)
	Echotexture	Normal	23 (27.7%)
		Coarse	60 (72.3%)
	Fatty Liver Grade	Grade 0 (Normal)	12 (14.5%)
		Grade I (Mild)	16 (19.3%)
		Grade II (Moderate)	39 (47.0%)
		Grade III(Severe)	16 (19.3%)
Elastography Findings: Fibrosis Staging	Fibrosis Stage	F0 (No fibrosis)	14 (16.9%)
		F1 (Mild)	18 (21.7%)
		F2 (Moderate)	24 (28.9%)
		F3 (Severe)	22 (26.5%)
		F4 (Cirrhosis)	5 (6.0%)
	Liver Stiffness (kPa)	Mean ±SD (Min–Max)	8.74 ± 2.87 (3.00-15.13)

Table 4: Association of Selected Variables with Significant Fibrosis ≥F2 (n = 83)

Variable	Category	Fibrosis		Cramér's V	p-value
		≥F2 n (%)	<F2 n (%)		
BMI Category	Normal	7(30.4 %)	16 (69.6 %)	0.49	<0.001
	Overweight	23(60.5 %)	15 (39.5 %)		
	Obese	21(95.5 %)	1(4.5%)		
Diabetes Mellitus	Yes	23 (69.7 %)	10 (30.3 %)	0.14	0.210
	No	28 (56.0 %)	22 (44.0 %)		
ALT Category	≤40 U/L (Normal)	8 (28.6 %)	20(71.4 %)	0.48	<0.001
	>40 U/L (Elevated)	43(78.2 %)	12(21.8 %)		
Fatty Liver Grade	Grade 0	0(0.0%)	12(100.0 %)	0.72	<0.001
	Grade I	4 (25.0 %)	12 (75.0 %)		
	Grade II	31(79.5 %)	8 (20.5 %)		
	Grade III	16(100. 0%)	0 (0.0%)		

Table 5: Multivariate Logistic Regression Analysis for Independent Factors Associated with Significant Fibrosis ≥F2

Variable	Adjusted OR	95% CI	p-value
Elevated ALT >40 U/L	5.85	1.12–30.30	0.036
Fatty liver grade	15.87	3.47–72.64	<0.001
BMI	1.05	0.84–1.32	0.681
Diabetes mellitus	2.40	0.47–12.20	0.295
Male gender	1.09	0.25–4.65	0.909
Age group	-	-	0.979

Note: Significant fibrosis was defined as fibrosis stage ≥F2. The model was adjusted for age group, BMI, ALTcategory, gender, diabetes mellitus, and fatty liver grade. Fatty liver grade was entered as an ordinal variable.

DISCUSSION

This study evaluated fatty liver grade and fibrosis stage using ultrasound and elastography in adults undergoing liver ultrasound, correlating these with metabolic and biochemical factors. The predominantly middle-aged, overweight/obese cohort reflects the established connections between NAFLD, obesity, insulin resistance, and metabolic risk factors. Consistent with the current literature, our results indicate a strong association between NAFLD and components of metabolic syndrome, particularly elevated body weight and impaired glucose metabolism, which promote hepatic steatosis and fibrosis.[10] The ultrasound findings demonstrated that fatty liver was common in the study population, with Grade II steatosis being the most frequent category. Similar distributions have been reported in other hospital-based studies.[11] While ultrasound is a common first-line modality due to its availability, affordability, and safety, its ability to assess

fibrosis is limited. Elastography, used in conjunction with conventional ultrasound provides additional noninvasive information on liver stiffness. In this study, elastography revealed significant fibrosis (≥F2 stage) in a considerable proportion of participants, indicating a clinically relevant burden of fibrosis within this hospital-based sample.[12]However, because liver biopsy or an external reference standard was not performed, these findings should be considered elastography-based staging rather than diagnostic confirmation. Prior research suggests that elastography is valuable for non-invasive fibrosis assessment, particularly in identifying patients with elevated liver stiffness who may need further evaluation or follow-up.[12] In the present study, elastography was not evaluated for diagnostic accuracy; therefore, claims regarding accuracy, validation, or superiority over biopsy are avoided.[11] A strong unadjusted association was observed between fatty liver grade and significant fibrosis, with Cramér's V = 0.72 and $p < 0.001$. After adjustment in a binary logistic regression model, fatty liver grade remained independently associated with significant fibrosis. Each increase in fatty liver grade was associated with higher odds of significant fibrosis (AOR = 15.87, 95% CI: 3.47–72.64, $p < 0.001$). This finding suggests that increasing sonographic fatty liver severity was associated with greater elastography-based liver stiffness in this study population. Similar findings have been reported in studies showing that higher steatosis grades are associated with increased liver stiffness values on elastography.[11,13] Due to the cross-sectional design, the observed association between steatosis and fibrosis cannot be interpreted as causation or evidence of sequential development from fatty liver. Elevated ALT levels were significantly associated with significant fibrosis. Unadjusted analysis showed a moderate association, and after multivariate adjustment, elevated ALT was associated with approximately 5.85 times greater odds of significant fibrosis, consistent with ALT reflecting hepatocellular injury and fibrosis risk in fatty liver disease.[14] However, ALT alone is insufficient to exclude clinically relevant fibrosis, as normal liver enzymes can occur with fibrosis. Biochemical markers should therefore be interpreted alongside imaging and clinical risk factors. BMI showed a significant association with fibrosis in the unadjusted analysis, but this association was not independent after adjustment, likely due to overlap with fatty liver grade, ALT levels, and other metabolic variables. While obesity is a recognized contributor to the burden of NAFLD and liver stiffness and has been associated with hepatic inflammation, oxidative stress, and fibrotic changes, its independent predictive value in this study was limited.[14] In the present study, the loss of statistical significance after adjustment suggests that BMI may be related to fibrosis through its association with fatty liver severity and other metabolic factors. However, the modest sample size may also have limited the precision of adjusted estimates.[15] Diabetes mellitus was not significantly associated with fibrosis in this study, either in the unadjusted analysis or after adjustment. This finding differs from several studies that have reported diabetes as an important risk factor for advanced fibrosis in NAFLD. The difference may be due to variation in sample size, diabetes duration, glycemic control, treatment status, or the hospital-based nature of the sample.[16] Therefore, the non-significant association observed in this study should not be interpreted as absence of a relationship between diabetes and fibrosis. Rather, it indicates that diabetes was not an independent predictor in this particular dataset after adjustment for other variables.[17] The findings support the use of combining conventional ultrasound and elastography as a practical, non-invasive approach for assessing fatty liver grade and liver stiffness in routine radiology practice. Recent developments in shear wave elastography, transient elastography, quantitative ultrasound, and artificial intelligence-based ultrasound models have improved non-invasive liver assessment and may further support risk stratification in liver disease.[18] However, the present study was not designed as a diagnostic accuracy or validation study. Therefore, the findings should be understood as associations between ultrasound/elastography findings and clinical variables, rather than proof of diagnostic performance.[19]

CONFLICT OF INTEREST: None

FUNDING SOURCES: None

LIMITATIONS

This study cannot establish a causal relationship between metabolic factors and fibrosis. Generalizability is limited by non-probability sampling. The absence of a reference standard, like liver biopsy, precludes assessing elastography's diagnostic accuracy. Although trained radiologists performed or supervised examinations using a standardized protocol, interobserver reliability was not formally assessed.

CONCLUSION

In adults undergoing liver ultrasound in this hospital-based sample, significant fibrosis (≥F2) was common. Elevated ALT and higher fatty liver grade were independently associated with significant fibrosis, even after adjusting for age, BMI, gender, diabetes, and fatty liver grade. These findings suggest ultrasound-detected

fatty liver grade and elastography-based fibrosis staging may aid non-invasive risk stratification in suspected fatty liver disease. However, due to the cross-sectional design and lack of liver biopsy or external validation, these findings indicate associations rather than causality, diagnostic accuracy, or effectiveness. Larger prospective studies using standardized elastography, reliability assessment, and comparison to a reference standard are needed.

REFERENCES

1. D'Hondt A, Rubesova E, Xie H, Shamdasani V, Barth RA. Liver fat quantification by ultrasound in children: a prospective study. AJR Am J Roentgenol. 2021;217(4):996-1006. https://doi.org/10.2214/AJR.20.23828 PMID: 34081531.
2. Pirmoazen AM, Khurana A, El Kaffas A, Kamaya A. Quantitative ultrasound approaches for diagnosis and monitoring hepatic steatosis in non-alcoholic fatty liver disease. Theranostics. 2020;10(9):4277-89. https://doi.org/10.7150/thno.42317 PMID: 32292511.
3. Jesper D, Klett D, Schellhaas B, Pfeifer L, Leppkes M, Waldner M, et al. Ultrasound-based attenuation imaging for non-invasive quantification of liver fat: a pilot study on feasibility and interobserver variability. IEEE J Transl Eng Health Med. 2020;8:1800119. https://doi.org/10.1109/JTEHM.2020.2989387 PMID: 32411834.
4. Han A, Byra M, Heba E, Andre MP, Erdman JW, Loomba R, et al. Non-invasive diagnosis of non-alcoholic fatty liver disease using radiofrequency ultrasound data and convolutional neural networks. Radiology. 2020;295(2):342-50. https://doi.org/10.1148/radiol.2020191452 PMID: 32097033.
5. Fetzer DT, Pierce TT, Robbin ML, Cloutier G, Mufti A, Hall TJ, et al. US quantification of liver fat: past, present, and future. Radiographics. 2023;43(7):e220178. https://doi.org/10.1148/rg.220178 PMID: 37358889.
6. Ferraioli G, Kumar V, Ozturk A, Nam K, de Korte CL, Barr RG. US attenuation for liver fat quantification: an AIUM-RSNA QIBA initiative. Radiology. 2022;302(3):495-506. https://doi.org/10.1148/radiol.210774 PMID: 34995068.
7. Bozic D, Podrug K, Mikolasevic I, Grgurevic I. Ultrasound methods for assessment of liver steatosis: a critical appraisal. Diagnostics (Basel). 2022;12(10):2287. https://doi.org/10.3390/diagnostics12102287 PMID: 36292249.
8. Destrempes F, Gesnik M, Chayer B, Roy-Cardinal MH, Olivié D, Giard JM, et al. Quantitative ultrasound, elastography, and machine learning for assessment of steatosis and fibrosis. PLoS One. 2022;17(1):e0262291. https://doi.org/10.1371/journal.pone.0262291 PMID: 35025838.
9. Kavvadas D, Rafailidis V, Liakos A, Sinakos E, Partovi S, Papamitsou T, et al. Quantitative ultrasound for hepatic steatosis: a systematic review. Diagnostics (Basel). 2025;15(20):2640. https://doi.org/10.3390/diagnostics15202640 (PMID pending)
10. Shabbir A, Abbas Z, Khatoon A, Mirza TJA. Role of alanine transaminase and transient elastography in categorising non-alcoholic fatty liver disease subgroups. J Coll Physicians Surg Pak. 2024;34(6):718-25. (DOI/PMID not indexed)
11. Arun Kumar D, Kumar S, Rajagopal R, Ramesh R, M M. Non-invasive assessment of liver fibrosis using shear wave elastography in type 2 diabetes mellitus with NAFLD. Cureus. 2024;16(10):e72471. https://doi.org/10.7759/cureus.72471 PMID: 39428177.
12. Villani R, Lupo P, Sangineto M, Romano A, Serviddio G. Liver ultrasound elastography in non-alcoholic fatty liver disease: a state-of-the-art summary. Diagnostics (Basel). 2023;13:1236. https://doi.org/10.3390/diagnostics13071236 PMID: 37046231.
13. Liguori A, Esposto G, Ainora ME, Mignini I, Borriello R, Galasso L, et al. Liver elastography for fibrosis stratification in MASLD: comparison of three techniques. Biomedicines. 2025;13(1):95. https://doi.org/10.3390/biomedicines13010095 (PMID pending)
14. Eltony HAR, Kasem G, Elshraby RM, Badawi R, Helal EM. Non-invasive detection of fibrosis in NAFLD using serum MFAP4 and transient elastography. Egypt Liver J. 2025;15(1):34. https://doi.org/10.1186/s43066-025-00340-0 (PMID pending)
15. Jahani P, Fattahi MR, Neydavoodi M. Correlation of Fibroscan with liver elastography and liver enzymes in fatty liver disease. J Kermanshah Univ Med Sci. 2025;29(1). (DOI/PMID not indexed)
16. Cormack JM, Lee HO, Chao YH, Kim K, Behari J. Focused shear wave elastography for liver fibrosis in MASLD. Gastro Hep Adv. 2026;5(3):100855. https://doi.org/10.1016/j.gastha.2025.100855 (PMID pending)
17. Malik N, Malik G, Rauf M, Basit A, Aftab S, Malik AK. Liver stiffness distribution in Pakistani adults assessed by shear wave elastography. Ann PIMS SZABMU. 2025;21(2):490-5.
18. Seneviratne N, Fang C, Sidhu PS. Ultrasound-based hepatic fat quantification: current status and future directions. Clin Radiol. 2023;78(3):187-200. https://doi.org/10.1016/j.crad.2022.10.019 PMID: 36470653.
19. De Robertis R, Spoto F, Autelitano D, Guagenti D, Olivieri A, Zanutto P, et al. Ultrasound-derived fat fraction for detection of hepatic steatosis. Radiol Med. 2023;128(10):1174-80. https://doi.org/10.1007/s11547-023-01682-z PMID: 37561187.
20. Nakamura Y, Hirooka M, Koizumi Y, Yano R, Imai Y, Watanabe T, et al. Diagnostic accuracy of ultrasound-derived fat fraction for hepatic steatosis. J Med Ultrason (2001). 2025;52(1):85-94. https://doi.org/10.1007/s10396-024-01437-5 (PMID pending)
21. Li B, Tai DI, Yan K, Chen YC, Chen CJ, Huang SF, et al. Quantitative scoring of liver steatosis from ultrasound images via deep learning. World J Gastroenterol. 2022;28(22):2494-508. https://doi.org/10.3748/wjg.v28.i22.2494 PMID: 35774861.

AUTHORS CONTRIBUTION

Zubair Janan *- Concept & Design; Data Acquisition; Data Analysis/Interpretation; Drafting Manuscript; Critical Revision; Final Approval*

Laila Khan *- Concept & Design; Data Analysis/Interpretation; Drafting Manuscript; Critical Revision; Supervision; Final Approval*

Hina Baig *- Concept & Design; Data Acquisition; Data Analysis/Interpretation; Drafting Manuscript; Critical Revision; Final Approval*

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The authors accept responsibility for all aspects of the work and will ensure that any concerns regarding the accuracy or integrity of any part are properly investigated and resolved.