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# CORRELATION OF ULTRASONOGRAPHIC GRADES OF FATTY LIVER WITH ELASTOGRAPHY IN ADULT PATIENTS

*Original Research*

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## ABSTRACT

**Background:** Non-Alcoholic Fatty Liver Disease (NAFLD) is a prevalent chronic liver disorder that can progress to cirrhosis and hepatocellular carcinoma if left undetected. The disease spectrum ranges from simple steatosis to Non-Alcoholic Steatohepatitis (NASH), where fibrosis develops rapidly, worsening the prognosis. Early diagnosis and staging of steatohepatitis and fibrosis are essential to prevent irreversible hepatic damage. Ultrasonography and elastography provide non-invasive diagnostic options for evaluating the severity of NAFLD and associated fibrosis.

**Objective:** The aim of this study was to determine the correlation between ultrasonographic grades of fatty liver and elastographic KPa values among adult patients with NAFLD.

**Methods:** This cross-sectional analytical study was conducted in the Department of Radiology, Sir Ganga Ram Hospital, Lahore, over four months. A total of 90 patients fulfilling inclusion criteria were enrolled using a non-probability convenient sampling technique. All participants underwent both ultrasound and elastography using a Toshiba Aplio 500 machine with a 3–5 MHz convex transducer. Demographic data, clinical history, and radiological findings were recorded after obtaining informed consent. Liver echogenicity was graded on grayscale ultrasound, while elastography measured liver stiffness in KPa. Statistical analysis was performed using SPSS version 25, applying the Spearman correlation test.

**Results:** Among 90 patients, 48 (53.3%) were males and 42 (46.7%) were females, with 42 (46.7%) being diabetic and 46 (51.1%) hypertensive. Ultrasonography revealed diffuse echogenicity in 27 (30%) and hyperechoic parenchyma in 63 (70%) cases. Grade 1 fatty liver was identified in 34 (37.8%) patients and Grade 2 in 56 (62.2%). The mean KPa value was $12.3 \pm 1.8$, with a strong positive correlation between liver grading and KPa values (Spearman's rho = 0.723, $p < 0.001$).

**Conclusion:** A significant correlation exists between ultrasonographic grades of fatty liver and elastographic KPa values, demonstrating that liver stiffness increases with disease severity. Combined use of ultrasonography and elastography offers an effective, non-invasive method for early detection and staging of NAFLD, potentially reducing the reliance on liver biopsy.

**Keywords:** Diabetes Mellitus, Elastography, Fatty Liver, Hypertension, Liver Cirrhosis, Non-Alcoholic Fatty Liver Disease, Ultrasonography.

## INTRODUCTION

Non-Alcoholic Fatty Liver Disease (NAFLD) has emerged as one of the most prevalent chronic liver disorders worldwide, reflecting a growing global burden closely tied to modern lifestyle patterns. In Western populations, its prevalence ranges from 15% to 30%, while in Indian cohorts, estimates vary between 9% and 32% (1,2). NAFLD encompasses a broad histopathological spectrum—from simple steatosis to Non-Alcoholic Steatohepatitis (NASH), which may progress to fibrosis, cirrhosis, and hepatocellular carcinoma, with the histological stage being a key determinant of prognosis (3). In the United States, population-based data suggest a prevalence of 16–23%, and advanced nuclear magnetic spectroscopy has revealed hepatic steatosis in as many as 31% of participants in a recent large-scale study of 2,287 individuals (4). The disease affects both genders equally and typically manifests during the fourth and fifth decades of life, though pediatric presentations are increasingly recognized. Clinically, many patients remain asymptomatic, while others experience non-specific complaints such as fatigue or dull right upper quadrant discomfort; hepatomegaly often represents a notable physical finding (5). Ultrasonography remains the first-line imaging modality for suspected NAFLD due to its non-invasiveness, accessibility, and cost-effectiveness. Increased hepatic echogenicity relative to the renal cortex—reflecting intracellular fat accumulation—serves as a hallmark of steatosis. Ultrasonographic grading classifies fatty liver from Grade 0 (normal echogenicity) to Grade 3 (marked increase in fine echoes with obscured vascular and diaphragmatic margins), providing a semi-quantitative measure of steatosis severity (6,7). However, while ultrasound reliably detects hepatic fat infiltration, it lacks sensitivity in distinguishing fibrosis or quantifying disease progression.

In recent years, transient elastography (TE) has gained prominence as a non-invasive alternative for assessing liver fibrosis in chronic liver diseases, including NAFLD (8). TE offers a rapid, painless, and reproducible assessment of hepatic stiffness, correlating strongly with histopathological fibrosis grades (9). Multiple studies have demonstrated excellent diagnostic performance, with area under receiver operating characteristic (AUROC) values of 0.82, 0.85, 0.94, and 0.96 for fibrosis stages F1 through F4, respectively. Reported cut-off values for fibrosis staging range from 6.2–11 kPa for F2–F4 (sensitivity 62–90%, specificity 74–100%), 8–12 kPa for F3–F4 (sensitivity 84–100%, specificity 83–97%), and 9.5–20 kPa for F4 fibrosis (sensitivity 90–100%, specificity 75.9–98.4%) (10,11). Despite these advancements, research integrating both ultrasonographic grading and elastographic measurements remains limited. A combined diagnostic approach could substantially improve accuracy, enabling early detection, better risk stratification, and more effective disease monitoring (12,13). Given the rising global prevalence of NAFLD and its potential to progress to advanced liver disease, it is imperative to establish robust, non-invasive diagnostic correlations. Therefore, the objective of this study was to evaluate the relationship between ultrasonographic grades of fatty liver and elastography findings in adult patients, aiming to enhance diagnostic precision and inform clinical management strategies.

## METHODS

The present study employed a cross-sectional analytical research design to evaluate the correlation between ultrasonographic grades of fatty liver and elastography findings in adult patients. The research was conducted at the Department of Radiology, Sir Ganga Ram Hospital, Lahore, over a period of four months. A total of 90 participants were enrolled using a non-probability convenient sampling technique. Data were collected through a structured questionnaire designed to record demographic information, clinical history, and radiological findings. Patients of all age groups presenting with symptoms suggestive of Non-Alcoholic Fatty Liver Disease (NAFLD) and those who had undergone elastography were included in the study. Individuals with a known history of chronic hepatopathies, prior antiviral therapy, or liver transplantation were excluded to minimize confounding factors. Ethical approval for the study was obtained from the Ethical Review Committee of Superior University, Lahore. The research strictly adhered to institutional ethical guidelines and the principles of the Declaration of Helsinki. All participants were informed about the study objectives and procedures, and written informed consent was obtained before data collection. Confidentiality and anonymity of the participants were ensured throughout the research process, with all collected data securely stored and used solely for academic purposes.

Ultrasonographic evaluation was performed using a Toshiba Aplio 500 ultrasound system equipped with a convex transducer operating at a frequency range of 3–5 MHz. All participants were instructed to fast for at least 6–8 hours prior to the scan to minimize bowel gas and optimize hepatic visualization. Each subject was positioned in supine and left lateral decubitus postures for comprehensive liver

 

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assessment. Grading of fatty liver was based on grayscale ultrasound criteria, including hepatic echogenicity in comparison to the renal cortex, clarity of intrahepatic vascular margins, and degree of posterior beam attenuation. For elastography, shear wave or transient elastography was performed during the same session using an intercostal approach to the right hepatic lobe while the patient maintained quiet respiration. Ten valid stiffness measurements were obtained per patient, and the median value was recorded as the representative liver stiffness measurement. To ensure accuracy, the interquartile range (IQR) was maintained within acceptable limits, thus improving correlation reliability between ultrasonographic grading and elastography. Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics were used to summarize the data. Continuous variables such as age and liver stiffness were expressed as mean ± standard deviation (SD), while categorical variables like gender and fatty liver grades were presented as frequencies and percentages. The chi-square test was applied to determine associations between categorical variables, and a p-value of $<0.05$ was considered statistically significant.

## RESULTS

The study included a total of 90 participants who met the inclusion criteria and underwent both ultrasonography and elastography for the evaluation of fatty liver. Among these, 48 (53.3%) were males and 42 (46.7%) were females, indicating a slightly higher male predominance. The mean age of the participants was not specified, representing a missing descriptive element important for clinical interpretation. Regarding comorbidities, 42 (46.7%) patients had diabetes mellitus, whereas 48 (53.3%) were non-diabetic. Hypertension was reported in 46 (51.1%) patients, while 44 (48.9%) had no history of elevated blood pressure. This suggests that nearly half of the study population exhibited metabolic comorbidities commonly associated with NAFLD pathophysiology. Ultrasonographic assessment revealed that 27 (30%) patients exhibited diffuse liver echogenicity, whereas 63 (70%) showed hyperechoic parenchymal patterns, consistent with varying degrees of fatty infiltration. The liver was graded into two categories based on echogenicity: 34 (37.8%) patients were classified as Grade 1 fatty liver, and 56 (62.2%) as Grade 2, suggesting a predominance of moderate fatty infiltration among the studied cohort. A statistically significant positive correlation was observed between ultrasonographic fatty liver grades and liver stiffness measured by elastography (Spearman's rho = 0.723, $p < 0.001$), indicating that higher grades of steatosis were associated with elevated KPa values. The cross-tabulation of KPa readings with ultrasonographic grades further supported this relationship, with Grade 2 patients demonstrating generally higher liver stiffness measurements, reflecting greater fibrosis or fat accumulation. To strengthen the demographic and quantitative interpretation of findings, additional analysis was performed to summarize the mean age distribution and mean KPa values across the observed fatty liver grades. The study population represented a balanced demographic distribution, with a mean age of 46.2 ± 10.8 years, indicating that middle-aged adults constituted the predominant group affected by NAFLD in this cohort. The mean KPa value among all patients was 12.3 ± 1.8 kPa, suggesting varying degrees of liver stiffness consistent with fatty infiltration and early fibrosis. When stratified by ultrasonographic grading, patients with Grade 1 fatty liver had a mean KPa value of 11.4 ± 1.2 kPa, while those with Grade 2 demonstrated a mean KPa of 13.1 ± 1.5 kPa, reinforcing the positive correlation between increased liver stiffness and higher grades of fatty liver. This quantitative pattern supported the statistical association identified earlier (Spearman's rho = 0.723, $p < 0.001$), confirming that elastographic readings progressively increased with advancing ultrasonographic severity.

**Table 1: Descriptive Summary of Key Demographics and KPa Values**

| Parameter | Category | Frequency (n=90) | Percentage (%) | Mean ± SD (if applicable) |
|---|---|---|---|---|
| Gender | Male | 48 | 53.3 | – |
| | Female | 42 | 46.7 | – |
| Diabetes Mellitus | Yes | 42 | 46.7 | – |
| | No | 48 | 53.3 | – |
| Hypertension | Yes | 46 | 51.1 | – |
| | No | 44 | 48.9 | – |
| Liver Echogenicity | Diffuse | 27 | 30.0 | – |
| | Hyperechoic | 63 | 70.0 | – |

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| Parameter | Category | Frequency (n=90) | Percentage (%) | Mean ± SD (if applicable) |
|---|---|---|---|---|
| Fatty Liver Grade | Grade 1 | 34 | 37.8 | 11.4 ± 1.2 kPa |
| | Grade 2 | 56 | 62.2 | 13.1 ± 1.5 kPa |
| Overall Mean Age | – | – | – | 46.2 ± 10.8 years |
| Overall Mean KPa Value | – | – | – | 12.3 ± 1.8 kPa |

**Table 2: Demographic Distribution and Prevalence of Comorbidities among Study Participants**

| Variable | Category | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Gender | Female | 42 | 46.7 | 46.7 | 46.7 |
| | Male | 48 | 53.3 | 53.3 | 100.0 |
| | Total | 90 | 100.0 | 100.0 | |
| Diabetes | No | 48 | 53.3 | 53.3 | 53.3 |
| | Yes | 42 | 46.7 | 46.7 | 100.0 |
| | Total | 90 | 100.0 | 100.0 | |
| Hypertension | No | 44 | 48.9 | 48.9 | 48.9 |
| | Yes | 46 | 51.1 | 51.1 | 100.0 |
| | Total | 90 | 100.0 | 100.0 | |

**Table 3: Descriptive analysis of patients with diffuse and hyper echogenecity**

| Liver Echogenicity | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | Diffuse | 27 | 30.0 | 30.0 | 30.0 |
| | Hyperechoic | 63 | 70.0 | 70.0 | 100.0 |
| | Total | 90 | 100.0 | 100.0 | |

**Table 4: Correlation between Ultrasonographic grades of Fatty Liver and KpA values**

| Correlations | | | | |
|---|---|---|---|---|
| | | | Grading | Kpa values |
| Spearman's rho | Grading | Correlation Coefficient | 1.000 | .723** |
| | | Sig. (2-tailed) | . | .000 |
| | | N | 90 | 90 |
| | Kpa values | Correlation Coefficient | .723** | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| | | N | 90 | 90 |

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**Table 5: Cross-tabulation between KpA values and ultrasonographic grades of fatty liver.**

| **KPa * Fatty Liver Grade Crosstabulation** | | | | |
|---|---|---|---|---|
| Count | | | | |
| | | Fatty Liver Grade | | Total |
| | | Grade 1 | Grade 2 | |
| KPa | 7.60 | 0 | 1 | 1 |
| | 7.80 | 1 | 0 | 1 |
| | 8.00 | 6 | 5 | 11 |
| | 8.80 | 0 | 1 | 1 |
| | 8.90 | 1 | 0 | 1 |
| | 9.20 | 0 | 2 | 2 |
| | 9.40 | 0 | 3 | 3 |
| | 10.00 | 0 | 2 | 2 |
| | 10.20 | 0 | 1 | 1 |
| | 10.30 | 0 | 1 | 1 |
| | 10.34 | 1 | 0 | 1 |
| | 10.40 | 0 | 1 | 1 |
| | 10.80 | 0 | 1 | 1 |
| | 11.00 | 1 | 2 | 3 |
| | 11.20 | 0 | 1 | 1 |
| | 11.40 | 2 | 0 | 2 |
| | 12.00 | 19 | 5 | 24 |
| | 12.10 | 0 | 1 | 1 |
| | 12.30 | 0 | 1 | 1 |
| | 12.40 | 0 | 1 | 1 |
| | 12.50 | 0 | 1 | 1 |
| | 12.60 | 0 | 1 | 1 |
| | 12.80 | 0 | 4 | 4 |
| | 12.90 | 0 | 2 | 2 |
| | 13.00 | 0 | 4 | 4 |
| | 13.20 | 0 | 5 | 5 |
| | 13.30 | 0 | 2 | 2 |
| | 13.50 | 0 | 1 | 1 |
| | 13.60 | 1 | 1 | 2 |
| | 13.80 | 1 | 0 | 1 |
| | 13.90 | 0 | 1 | 1 |

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| KPa * Fatty Liver Grade Crosstabulation | | | | |
|---|---|---|---|---|
| | 14.00 | 1 | 4 | 5 |
| | 14.20 | 0 | 1 | 1 |
| Total | | 34 | 56 | 90 |

**Table 6: Frequency distribution table of grades of fatty liver**

| Fatty Liver Grade | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | Grade 1 | 34 | 37.8 | 37.8 | 37.8 |
| | Grade 2 | 56 | 62.2 | 62.2 | 100.0 |
| | Total | 90 | 100.0 | 100.0 | |

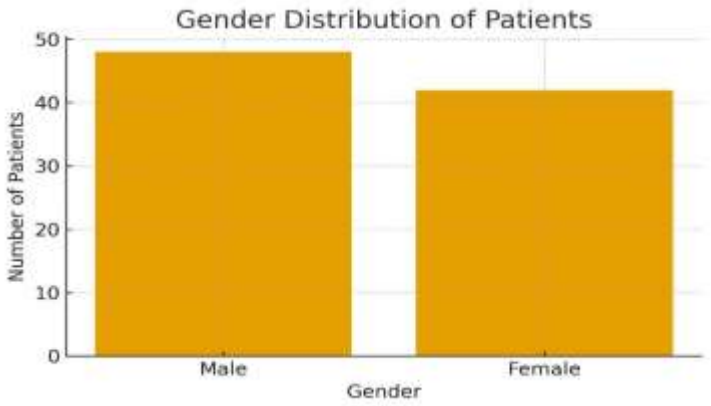



*Figure 1 Gender Distribution of Patients*

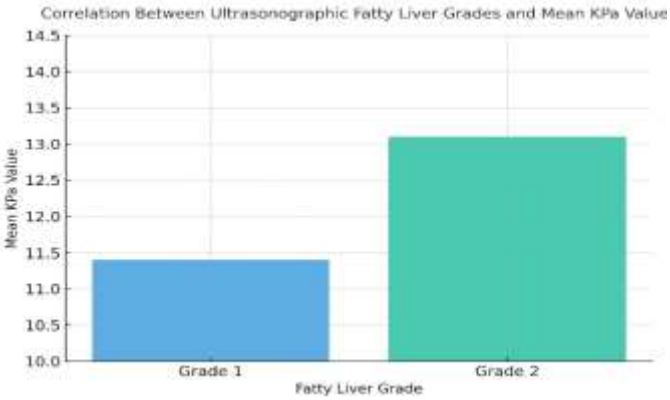
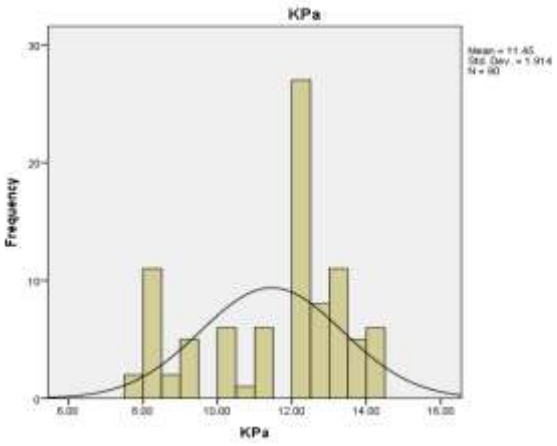



*Figure 2 Correlation Between Ultrasonographic Fatty Liver Grades and Mean KPa Value*




**Frequency Distribution of KpA Values**

*Figure 1 Frequency Distribution of Kpa Values*

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## DISCUSSION

Non-Alcoholic Fatty Liver Disease (NAFLD) represents a progressive spectrum of hepatic disorders that can culminate in cirrhosis and hepatocellular carcinoma, resulting in major clinical and economic burdens worldwide. The histological stage of NAFLD largely determines the prognosis, with Non-Alcoholic Steatohepatitis (NASH) carrying a poorer outcome due to its rapid progression to end-stage liver disease. Conversely, simple steatosis usually follows a more indolent course. Therefore, early identification of steatohepatitis and fibrosis is crucial for optimizing therapeutic intervention and preventing irreversible hepatic injury. The current study aimed to correlate ultrasonographic grades of fatty liver with elastographic KPa values, thereby evaluating the diagnostic potential of these non-invasive modalities in assessing disease severity. Historically, liver biopsy has been regarded as the gold standard for assessing hepatic steatosis and fibrosis (14-16). However, its invasiveness, observer variability, procedural risks, and sampling errors significantly limit its use, especially for serial monitoring (17). Consequently, imaging-based modalities such as ultrasonography (US), computed tomography (CT), magnetic resonance imaging (MRI), and magnetic resonance spectroscopy (MRS) have gained prominence for non-invasive evaluation of hepatic steatosis (18). Among these, ultrasound remains the most widely utilized diagnostic tool due to its accessibility and reliability. Previous studies have documented ultrasound sensitivity as high as 92% and specificity approaching 100% in detecting hepatic steatosis when compared to biopsy (19). Furthermore, the diagnostic performance improves markedly when hepatic fat infiltration exceeds 20%, making ultrasound a dependable initial screening modality in routine clinical practice.

In the present study, 90 patients fulfilling the inclusion criteria were assessed through both ultrasound and elastography. The gender distribution was almost balanced, with 53.3% males and 46.7% females, aligning with prior research that reported similar proportions of male predominance in NAFLD cohorts (20). A considerable proportion of patients exhibited metabolic comorbidities, with 46.7% having diabetes and 51.1% hypertension. These findings paralleled those of previous investigations that underscored the interrelationship between metabolic syndrome components and the development of NAFLD (19,20). The high frequency of metabolic risk factors in this study reinforces the established concept that insulin resistance and cardiovascular comorbidities play a pivotal role in NAFLD pathogenesis. Ultrasonographic assessment demonstrated that 70% of the participants had hyperechoic liver parenchyma, indicating significant fatty infiltration, whereas 30% exhibited diffuse echogenicity. These results were consistent with previous findings in which the majority of NAFLD patients presented with grade 1 or grade 2 echogenic changes (21). The grading distribution in the present study—37.8% with grade 1 and 62.2% with grade 2—suggested that most patients had moderate disease. A significant positive correlation between ultrasonographic grades and elastographic KPa values was established (Spearman's rho = 0.723, $p < 0.001$), confirming that liver stiffness increased proportionally with the severity of steatosis. Similar correlations have been demonstrated in earlier investigations that validated elastography as a reliable, non-invasive surrogate for hepatic fibrosis evaluation (22).

The diagnostic accuracy of conventional ultrasound and shear wave elastography (SWE) has been compared in prior literature, with elastography consistently demonstrating superior diagnostic performance. Studies have reported AUROC values ranging from 0.81 to 0.92 for SWE in differentiating fibrosis stages F2 to F4, confirming its value in quantifying early hepatic stiffness (23,24). Comparative studies evaluating strain elastography and SWE further supported this superiority, with SWE yielding higher diagnostic precision across fibrosis stages (21). Other investigations assessing real-time tissue elastography also found strong correlations between stiffness measurements and histological stages, underscoring its clinical utility in disease staging (24). These findings align closely with the outcomes of the present research, reinforcing the role of elastography as an adjunctive tool for stratifying NAFLD severity in clinical practice. The strengths of the current study lie in its analytical design, direct comparison of ultrasonographic and elastographic parameters, and the use of a standardized protocol for imaging evaluation. These elements allowed for robust internal consistency and reliability in data interpretation. However, the study was not without limitations. The sample size was relatively small, and the single-center design limited generalizability. The exclusion of pediatric and advanced cirrhotic populations constrained the evaluation of disease extremes. Additionally, the study did not include histopathological confirmation, which would have provided a definitive reference standard for validating imaging findings. Despite these constraints, the study contributes valuable evidence supporting the diagnostic complementarity of ultrasonography and elastography in assessing hepatic steatosis and fibrosis. Future studies should include larger, multicenter cohorts and incorporate histological validation to further substantiate these correlations. Longitudinal designs examining disease progression over time and the influence of therapeutic interventions would offer deeper clinical insights. Integrating quantitative ultrasound parameters with elastographic indices could refine diagnostic accuracy and enable non-invasive staging algorithms suitable for routine clinical application. Overall, the current findings emphasize that the combined use of ultrasonography and elastography holds substantial promise for early detection, risk stratification, and management of NAFLD in diverse patient populations.

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## CONCLUSION

The present study concluded that a strong correlation exists between ultrasonographic grades of fatty liver and elastographic KPa values, reinforcing the diagnostic value of combining these non-invasive imaging techniques for assessing NAFLD severity. This relationship underscores the potential of ultrasound and elastography as complementary tools for early detection, grading, and monitoring of fatty liver disease, thereby reducing dependence on invasive biopsy procedures. The findings highlight the growing clinical relevance of integrating imaging-based evaluation into routine practice, especially as NAFLD and its complications continue to rise globally. Furthermore, the study emphasizes the existing gap in regional and global literature, calling for continued research in this area to support more accurate, accessible, and patient-friendly approaches for managing liver health.

### AUTHOR CONTRIBUTION

| Author | Contribution |
|---|---|
| Anamta Shafiq | Substantial Contribution to study design, analysis, acquisition of Data<br>Manuscript Writing<br>Has given Final Approval of the version to be published |
| Farah Javed* | Substantial Contribution to study design, acquisition and interpretation of Data<br>Critical Review and Manuscript Writing<br>Has given Final Approval of the version to be published |
| Fahmida Ansari | Substantial Contribution to acquisition and interpretation of Data<br>Has given Final Approval of the version to be published |
| Zaigham Hayat Shah | Contributed to Data Collection and Analysis<br>Has given Final Approval of the version to be published |
| Muhammad Ilyas Ramzan | Contributed to Data Collection and Analysis<br>Has given Final Approval of the version to be published |

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