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Research Article

Ultrasound Assessment of Hepatobiliary Disorders: A Cross-Sectional Study in a Rural Population

Dr Pradeepkumar Deshmukh[1], Dr Megha Dilip Kale[2]

[1]Professor, Department of Radiodiagnosis, Government Medical College, Dharashiv, Maharashtra, INDIA.
[2]Assistant Professor, Department of Radiodiagnosis, Government Medical College, Dharashiv, Maharashtra, INDIA.

*Corresponding Author

Dr. Megha Dilip Kale, Assistant Professor, Department of Radiodiagnosis, Government Medical College, Dharashiv, Maharashtra, INDIA.

Email: vp224748@gmail.com

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Abstract: ***Introduction:*** Hepatobiliary disorders represent a major health concern, particularly in rural populations where access to advanced diagnostic facilities is limited. Ultrasonography is widely used as a first-line imaging modality due to its safety, availability, and cost-effectiveness. **Aim:** To assess the spectrum of hepatobiliary disorders using ultrasonography in a rural population. Objectives: 1. To determine the prevalence of hepatobiliary abnormalities detected on ultrasonography. 2. To evaluate the pattern and types of hepatobiliary disorders. 3. To correlate ultrasonographic findings with demographic and clinical parameters. **Materials and Methods:** This was a hospital-based cross-sectional study conducted over a period of 12 months, including 120 patients presenting with symptoms suggestive of hepatobiliary disorders. Detailed clinical evaluation and ultrasonographic examination were performed using standard protocols. Data were analyzed using descriptive and inferential statistics, including Chi-square test and calculation of odds ratios, with $p < 0.05$ considered statistically significant. **Results:** The mean age of the study population was 45.82 ± 14.36 years, with a slight male predominance (56.7%). Ultrasonography detected hepatobiliary abnormalities in 72.5% of patients ($p < 0.001$). The most common findings were fatty liver (33.3%), cholelithiasis (24.1%), and hepatomegaly (12.6%). Significant associations were observed between abnormal findings and age >45 years ($p = 0.008$), male gender ($p = 0.019$), alcohol consumption ($p = 0.003$), and diabetes mellitus ($p = 0.035$). **Conclusion:** Ultrasonography is an effective, non-invasive tool for the detection of hepatobiliary disorders in rural populations. The high prevalence of abnormalities, particularly fatty liver and gallstone disease, highlights the need for early screening and preventive strategies.
Keywords: Ultrasonography. Hepatobiliary disorders. Rural population.

INTRODUCTION

Hepatobiliary disorders constitute a significant proportion of morbidity worldwide, particularly in developing countries where access to advanced diagnostic modalities is often limited. These disorders include a wide spectrum of conditions affecting the liver, gallbladder, biliary tree, and pancreas, such as fatty liver disease, hepatitis, cirrhosis, cholelithiasis, cholecystitis, and obstructive biliary pathologies. In rural populations, the burden of hepatobiliary diseases is often underestimated due to lack of awareness, delayed healthcare-seeking behavior, and limited diagnostic infrastructure. Early diagnosis and timely management are essential to prevent complications such as liver failure, portal hypertension, and biliary obstruction.

Ultrasonography (USG) has emerged as a first-line imaging modality in the evaluation of hepatobiliary disorders due to its non-invasive nature, wide availability, cost-effectiveness, and absence of ionizing radiation. It plays a crucial role in detecting structural abnormalities, assessing organ size, identifying focal lesions, and evaluating biliary dilatation or gallstones. In resource-limited rural settings, ultrasonography serves as a cornerstone diagnostic tool, often guiding clinical decision-making and reducing the need for more expensive imaging techniques such as CT or MRI.

The epidemiological pattern of hepatobiliary disorders varies based on geographic, dietary, socioeconomic, and environmental factors. Rural populations are particularly vulnerable due to factors such as poor sanitation, malnutrition, alcohol consumption, and limited access to healthcare facilities. Studies have shown a rising prevalence of non-alcoholic fatty liver disease (NAFLD) even in rural areas, attributed to changing lifestyles and metabolic risk factors. Additionally, gallstone disease remains one of the most common hepatobiliary conditions, especially among females and individuals with dietary predispositions.

Ultrasound not only aids in diagnosis but also helps in monitoring disease progression and response to treatment. It is highly sensitive in detecting gallstones, biliary obstruction, and hepatic parenchymal changes such as steatosis and cirrhosis. Moreover, it allows real-time imaging, making it useful for guiding interventional

procedures when necessary. Despite its advantages, the effectiveness of ultrasound depends on operator expertise and patient-related factors such as obesity and bowel gas.

Given the increasing burden of hepatobiliary disorders and the pivotal role of ultrasonography in their diagnosis, especially in underserved rural populations, there is a need to systematically evaluate the spectrum of hepatobiliary findings using ultrasound. This study aims to assess the prevalence and pattern of hepatobiliary disorders detected by ultrasonography in a rural population, thereby contributing to improved diagnostic strategies and healthcare planning in such settings [1-5].

AIM

To assess the spectrum of hepatobiliary disorders using ultrasonography in a rural population.

OBJECTIVES

1. To determine the prevalence of hepatobiliary abnormalities detected on ultrasonography.
2. To evaluate the pattern and types of hepatobiliary disorders in the study population.

To correlate ultrasonographic findings with demographic and clinical parameters.

MATERIALS AND METHODS

Source of Data: The data were collected from patients attending the outpatient and inpatient departments of a tertiary care hospital serving a predominantly rural population.

Study Design: The study was a hospital-based cross-sectional observational study.

Study Location: The study was conducted at a tertiary care center catering to rural populations.

Study Duration: The study was carried out over a period of 12 months.

Sample Size: A total of 120 patients were included in the study.

Inclusion Criteria:

- Patients aged 18 years and above
- Patients presenting with symptoms suggestive of hepatobiliary disorders such as abdominal pain, jaundice, dyspepsia, or abnormal liver function tests
- Patients willing to participate and provide informed consent

Exclusion Criteria:

- Patients with a history of previous hepatobiliary surgery
- Pregnant women (where imaging interpretation may be altered)
- Patients unwilling to participate
- Patients with incomplete clinical or imaging data

Procedure and Methodology: All eligible patients underwent detailed clinical evaluation including history taking and physical examination. Relevant laboratory investigations such as liver function tests were noted. Ultrasonographic examination of the abdomen was performed using a standard ultrasound machine with a convex probe (3.5-5 MHz). Patients were examined in fasting state whenever possible to improve visualization of hepatobiliary structures. The liver was assessed for size, echotexture, focal lesions, and signs of cirrhosis. The gallbladder was evaluated for wall thickness, presence of calculi, sludge, or inflammation. The biliary tree was examined for dilatation or obstruction. The pancreas and adjacent structures were also assessed when feasible. All findings were systematically recorded.

Sample Processing: Ultrasound findings were documented in a structured proforma. Data were categorized based on type of hepatobiliary disorder such as fatty liver, cirrhosis, cholelithiasis, cholecystitis, biliary obstruction, and others. The collected data were verified for completeness and accuracy before analysis.

Statistical Methods: Data were entered into Microsoft Excel and analyzed using appropriate statistical software (such as SPSS). Descriptive statistics were used to summarize the data, including mean and standard deviation for continuous variables and frequencies and percentages for categorical variables. Chi-square test was applied to assess associations between variables. A p-value of <0.05 was considered statistically significant.

Data Collection: Data were collected prospectively using a predesigned case record form. Demographic details, clinical features, laboratory findings, and ultrasonographic findings were recorded systematically for each patient. Confidentiality of patient information was maintained throughout the study.

RESULTS

Table 1: Baseline demographic and clinical profile of the study population (N = 120)

Variable	n (%) / Mean ± SD	95% CI	Test of significance	p value
Age (years)	**45.82 ± 14.36**	43.25 - 48.39	t = 34.96	<0.001*
BMI (kg/m²)	**23.91 ± 3.88**	23.22 - 24.60	t = 67.49	<0.001*
Duration of symptoms (weeks)	**4.72 ± 2.16**	4.33 - 5.11	t = 23.96	<0.001*

Age group			$\chi^2 = 4.33$	0.228
18-30 years	23 (19.2)	12.1 - 26.2		
31-45 years	37 (30.8)	22.6 - 39.1		
46-60 years	34 (28.3)	20.3 - 36.4		
>60 years	26 (21.7)	14.3 - 29.0		
Sex			$\chi^2 = 2.13$	0.144
Male	68 (56.7)	47.8 - 65.5		
Female	52 (43.3)	34.5 - 52.2		
Presenting symptom			$\chi^2 = 26.67$	<0.001*
Right hypochondrial pain	41 (34.2)	25.7 - 42.7		
Jaundice	29 (24.2)	16.5 - 31.8		
Dyspepsia / bloating	27 (22.5)	15.0 - 30.0		
Abdominal distension	13 (10.8)	5.3 - 16.4		
Incidental abnormal LFT	10 (8.3)	3.4 - 13.3		

In the present study comprising 120 participants, the mean age was 45.82 ± 14.36 years (95% CI: 43.25-48.39), which was statistically significant (p <0.001), indicating a predominance of middle-aged individuals in the study population. The mean BMI was 23.91 ± 3.88 kg/m² (95% CI: 23.22-24.60), and the mean duration of symptoms was 4.72 ± 2.16 weeks (95% CI: 4.33-5.11), both showing statistical significance (p <0.001). Age distribution revealed that the majority of participants were in the 31-45 years age group (30.8%), followed by 46-60 years (28.3%), although this distribution was not statistically significant (p = 0.228). There was a slight male predominance with 56.7% males compared to 43.3% females, but this difference was not statistically significant (p = 0.144). Regarding clinical presentation, right hypochondrial pain (34.2%) was the most common symptom, followed by jaundice (24.2%) and dyspepsia/bloating (22.5%), and this distribution was highly significant ($\chi^2 = 26.67$, p <0.001).

Table 2: Prevalence of hepatobiliary abnormalities detected on ultrasonography (N = 120)

Ultrasound finding	**n (%)**	**95% CI**	**Test of significance**	**p value**
Abnormal hepatobiliary finding present	87 (72.5)	64.5 - 80.5	Z = 4.93	<0.001*
No abnormality detected	33 (27.5)	19.5 - 35.5	Z = 4.93	<0.001*

Ultrasonographic evaluation demonstrated that 87 out of 120 participants (72.5%) had abnormal hepatobiliary findings (95% CI: 64.5-80.5), whereas 33 participants (27.5%) had normal scans (95% CI: 19.5-35.5). This difference was statistically highly significant (Z = 4.93, p <0.001), indicating that a substantial proportion of the rural population studied had detectable hepatobiliary abnormalities on ultrasound.

Table 3: Pattern and types of hepatobiliary disorders on ultrasonography among abnormal cases (n = 87)

Type of hepatobiliary disorder	**n (%)**	**95% CI**	**Test of significance**	**p value**
Fatty liver / hepatic steatosis	29 (33.3)	23.4 - 43.2		
Cholelithiasis	21 (24.1)	15.1 - 33.1		
Hepatomegaly	11 (12.6)	5.7 - 19.6		
Cirrhosis / chronic liver parenchymal disease	9 (10.3)	3.9 - 16.7		

Cholecystitis	7 (8.0)	2.3 - 13.8		
Biliary obstruction / dilated biliary radicles	5 (5.7)	0.9 - 10.6		
Hepatic cyst / focal hepatic lesion	3 (3.4)	0.0 - 7.3		
Pancreatitis-related hepatobiliary changes	2 (2.3)	0.0 - 5.4	$\chi^2 = 45.79$	<0.001*

Among the 87 patients with abnormal ultrasonographic findings, the most common disorder identified was fatty liver/hepatic steatosis (33.3%), followed by cholelithiasis (24.1%) and hepatomegaly (12.6%). Other findings included cirrhosis or chronic liver parenchymal disease (10.3%), cholecystitis (8.0%), and biliary obstruction (5.7%). Less common findings were hepatic cysts or focal lesions (3.4%) and pancreatitis-related hepatobiliary changes (2.3%). The overall distribution of hepatobiliary disorders was statistically significant ($\chi^2 = 45.79$, $p < 0.001$), indicating a varied but non-random pattern of disease occurrence, with metabolic and gallbladder-related conditions being the most prevalent.

Table 4: Correlation of ultrasonographic abnormality with demographic and clinical parameters (N = 120)

Parameter	**Abnormal USG n (%)**	**Normal USG n (%)**	**Test of significance**	**p value**	**Odds Ratio (95% CI)**
Age group			$\chi^2 = 7.06$	0.008*	
≤45 years (n = 60)	37 (61.7)	23 (38.3)			Reference
>45 years (n = 60)	50 (83.3)	10 (16.7)			3.11 (1.32 - 7.31)
Sex			$\chi^2 = 5.53$	0.019*	
Male (n = 68)	55 (80.9)	13 (19.1)			2.64 (1.16 - 6.02)
Female (n = 52)	32 (61.5)	20 (38.5)			Reference
Alcohol consumption			$\chi^2 = 8.62$	0.003*	
Present (n = 39)	35 (89.7)	4 (10.3)			4.88 (1.58 - 15.10)
Absent (n = 81)	52 (64.2)	29 (35.8)			Reference
Diabetes mellitus			$\chi^2 = 4.47$	0.035*	
Present (n = 31)	27 (87.1)	4 (12.9)			3.26 (1.04 - 10.20)
Absent (n = 89)	60 (67.4)	29 (32.6)			Reference

A significant association was observed between abnormal ultrasonographic findings and various demographic and clinical parameters. Patients aged >45 years had a significantly higher prevalence of abnormal findings (83.3%) compared to those aged ≤45 years (61.7%) ($p = 0.008$), with an odds ratio (OR) of 3.11 (95% CI: 1.32-7.31). Similarly, male patients showed a higher proportion of abnormal findings (80.9%) compared to females (61.5%) ($p = 0.019$), with an OR of 2.64 (95% CI: 1.16-6.02). A strong association was also observed with alcohol consumption, where individuals with alcohol intake had significantly higher abnormal findings (89.7%) compared to non-users (64.2%) ($p = 0.003$), with the highest odds ratio of 4.88 (95% CI: 1.58-15.10). Additionally, diabetes mellitus was significantly associated with abnormal ultrasound findings (87.1% vs 67.4%, $p = 0.035$), with an OR of 3.26 (95% CI: 1.04-10.20). These findings indicate that advancing age, male gender, alcohol use, and diabetes are important risk factors associated with hepatobiliary abnormalities detected on ultrasonography.

DISCUSSION

In the present study, the mean age of participants was 45.82 ± 14.36 years, indicating that hepatobiliary disorders were more common in middle-aged individuals. This finding is comparable to Marini TJ et al.(2021)[1], who reported a similar adult age group predominance in patients undergoing abdominal ultrasonography in rural settings. Similarly, Khan MF et

al.(2025)[2] observed that the majority of hepatobiliary disorders occurred in the 40-60 years age group, consistent with the current study where 59.1% of patients belonged to this age range. The age group distribution in the present study, though not statistically significant, reflects a typical epidemiological trend seen in developing countries where lifestyle and metabolic factors contribute to hepatobiliary diseases, as also highlighted by Asadullah M et al.(2022)[3] in their rural-urban NAFLD study.

A slight male predominance (56.7%) was noted in the present study, which is in agreement with Ramakrishnan A et al.(2022)[5], who reported higher prevalence of abnormal liver findings among males, possibly due to lifestyle-related risk factors such as alcohol consumption. However, some studies such as Thomas O et al.(2023)[4] have reported variability in gender distribution depending on disease profile and healthcare access, especially in rural populations. In the present study, the difference in gender distribution was not statistically significant ($p = 0.144$), indicating a relatively balanced representation.

Regarding clinical presentation, right hypochondrial pain (34.2%) was the most common symptom, followed by jaundice (24.2%) and dyspepsia (22.5%), which was statistically significant ($p < 0.001$). These findings are consistent with Miravent S et al.(2023)[9], who reported that right upper quadrant pain was the most frequent indication for ultrasound evaluation in hepatobiliary conditions. Similarly, Li S et al.(2023)[6] observed jaundice and biliary symptoms in a significant proportion of patients with biliary tract diseases, aligning closely with the present results. The significant association of presenting symptoms with hepatobiliary abnormalities highlights the importance of clinical evaluation in guiding ultrasonographic diagnosis.

The prevalence of hepatobiliary abnormalities detected on ultrasonography in this study was 72.5%, which was statistically significant ($p < 0.001$). This high detection rate is comparable to Coombs PR et al.(2022)[8], who reported a high yield of ultrasound screening for chronic liver disease in rural populations. Likewise, Zhou YJ et al.(2023)[12] demonstrated that ultrasound, including handheld devices, could effectively detect hepatobiliary pathology in remote communities, supporting the high diagnostic yield observed in the present study. These findings reaffirm the role of ultrasound as an effective first-line imaging modality, particularly in rural and resource-limited settings.

In terms of the pattern of hepatobiliary disorders, fatty liver (33.3%) was the most common finding, followed by cholelithiasis (24.1%) and hepatomegaly (12.6%). This pattern is consistent with the rising prevalence of metabolic liver disease reported by Asadullah M et al.(2022)[3], where NAFLD was highly prevalent even in rural populations. Similarly, Lucius C et al.(2025)[11] reported that gallbladder pathologies such as cholelithiasis are among the most frequently detected abnormalities on ultrasound, closely matching the present study findings. The statistically significant distribution of disorders ($p < 0.001$) indicates a non-random and clinically relevant pattern, with metabolic and gallstone diseases being the major contributors.

The correlation analysis revealed that age >45 years was significantly associated with abnormal ultrasonographic findings (OR = 3.11, $p = 0.008$), which is consistent with Acosta-Jamett G et al.(2022)[7], who reported increasing prevalence of hepatobiliary pathology with advancing age in community-based ultrasound studies. Similarly, male gender showed a significant association (OR = 2.64, $p = 0.019$), aligning with findings of Zhou YJ et al.(2023)[12]. A strong association was also noted with alcohol consumption (OR = 4.88, $p = 0.003$), which is supported by Ramakrishnan A et al.(2022)[5], who emphasized alcohol as a major determinant of liver abnormalities in rural populations. Additionally, diabetes mellitus was significantly associated with abnormal findings (OR = 3.26, $p = 0.035$), consistent with Asadullah M et al.(2022)[3], who reported a strong link between metabolic disorders and fatty liver disease.

CONCLUSION

The present cross-sectional study highlights the significant burden of hepatobiliary disorders in a rural population and underscores the pivotal role of ultrasonography as an effective, non-invasive diagnostic modality. A high prevalence of hepatobiliary abnormalities (72.5%) was observed, indicating that a substantial proportion of individuals presenting with abdominal complaints had detectable pathology on ultrasound. The study population predominantly comprised middle-aged individuals, with a slight male predominance, reflecting the influence of lifestyle and metabolic risk factors.

Among the spectrum of hepatobiliary disorders identified, fatty liver disease emerged as the most common finding, followed by cholelithiasis and hepatomegaly, suggesting a growing contribution of metabolic and dietary factors even in rural settings. The statistically significant distribution of these conditions indicates a clear epidemiological shift towards non-communicable hepatobiliary diseases.

Furthermore, significant associations were observed between abnormal ultrasonographic findings and key risk factors such as advancing age, male gender, alcohol consumption, and diabetes mellitus. These findings emphasize the importance of early screening and risk stratification in vulnerable populations. Ultrasonography proved to be highly valuable in detecting both parenchymal and biliary pathologies, making it an indispensable tool in primary and secondary healthcare settings, especially in resource-limited rural areas.

In conclusion, ultrasonography serves as a reliable, accessible, and cost-effective modality for the early detection and evaluation of hepatobiliary disorders. The study reinforces the need for increased awareness, routine screening, and targeted interventions to reduce the burden of hepatobiliary diseases in rural populations.

LIMITATIONS OF THE STUDY

1. The study was conducted at a single tertiary care center, which may limit the generalizability of the findings to the wider rural population.
2. The sample size (N = 120) was relatively modest, which may affect the statistical power of subgroup analyses.
3. Being a cross-sectional study, causal relationships between risk factors and hepatobiliary disorders could not be established.
4. Ultrasonography is operator-dependent, and variations in expertise may influence diagnostic accuracy.
5. Certain conditions such as early-stage liver disease or small lesions may have been missed due to limitations of ultrasound resolution.
6. Lack of correlation with advanced imaging modalities (CT/MRI) or histopathological confirmation may have affected diagnostic precision.
7. Data on dietary habits, socioeconomic status, and genetic predisposition were not extensively analyzed.
8. Some patients were evaluated based on clinical symptoms alone without long-term follow-up, limiting outcome assessment.
9. Recall bias may have affected the accuracy of patient-reported symptoms and duration.
10. The study did not assess inter-observer variability, which could influence reproducibility of findings.

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