ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 10, Issue – 4, July – 2025, Page No. : 01 – 11

Evaluating the Clinical Spectrum of MAFLD Through Biochemical Profiling

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Citation this Article: Dr Gunita Sharma, Dr Ravi Saini, Dr Puneet Rijhwani, Dr Tapas Kanu Vyas, "Evaluating the Clinical Spectrum of MAFLD Through Biochemical Profiling", IJMSIR - July – 2025, Vol – 10, Issue - 4, P. No. 01 – 11.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: Metabolic Dysfunction-Associated Fatty Liver Disease (MAFLD) is now the most common chronic liver disease globally, linked closely with obesity, diabetes, and other metabolic risk factors. It presents a wide clinical spectrum—from simple steatosis to steatohepatitis, fibrosis, and cirrhosis. Early identification of disease severity through clinical and biochemical markers is essential for timely intervention. This study aims to evaluate the clinical and biochemical profile of MAFLD patients in a tertiary care setting and explore the association of key parameters with disease progression.

Aim and Objective

1. To study the spectrum and clinical profile of MAFLD including MAFL, MASH, MASH related cirrhosis and MASH related HCC in patients presenting to MGH.
2. To study the frequency of extrahepatic manifestations in cohort of patients with MAFLD.

Methodology: This study included 100 patients. In this study, inclusion and exclusion criterias were implemented and patients were categorized into MAFL, MASH, MASH related cirrhosis and HCC.

A cross sectional (observational) study was conducted at Mahatma Gandhi Hospital, Jaipur with due ethical permission.

Observation: In this study of 110 MAFLD patients, the majority were aged 40–60 years (mean age 52), with a slight male predominance (58%). Urban and rural representation was nearly equal. High waist circumference and obesity were common, with 65% classified as overweight or obese. Hypertension and Type 2 diabetes were present in 57% and 52% of patients, respectively, while full metabolic syndrome was identified in 35%. Subclinical hypothyroidism (17.2%)

was the most common extrahepatic manifestation. Thrombocytopenia was found in 35% of patients, and 8% had hypoalbuminemia. Elevated SGOT was seen in 18% of the population. Hypertriglyceridemia and low HDL levels were present in over half of the patients. Ultrasonography revealed Grade 1 fatty liver in 64.5% of participants, while FibroScan results showed that 82% had simple steatosis (MAFL), 14.5% had fibrosis, and 2.7% had cirrhosis.

Conclusion: This study highlights the diverse clinical and biochemical spectrum of MAFLD in a tertiary care population. While common metabolic risk factors such as obesity, hypertension, and Type 2 diabetes were prevalent, they did not significantly differentiate between disease stages. Most patients had simple steatosis, with a smaller proportion progressing to fibrosis or cirrhosis. Notably, liver-specific markers such as SGOT, dyslipidemia, and imaging findings (ultrasound grading and FibroScan-based liver stiffness measurements) showed stronger associations with disease severity. The findings underscore the importance of incorporating liver-focused assessments alongside metabolic evaluation to better stratify risk and guide early intervention in MAFLD. Further large-scale and longitudinal studies are warranted to validate these associations and improve disease management strategies.

Keywords: Metabolic Dysfunction-Associated Fatty Liver Disease, Non-alcoholic Fatty Liver Disease, Obesity, Type 2 Diabetes Mellitus, Dyslipidemias, Hypertension, Ultrasonography, Fibrosis ,Hepatic Steatosis, Thyroid Diseases

Introduction

Non-alcoholic fatty liver disease (MAFLD) is a metabolic liver disorder characterized by excessive hepatic fat accumulation in individuals with minimal or no alcohol intake. It encompasses a pathological continuum ranging from benign steatosis (non-alcoholic fatty liver, MAFL) to non-alcoholic steatohepatitis (MASH), which may be accompanied by hepatocellular inflammation, ballooning, fibrosis, and potentially progress to cirrhosis and hepatocellular carcinoma (HCC). Unlike alcoholic liver disease, the progression of MAFLD is heterogeneous and not easily predicted, with certain cases of HCC arising even in the absence of cirrhosis.

Globally, MAFLD affects an estimated 30–32% of the adult population, with the highest prevalence observed in Latin America and the Asia-Pacific region. The increasing incidence of MAFLD mirrors the global rise in obesity, type 2 diabetes mellitus (T2DM), and metabolic syndrome (MS), reinforcing its status as the most prevalent chronic liver disease worldwide. The condition is strongly associated with central obesity, insulin resistance, hypertension, dyslipidemia, and other components of MS. Notably, studies have demonstrated that T2DM patients may harbor undiagnosed MAFLD despite normal liver enzyme profiles and are at substantially increased risk for progression to MASH and liver-related complications.

Clinically, MAFLD remains largely silent in its early stages and is often detected incidentally through imaging or biochemical investigations. As the disease advances, patients may present with non-specific symptoms or manifestations of liver dysfunction. Although early-stage MAFLD is potentially reversible with structured lifestyle interventions—primarily weight reduction, dietary modification, and physical activity—there is a conspicuous lack of approved pharmacotherapies, despite ongoing research efforts.

Given the rising burden and clinical complexity of MAFLD, early diagnosis, non-invasive staging, and comprehensive risk assessment are critical for mitigating

long-term morbidity and mortality. This study aims to delineate the clinical and biochemical spectrum of MAFLD in patients attending a tertiary care hospital and to categorize disease stages using validated non-invasive tools. By advancing our understanding of MAFLD phenotypes and associated metabolic derangements, this work aspires to inform more effective diagnostic and therapeutic strategies.

Aim and Objective

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Methodology

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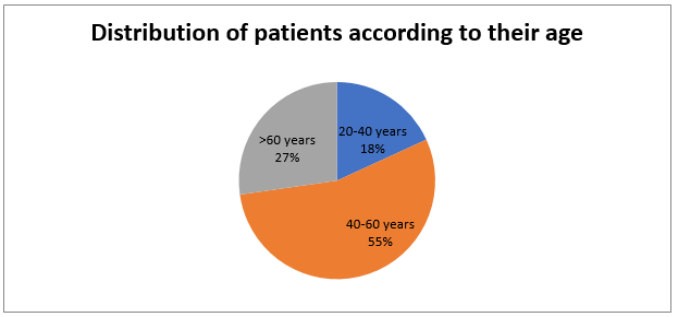
Observation

Age distribution

Age	No. of patients	percentage
20-40 years	20	18%
40-60 years	60	54%
>60 years	30	27%

Table 1: Showing the age wise distribution of the study population.



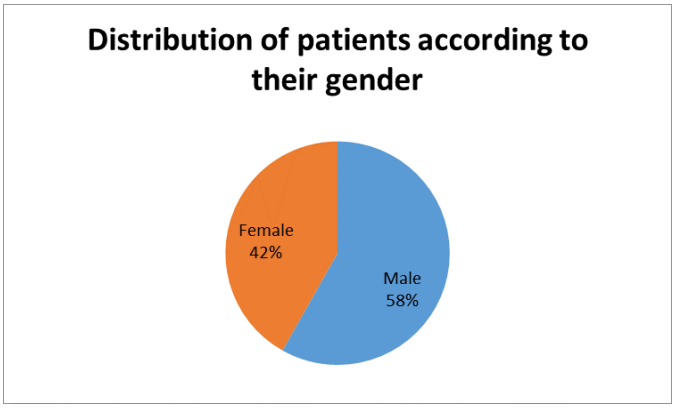
Maximum distribution of patients is between 40-60 years of age which is 54% of the total population with mean age being 52 years. 20 patients were among 20-40 years which is 18% of the population whereas 30 patients that is 27 % of population were more than 60 years of age.

Sex distribution

Sex	No. of patients	Percentage of population
Male	64	58%
Female	46	42%

Table 2: Showing the classification of patients based on sex.

Metabolic associated fatty liver disease was reported slightly higher in males than in females that is 58 % of the total test population.

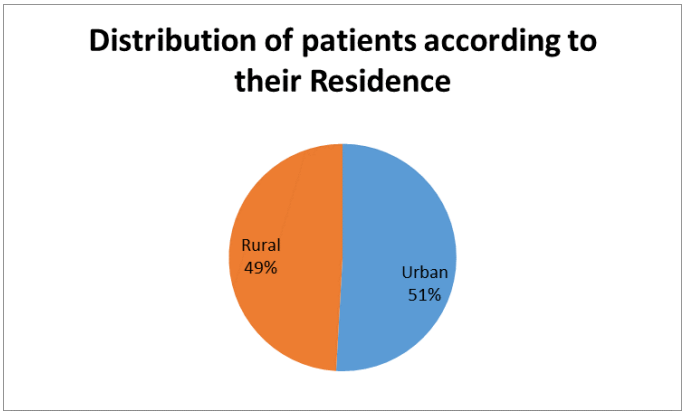


Urban VS rural

Table 3: Showing the classification of patients based on background.

Background	No.of patients	Percentage of patients
Urban	56	51%
Rural	54	49%

Contrary to the belief that fatty liver is a disease of urban population owing to their sedentary lifestyle, almost half of the patients enrolled in this study who had MAFLD Belonged to rural background indicating that diet also plays an important role in developing MAFLD.

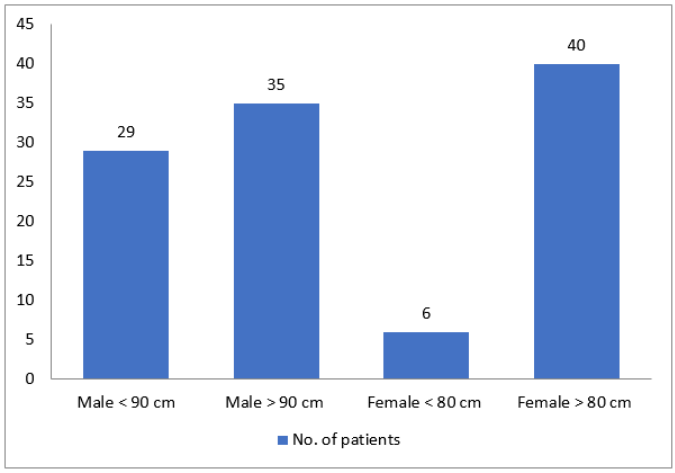


Waist circumference

Table 4: Showing the classification of patients based waist circumference

Sex and waist circumference	No. of patients	Percentage of total population.
Male < 90 cm	29	26 %
Male > 90 cm	35	31.8 %
Female < 80 cm	6	5.4 %
Female > 80 cm	40	36.3 %

One of the component of metabolic syndrome is waist circumference. The reference value for both males and females is different that is 90 cm and 80 cm respectively. Males and females above the reference range have centripetal obesity and are more prone to developing nonalcoholic fatty liver disease.



Distribution of patients according to their waist circumference

Body Mass Index

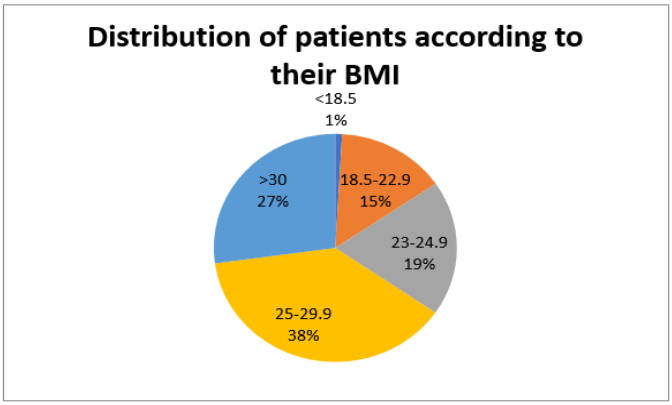
BMI = weight (kg) / (height (m))^2

Table 5: Showing the classification of patients based on BMI

BMI	Interpretation	No. of patients	Percentage of study population.
<18.5	Lean	1	0.9%
18.5-22.9	Normal	16	14.5%
23-24.9	Overweight	21	19%
25-29.9	Obese class I	42	38%
>30	Obese class II	30	27%

Body mass index is an important predictor of obesity. Higher the BMI higher are the chances of developing MAFLD along with cardiovascular, renal and gastrointestinal disorders.

Classifying the study population based on BMI has showed that nearly 19% of people are overweight, whereas 38% population fell under Class I Obesity, 27 % of total were labelled as class II obesity

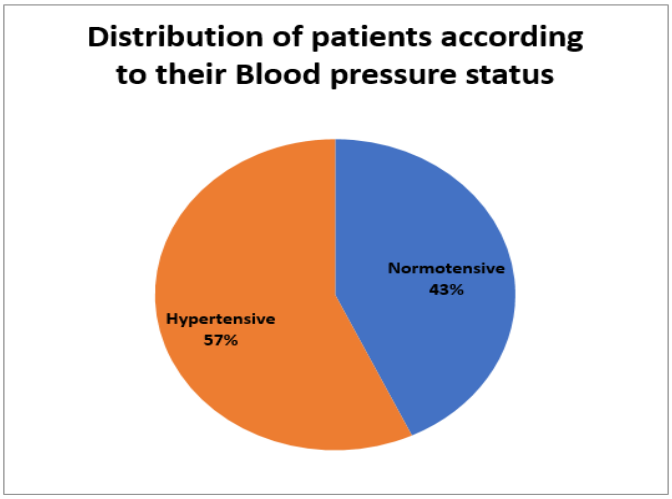


Hypertension

Table 6: Showing the classification of patients based on presence and absence of hypertension.

Blood pressure status	No. of patients	Percentage of patients
Normotensive	47	43%
Hypertensive	63	57%

Arterial stiffness develops as an extrahepatic manifestation of fatty liver which in turn increases the blood pressure. Study also shows that 57% of the patients had higher blood pressure.



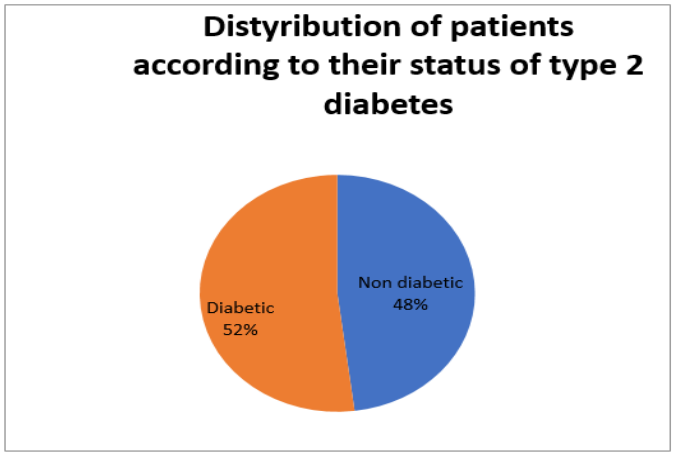
Type 2 Diabetes

Table 7: Showing the classification of patients based on diabetic status.

	No. of patients	Percentage of patients
Non diabetic	53	48%
Diabetic	57	52%

Higher blood sugars (>110 mg/dl) is a component of metabolic syndrome. Metabolic syndrome leads to Insulin resistance which in itself is a causative factor for MAFLD.

In our study 58% patients had diabetes which could be a major causative factor for fatty liver.



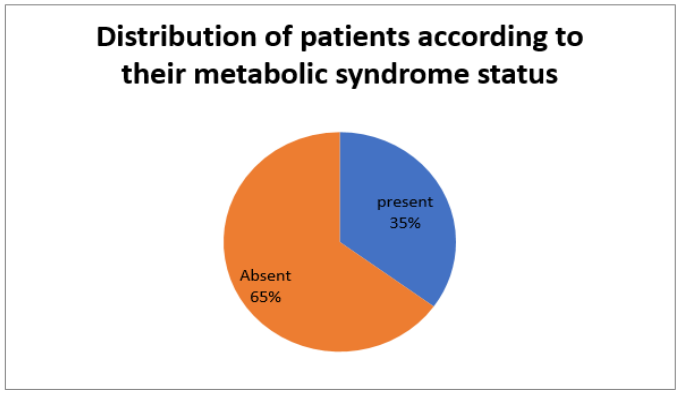
Metabolic syndrome

Table 8: Showing the classification of patients based on presence and absence of metabolic syndrome

Metabolic syndrome	No. of patients	Percentage of population
present	38	35%
Absent	72	65%

Although one or two components of metabolic syndrome were seen in almost entire study population but complete syndrome was present in 35% of the population only.

Presence of metabolic syndrome signifies multiple factors which has lead to the development of MAFLD.

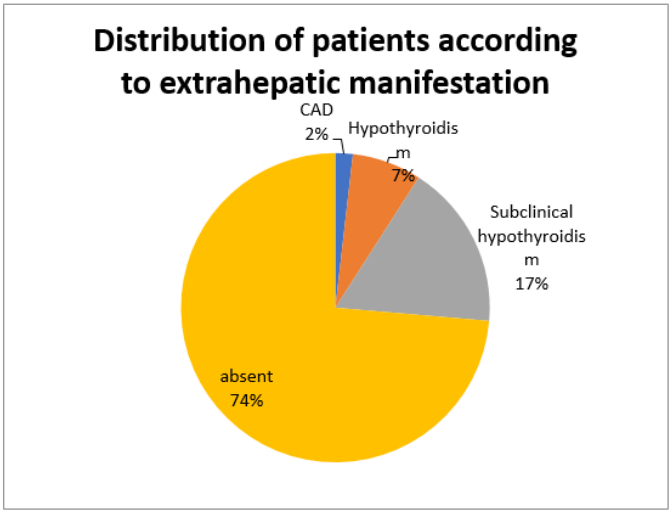


Extrahepatic manifestations

Table 9: Showing the distribution of other co morbidities in the study population.

Extrahepatic manifestations	No. of patients	Percentage of population
CAD	2	1.8%
Hypothyroidism	8	7.2%
Subclinical Hypothyroidism	19	17.2%
Absent	81	73.8%

Most of the population did not develop extrahepatic manifestations but most common extrahepatic manifestation seen was hypothyroidism being clinical comprising 7.2 % of the study population and subclinical comprising 17.2% of population. CAD was also seen in 2% of population.



Investigations

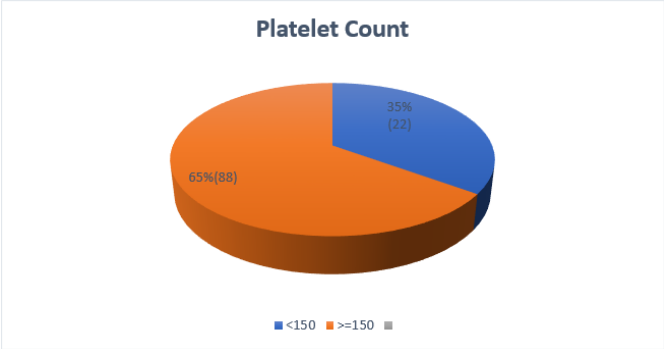
Platelet count

Table 10: Showing the classification of patients based on platelet count.

Platelet count	No. of patients	Percentage of population
<150 x 10^9	22	35%
>=150 x 10^9	88	65%

Thrombocytopenia is defined a low platelet count that is < 150 x 10^9 .

35% of the study population showed thrombocytopenia with no symptoms. Low platelet count is one of the major manifestation of liver disease.

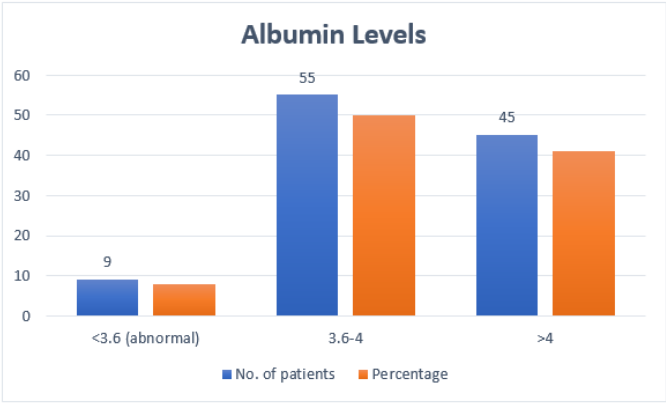


Albumin

Table 11: Showing the distribution of albumin in the study population.

Albumin levels	No. of patients	Percentage
<3.6 (abnormal)	9	8%
3.6-4	55	50%
>4	45	41%

8% of the study population had hypoalbuminemia. Remaining 91% had albumin in the normal reference range.

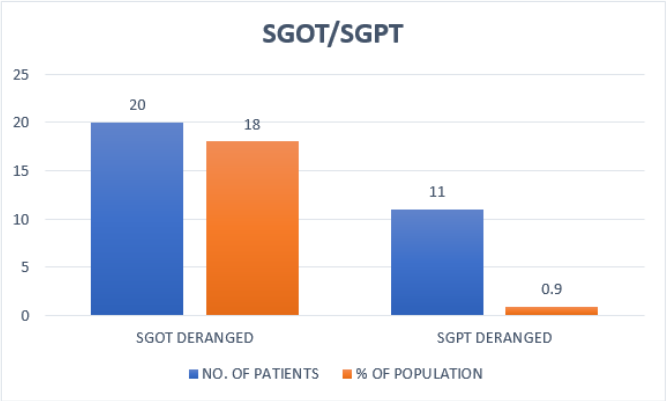


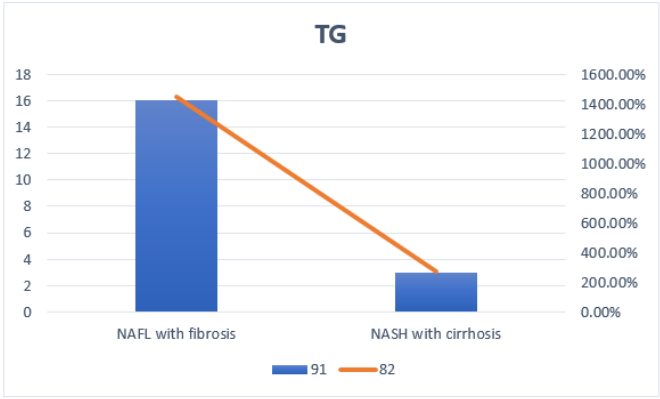
SGOT and SGPT

Table 12: Showing the SGOT and SGPT derangements in the study population.

	No. of Patients	% of Population
SGOT DERANGED	20	18
SGPT DERANGED	11	0.9

18 % population showed deranged SGOT and 0.9% population showed deranged SGPT.



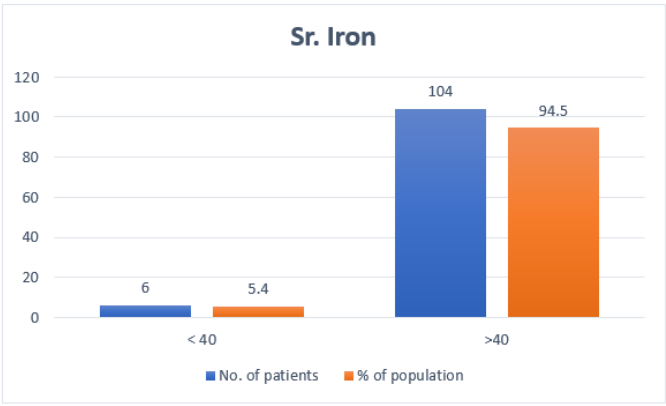


Serum iron

Table 13: Showing the serum iron distribution in the study population.

Sr. iron	No. of patients	% of population
< 40	6	5.4
>40	104	94.5

Only 5.4 % of population showed iron deficiency. Rest of the study population had serum iron in normal range.



Dyslipidemia

Triglycerides

Table 14 : showing triglycerides levels in the population

TG	No. of patients	% of population
>150	61	55.5%
Normal	49	44.5%

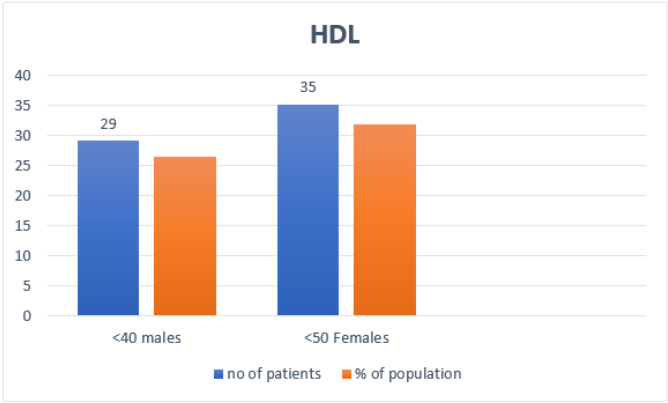
55.5% population showed hypertriglyceridemia whereas 44.5% had normal values of triglycerides.

HDL

Table 15: showing HDL distribution in study population

HDL	No . of patients	Percentage of population
<40 males	29	26.3 %
< 50 females	35	31.81%

Low HDL seen in 29 males and 35 females totaling at 64 patients.

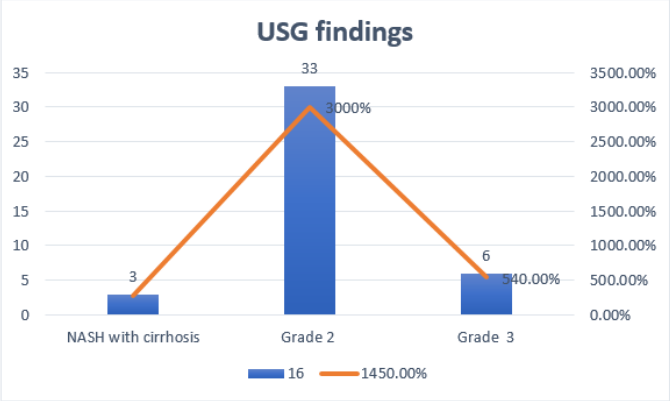


Fatty liver

Table 16: Classification based on USG findings

USG findings	No. of patients	Percentage of population
Grade 1	71	64.5%
Grade 2	33	30%
Grade 3	6	5.4%

64.5% of the study population had grade I fatty liver whereas 30 % has grade 2. Only 5,4 % population visiting the OPD had grade 3 fatty liver .

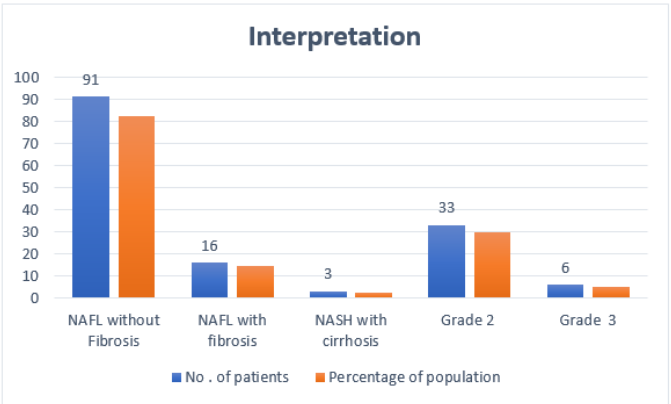


Fibro scan

Table 17: Based on LSM and CAP score

interpretation	No . of patients	Percentage of population
MAFL without Fibrosis	91	82
MAFL with fibrosis	16	14.5%
MASH with cirrhosis	3	2.7%

Based on the LSM and CAP score 90% patients had only fatty liver . 14.5 % population had fibrosis and 2.7% patients had MASH with Cirrhosis.



Results And Discussion

The study cohort, comprising 110 patients, predominantly included individuals aged 40–60 years, with a mean age of 52 years, highlighting the peak prevalence of MAFLD among middle-aged adults. This observation is consistent with the findings of Amarapurkar DN et al. (2007)[1], who also identified middle age as a critical window for MAFLD onset. Moreover, a modest male predominance (58%) was observed in our sample, which concurs with the global epidemiological data reported by Younossi et al. (2016)[2] whose meta-analysis demonstrated consistently higher MAFLD prevalence rates among males across diverse populations.

Notably, the nearly equal distribution of patients from urban (51%) and rural (49%) regions suggests that MAFLD is not exclusively an urban phenomenon, thereby challenging the conventional notion that it primarily arises from sedentary lifestyles and poor dietary patterns characteristic of urban environments. This observation is supported by findings from Ruhl CE et al. (2003)[3], who reported a higher MAFLD prevalence among individuals of lower socioeconomic status in urban settings, attributed to limited access to nutritious food and recreational resources. Conversely, our results diverge from those of Cotrim et al. (2013)[4], who, in their study on the Brazilian population, observed a significantly higher prevalence of MAFLD in urban areas compared to rural counterparts.

A substantial proportion of the study population demonstrated increased waist circumference and elevated body mass index (BMI), with 19% classified as overweight and 65% as obese. These findings underscore the well-established correlation between obesity and MAFLD, which is largely mediated through mechanisms such as insulin resistance and the metabolic syndrome. The observed data are consistent with the study conducted by Fan JG et al. (2019)[5], which reported that while the prevalence of MAFLD in the general population ranged from 15% to 30%, it surged to approximately 50–90% among obese individuals,

reinforcing the pivotal role of obesity as a major risk factor in the pathogenesis of MAFLD.

Hypertension and type 2 diabetes mellitus (T2DM) were prominently represented in the study cohort, with respective prevalence rates of 57% and 52%. These findings reaffirm the pivotal role of both conditions as integral components of metabolic syndrome and major risk factors in the pathogenesis of MAFLD. The results are in concordance with a study by Prashanth M et al. (2012)[6], which reported a 50% prevalence of MAFLD among hypertensive individuals and advocated for routine MAFLD screening in this subgroup. Similarly, Mohan V et al. (2009)[7], in a study conducted among the South Indian population, found a 54.5% prevalence of MAFLD among patients with T2DM. These associations underscore the necessity for integrated, multidisciplinary strategies targeting metabolic comorbidities to effectively manage and mitigate the burden of MAFLD.

Among the extrahepatic manifestations observed in the study population, hypothyroidism—both clinical and subclinical—was the most prevalent, affecting 24.4% of participants. This observation is consistent with the findings of Bano A et al. (2016)[8], who reported a significant association between reduced thyroid hormone levels and increased risk of MAFLD. Thyroid hormones (THs) play a critical role in hepatic metabolism by facilitating lipid export and oxidation, promoting de novo lipogenesis, enhancing insulin sensitivity, and suppressing gluconeogenesis. Given their central involvement in lipid and carbohydrate homeostasis, thyroid dysfunction has a biologically plausible link to the pathogenesis of MAFLD. Furthermore, the detection of coronary artery disease (CAD) in 1.8% of patients, though infrequent, reinforces the established association between MAFLD and elevated cardiovascular risk.

Thrombocytopenia was identified in 35% of the study cohort, serving as a potential marker of advanced liver disease. Concurrently, hypoalbuminemia was observed in 8% of participants, further reflecting compromised hepatic synthetic function. Although elevated aminotransferases—SGOT (18%) and SGPT (10%)—were less frequent, their presence indicates hepatocellular injury or inflammation, consistent with the typical biochemical profile of MAFLD.

Dyslipidemia was prominently noted, with 55.5% of patients exhibiting hypertriglyceridemia and 58% presenting with low high-density lipoprotein (HDL) levels. These findings align with the observations by Musso G et al. (2010)[9], who emphasized the contributory role of elevated triglycerides and low HDL as both metabolic and cardiovascular risk factors, as well as key elements in the pathogenesis of MAFLD.

Ultrasonographic evaluation revealed that the majority (64.5%) of patients had Grade 1 hepatic steatosis. Hernaez R et al. (2011)[10] validated the diagnostic utility of ultrasonography, particularly in detecting moderate-to-severe steatosis, supporting its continued use in routine clinical assessment.

FibroScan findings indicated that 82% of the patients had MAFLD without fibrosis, while 14.5% had developed fibrosis, and 2.7% had progressed to MASH-related cirrhosis. These results highlight the heterogeneity of disease severity within the MAFLD spectrum. A meta-analysis by Xiao G et al. (2017)[11] corroborated the diagnostic accuracy of transient elastography in identifying significant fibrosis and cirrhosis in MAFLD, underlining its value in non-invasive staging and longitudinal monitoring.

Conclusion

This study underscores the broad clinical spectrum of MAFLD, predominantly affecting middle-aged,

overweight or obese individuals with metabolic risk factors such as type 2 diabetes, hypertension, and dyslipidemia. A significant proportion of patients already demonstrated early-stage fibrosis, while a smaller subset had progressed to cirrhosis. Extrahepatic manifestations, especially hypothyroidism, further highlight the systemic nature of the disease.

Recommendations:

Based on the findings of this study, it is recommended that individuals with known metabolic risk factors—particularly obesity, type 2 diabetes mellitus, and hypertension—undergo routine screening for MAFLD using non-invasive diagnostic modalities such as ultrasonography and transient elastography (FibroScan). Early detection is vital to prevent progression to advanced fibrosis or cirrhosis. A multidisciplinary, integrated management approach should be emphasized, incorporating lifestyle modifications including weight reduction, dietary interventions, and physical activity, alongside optimal control of glycemic, lipid, and blood pressure parameters. Public health strategies must also focus on enhancing awareness of MAFLD and its systemic implications, particularly in rural populations where healthcare access may be limited. Finally, further prospective, large-scale studies are warranted to better elucidate the natural history of MAFLD, refine risk stratification tools, and develop effective pharmacotherapeutic options tailored to specific disease phenotypes.

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