An Observational Study on Correlation of Non-Alcoholic Fatty Liver Disease with Various Components of Metabolic

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Abstract

Non-Alcoholic Fatty Liver Disease (NAFLD) is a common hepatic manifestation linked with Metabolic Syndrome (MetS), a cluster of metabolic abnormalities including insulin resistance, obesity, dyslipidemia, and hypertension, which increases cardiovascular risk. The prevalence of NAFLD is rising in India, notably in populations with high rates of MetS and type 2 diabetes mellitus (T2DM). This study aims to explore the correlation between NAFLD and MetS components in patients from Western Uttar Pradesh, a region with a significant diabetic population. The objective was to evaluate the prevalence and characteristics of NAFLD in relation to MetS among patients in a tertiary care hospital setting. Methods: This cross-sectional study involved 127 NAFLD patients aged 18 and above, attending the outpatient or inpatient department at a tertiary care center from October 2022 to July 2023. MetS was diagnosed based on NCEP ATP III criteria, and NAFLD was confirmed via ultrasonography. Patients with chronic alcohol intake, viral hepatitis, or other liver diseases were excluded. Results: NAFLD prevalence was higher in females (57.48%) than males (42.52%), with the highest occurrence among those aged 50-60. A significant association was observed between NAFLD and MetS, particularly in patients with elevated BMI, waist circumference, fasting blood sugar, and triglycerides. Patients with MetS presented more severe NAFLD grades compared to those without MetS. Conclusion: The study underscores the need for early metabolic screening in NAFLD patients to prevent severe liver and cardiovascular complications. The findings highlight a high prevalence of NAFLD among females and support the association between NAFLD severity and MetS components, advocating for targeted interventions to manage metabolic health in this region.

Keywords: Non-Alcoholic Fatty Liver Disease; Metabolic Syndrome; Insulin Resistance; Western Uttar Pradesh; Obesity; Type 2 Diabetes

I. Introduction

Metabolic syndrome (MetS) is a cluster of metabolic abnormalities that collectively increase the risk of cardiovascular diseases and type 2 diabetes. It encompasses factors such as insulin resistance, dyslipidemia, central obesity, weight gain, and hypertension[1]. Globally, the prevalence of MetS varies, estimated to be between 8-13% in men and 2-18% in women, depending on population demographics and definitions used[2]. In India, studies have documented significant regional variations, with prevalence reaching up to 24.9% in northern India and 41% in southern India. MetS represents a significant health burden, as it predisposes individuals to critical conditions such as cardiovascular disease, stroke, and diabetes mellitus, leading India to be known as the "Diabetes Capital of the World[3]."

At the heart of MetS is insulin resistance, a primary underlying mechanism that fuels the development of these conditions. Hypertension, one of the syndrome's most common features, exacerbates these risks, emphasizing the need for early detection and management to prevent potential cardiovascular and cerebrovascular outcomes[4]. Prompt intervention for MetS is vital, as addressing these metabolic abnormalities early can significantly reduce the risk of severe health sequelae[5].

One condition frequently associated with MetS is non-alcoholic fatty liver disease (NAFLD), a prevalent yet often overlooked finding in ultrasonography reports of asymptomatic individuals. NAFLD encompasses a

spectrum of liver conditions ranging from simple fatty liver, or hepatic steatosis, to non-alcoholic steatohepatitis (NASH) and eventually to cirrhosis in advanced cases[6]. While the histological features of NAFLD resemble those of alcohol-induced liver disease, NAFLD occurs in individuals who do not consume alcohol in amounts that would lead to liver damage[7].

Obesity, type II diabetes, dyslipidemia, hypertension, and polycystic ovarian disease (PCOD) are all conditions associated with NAFLD, with insulin resistance emerging as a key linking factor. Numerous studies globally and in India have examined NAFLD, particularly due to its association with MetS and its implications for cardiovascular disease risk[8]. However, no study has comprehensively investigated NAFLD prevalence and characteristics in Western Uttar Pradesh, an area where diabetes and associated liver diseases are common, and many patients share clinical and demographic features typical of alcohol-related liver disease, despite not consuming cirrhotic doses of alcohol[9].

NAFLD is particularly common among individuals with type 2 diabetes mellitus (T2DM), with diabetes being a crucial determinant of NAFLD presence and severity. Although the exact origins of insulin resistance remain unclear, it plays a substantial role in NAFLD pathogenesis[10]. Hyperinsulinemia and increased free fatty acid delivery to the liver are two critical pathophysiologic abnormalities associated with insulin resistance that contribute to the development of fatty liver. Hyperinsulinemia, or elevated insulin levels in the blood, promotes fat accumulation within the liver cells[11].At the same time, free fatty acids, which circulate in greater quantities due to insulin resistance, are redirected to the liver, where they are stored as triglycerides. These factors collectively lead to the buildup of fat within the liver, progressing the disease from simple steatosis to more severe conditions, including NASH and cirrhosis if left unchecked[12].
For India, where NAFLD prevalence is rising, understanding this disease's epidemiology and impact on individuals in specific regions, such as Western Uttar Pradesh, is essential. This region's large diabetic population presents a unique opportunity to examine the intersection between diabetes and NAFLD[13]. Many patients at the local tertiary care institution display signs of chronic liver disease despite low or no alcohol intake, underscoring the importance of studying NAFLD in the context of MetS and T2DM within this demographic[14]. The goal of such studies is not only to document prevalence but also to provide insights that could inform future clinical practices, particularly in resource-limited settings where early intervention could prevent the escalation of liver disease in diabetic patients[15].

The close association between MetS and NAFLD reflects a broader relationship between metabolic dysfunction and liver health. Insulin resistance remains a pivotal factor in both conditions[16]. For patients with MetS, particularly those with central obesity and T2DM, the liver becomes a site of fat accumulation, leading to liver inflammation, fibrosis, and, in severe cases, cirrhosis. NAFLD has thus evolved from a seemingly benign condition to one with potentially serious consequences, making early detection and intervention vital[17]. In regions with a high prevalence of MetS and diabetes, such as Western Uttar Pradesh, NAFLD screening among at-risk populations could identify early liver disease and allow for timely management strategies, ultimately reducing the burden of liver-related complications[18].

Research on NAFLD and its association with MetS in specific regions like Western Uttar Pradesh is not only relevant for advancing local healthcare practices but also adds to the global understanding of metabolic health[19]. The findings from such studies could influence broader healthcare guidelines, particularly regarding the importance of NAFLD screening in patients with MetS. Moreover, as lifestyle and dietary habits continue to shift globally, the insights from Indian populations with high MetS prevalence can guide preventive strategies worldwide[20].

This study aims to evaluate the prevalence and characteristics of NAFLD as a hepatic manifestation of MetS among individuals in Western Uttar Pradesh, focusing on the role of insulin resistance and hyperinsulinemia in NAFLD pathogenesis. By understanding how these metabolic abnormalities drive liver disease in this population, healthcare providers can implement targeted interventions to manage and prevent the progression of NAFLD.

II. Method

This cross-sectional observational study was conducted at KDMCH&RC, Mathura, on 127 NAFLD patients attending the OPD or admitted to the IPD from October 2022 to July 2023, selected through random sampling. Ethical approval has been obtained from the ethical approval committee. Each patient underwent

thorough history taking and clinical examination, with metabolic syndrome diagnosed according to NCEP ATP 3 criteria based on parameters such as elevated waist circumference, triglycerides, reduced HDL cholesterol, blood pressure, and fasting glucose levels. Inclusion criteria included patients above 18 diagnosed with NAFLD via ultrasound. Exclusions included those with chronic drug use, alcohol intake, hepatitis markers, cirrhosis, metabolic disorders, and prior abdominal surgeries.

III. Result

Among 127 NAFLD cases, the majority fall between ages 30 and 70, with a peak in the 50-60 age group for both genders. Females represent a slightly higher prevalence at 57.48%, while males account for 42.52%. The mean age for both males and females is approximately 50 years, with no statistically significant difference observed ($p > 0.05$). This suggests a fairly balanced distribution of NAFLD across genders, with a marginally higher occurrence in females.

Table 1: Distribution of NAFLD patients according to BMI and Gender

BMI	Male		Female		Total	
	No.	%	No.	%	No.	%
15-20	-	-	-	-	-	-
20-25	2	3.70	5	6.85	7	5.51
25-30	7	12.96	15	20.55	22	17.32
30-35	17	31.48	19	26.03	36	28.35
40+	38	51.86	34	46.57	62	48.82
Total	54	42.52	73	57.48	127	100.00

In NAFLD patients, 51.86% of males and 46.57% of females have a BMI over 40. Among males, 31.48% fall in the 30-35 BMI range, while 26.03% of females are also in this category. This shows a high BMI prevalence in both genders, with a majority exceeding 40.

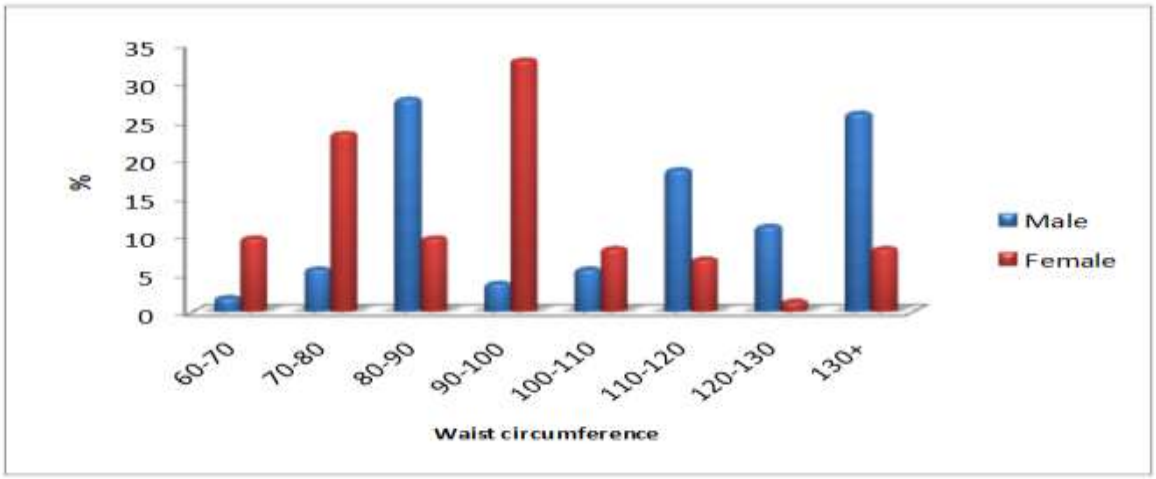

Figure 1: Bar chart showing Distribution of patients with NAFLD according to waist circumference and gender

In the NAFLD sample, females (57.48%) outnumber males (42.52%). Most females have a waist circumference of 90-100 cm (32.87%), while the majority of males fall within the 80-90 cm range (27.77%), indicating distinct waist distribution patterns by gender.

Table 2: Distribution of parameters on the basis of clinical demographic and biochemical variables in NAFLD patients

Variables	Male		Female		Total	
	No.	%	No.	%	No.	%
Age	49.56	20.55	50.49	21.17	50.08	20.91
BMI	36.52	7.81	35.40	7.36	35.60	8.19
Waist	107.33	22.02	91.96	18.87	97.77	23.27
SBP	137.44	15.69	137.62	12.65	137.54	14.03
DBP	85.83	8.74	84.44	8.81	85.03	8.81
FBS	153.91	53.02	151.66	49.34	152.61	50.95
Triglycride	158.26	67.30	155.66	56.66	157.19	61.43
HDL	50.80	12.33	51.41	11.28	51.15	11.74
SGOT	40.50	19.17	47.49	27.65	44.52	24.65
SGPT	48.76	30.22	47.59	28.76	48.09	29.39

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The average age is similar for both genders (males: 49.56 years, females: 50.49 years). Males show a slightly higher BMI (36.52 vs. 35.40), waist circumference (107.33 cm vs. 91.96 cm), and triglycerides, suggesting greater cardiovascular risk. Blood pressure and glucose levels are nearly equal, while females have higher HDL. Liver enzymes are more elevated in males, indicating potential liver function issues.

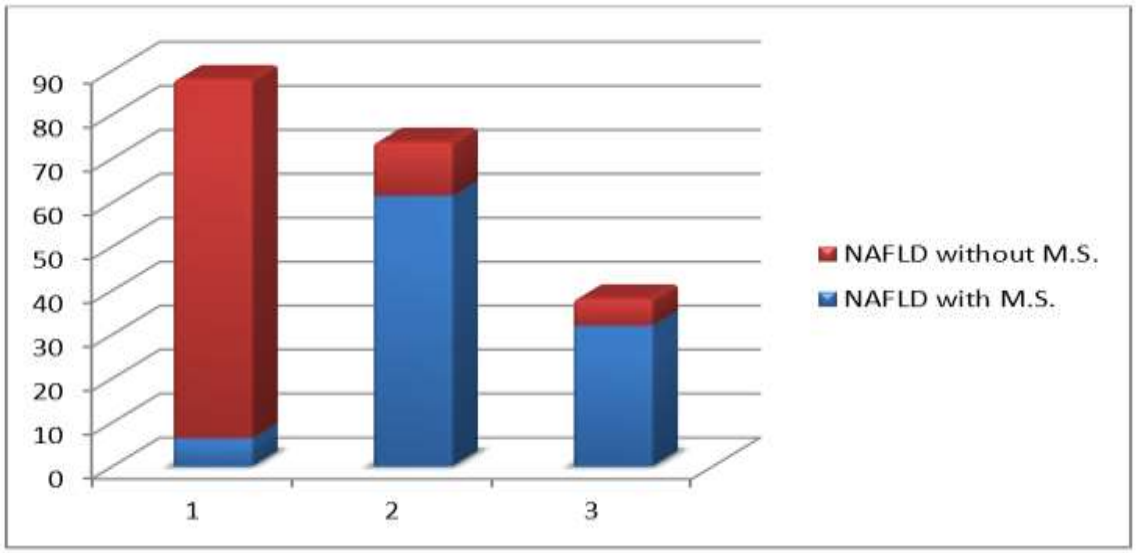

Figure 2: Bar chart showing Distribution of USG graded NAFLD patients having metabolic syndrome and no metabolic syndrome

In NAFLD patients with metabolic syndrome, 61.54% show USG grade 2 (moderate liver fat), while 32.05% have severe grade 3. Conversely, 81.64% of those without metabolic syndrome have mild grade 1, with only 6.12% in grade 3. This indicates that metabolic syndrome correlates with more severe liver fat deposition.

Table 3: Comparison of fasting blood sugar in both groups

USG grade	No.	NAFLD with metabolicsyndrome		No.	NAFLD without metabolicsyndrome		't'	'p'
		Mean	SD		Mean	SD		
1	5	174.80	55.18	40	96.65	32.96	4.633	<0.05
2	48	182.31	27.86	6	159.00	57.35	1.691	>0.05
3	25	178.88	28.31	3	117.00	41.74	3.430	<0.05
Total	78	180.73	30.57	49	105.53	42.65	11.550	<0.05

Patients with metabolic syndrome show significantly higher FBS than those without in USG grades 1 and 3. In grade 2, however, the FBS difference between groups is not significant ($p > 0.05$), indicating similar glucose levels.

Table 4: Comparison of diastolic blood pressure in both groups

USG grade	No.	NAFLD with metabolicsyndrome		No.	NAFLD without metabolicsyndrome		't'	'p'
		Mean	SD		Mean	SD		
1	5	83.00	9.12	40	86.00	8.73	0.721	>0.05
2	48	85.08	8.35	6	80.00	9.93	1.378	>0.05
3	25	85.76	8.28	3	80.00	11.43	1.102	>0.05
Total	78	85.17	8.41	49	84.90	9.36	0.169	>0.05

In USG grade 3, patients with metabolic syndrome have a higher DBP (85.76 mmHg) compared to those without metabolic syndrome, indicating elevated blood pressure associated with the syndrome.

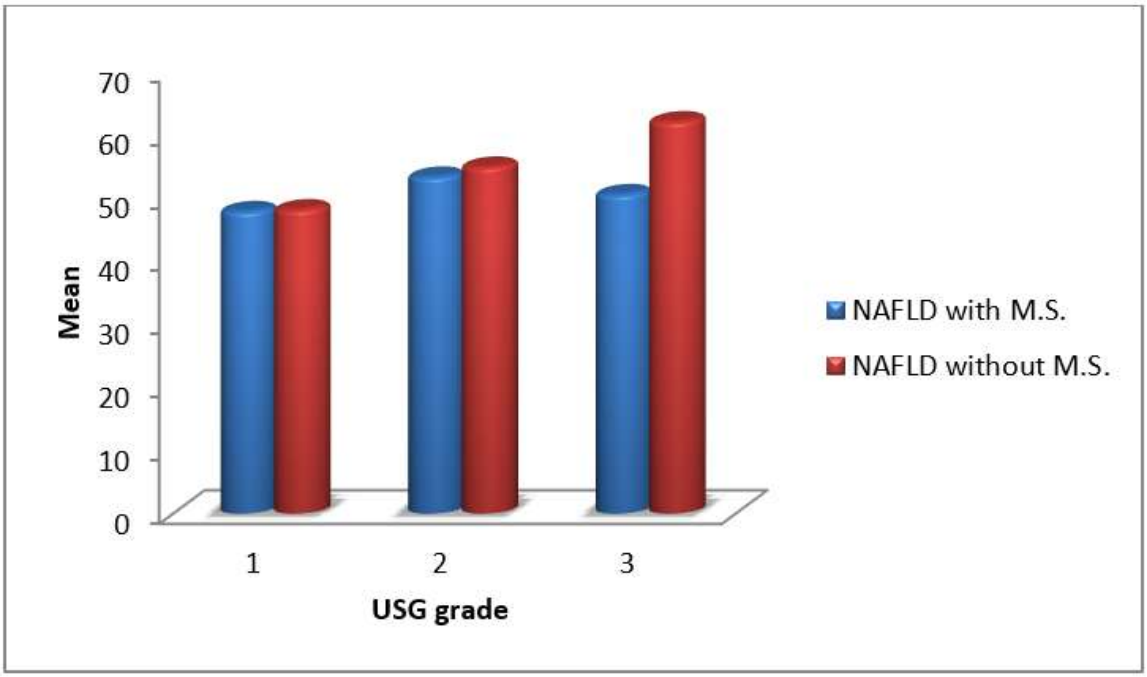

Figure 3: Bar chart showing Comparison of high density lipoproteinin both groups

HDL cholesterol levels show minimal variation across different USG grades in NAFLD patients, regardless of metabolic syndrome status, indicating limited association between HDL levels and USG grading in this context.

Table 5: Comparison of triglyceride in both groups

USG grade	No.	NAFLD with metabolic syndrome		No.	NAFLD without metabolic syndrome		't'	'p'
		Mean	SD		Mean	SD		
1	5	190.80	56.74	40	126.25	26.84	4.832	<0.05
2	48	173.94	73.16	6	120.50	18.14	1.767	>0.05
3	25	175.32	61.96	3	158.67	47.23	0.447	>0.05
Total	78	175.46	68.90	49	127.53	28.84	4.622	<0.05

In USG Grade 1, 5 NAFLD cases have metabolic syndrome, while 40 do not ($p < 0.05$). In Grade 2, 48 cases have metabolic syndrome, and 6 do not ($p > 0.05$). For Grade 3, there are 25 cases with metabolic syndrome and 3 without ($p > 0.05$). Overall, 78 cases have metabolic syndrome and 49 do not, with an overall $p < 0.05$.

Table 6: Comparison of various components of metabolic syndrome among the NAFLD patients

Variables	Metabolic syndrome		Non-Metabolic syndrome		't'	'p'
	Mean	SD	Mean	SD		
FBS	180.79	30.57	105.53	42.65	11.550	<0.05
SBP	138.85	13.26	134.49	14.87	1.720	>0.05
DBP	85.17	8.41	84.90	9.36	0.169	>0.05
HDL	52.01	11.31	49.76	12.28	1.056	>0.05
Waist	107.22	18.19	83.27	18.23	8.418	<0.05
Triglycride	175.46	68.90	127.53	28.84	4.622	<0.05

In comparing NAFLD patients with and without metabolic syndrome, those with metabolic syndrome have a significantly higher mean fasting blood sugar (FBS) at 180.79 mg/dL versus 105.53 mg/dL in those without. Additionally, systolic blood pressure (SBP) is slightly elevated in patients with metabolic syndrome (138.85 mmHg) compared to those without (134.49 mmHg).

IV. Discussion

A total of 127 NAFLD patients were diagnosed via ultrasound, categorized into 45 patients (35.4%) with grade-1, 54 patients (42.5%) with grade-2, and 28 patients (22.04%) with grade-3 fatty liver. Among them, 78 patients (61.4%) had metabolic syndrome (M.S.), while 49 patients (38.6%) did not. The mean age distribution shows most cases between 30 and 70 years, peaking in the 50–60 age group. Males constitute 42.52% of patients with a mean age of 49.56±20.55, and females constitute 57.48% with a mean age of 50.47±21.17. This age distribution aligns closely with findings by Gaharwar R et al. (2015), who observed mean ages of 49.06 for males and 49.20 for females in NAFLD cases[21].

In the study by Gaharwar R et al. (2015), 31.42% of patients were overweight, 45.7% were obese, and 11.42% were severely obese, with a mean BMI of 25.97±3.93. In contrast, our study shows a higher NAFLD prevalence in females (57.48%), with similar mean BMI values for males (36.52±7.81) and females (35.35±7.32), which are notably higher than those observed by Gaharwar et al[21].

In our study of 127 NAFLD patients, 78 met the criteria for metabolic syndrome (M.S.), while 49 were classified as non-M.S. Among NAFLD patients, 26 had a waist circumference in the 90-100 cm range, followed by 22 patients in the 80-90 cm range. Females predominantly fell within the 90-100 cm range,

whereas the highest male representation was within 80-90 cm. The overall mean waist circumference was 98.3±21.6 cm, aligning closely with findings by Goyal A. et al. (2020), who reported a mean waist circumference of 106±7.28 cm in NAFLD patients. This suggests similar waist circumference distributions between studies, supporting the association of higher waist measurements with NAFLD across different populations[22].

In our study, among 78 patients with metabolic syndrome (M.S.), 48 had grade-2 fatty liver with a mean waist circumference of 104.31±16.90 cm, and 25 had grade-3 fatty liver with a mean waist circumference of 116.84±14.00 cm. Gaharwar R et al. (2015) observed similar patterns, finding that most NAFLD patients with M.S. had grade-2 fatty liver. Additionally, 73% of patients without M.S. in Gaharwar's study had grade-1 fatty liver, aligning with our finding of 81% grade-1 cases in non-M.S. patients. Regarding fasting blood sugar (FBS), Gaharwar reported a mean FBS of 127.89±53.00 mg/dL in NAFLD patients with M.S., especially elevated in grades 2 and 3. Likewise, in our study, grade-1 and grade-3 NAFLD patients with M.S. showed significantly higher FBS, averaging 182.31±27.86 mg/dL, indicating elevated FBS in NAFLD with M.S. compared to those without[21].

In our study, HbA1c levels were elevated in most NAFLD cases, with no significant difference between M.S. and non-M.S. groups. The mean SBP and DBP for all NAFLD patients were 137.44±15.69 and 85.83±8.74, respectively, with slightly higher DBP in grade-3 patients with M.S. Elevated SBP was common across all cases, with no significant difference between M.S. and non-M.S. groups, consistent with findings by G. Akbulut et al., who also noted elevated SBP and DBP in M.S. patients. HDL levels showed minimal differences across groups, contrasting with Gaharwar R et al. (2015) and Akbulut et al., who observed lower HDL in M.S. patients[21, 23].

V. Conclusion

This study highlights the need for early screening of metabolic syndrome (M.S.) in NAFLD patients, with 61% prevalence observed. Females had a higher NAFLD rate, partially due to excluding high alcohol consumers. NAFLD patients with M.S. showed increased waist circumference, BMI, fasting blood sugar, and triglyceride levels, consistent with prior studies. Slightly higher BMI in females further supports the association between NAFLD and M.S. components, emphasizing comprehensive metabolic management. These findings indicate that NAFLD, often considered benign, poses significant health risks. Future research should investigate causal mechanisms, genetic factors, and interventions to reduce NAFLD's health and healthcare burdens.

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