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# Association of Metabolic Syndrome with Non-Alcoholic Fatty Liver Disease in Adult Patients Attending a Tertiary Care Hospital: A Cross-Sectional Study

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**Abstract:** ***Background and Objective: Non-Alcoholic Fatty Liver Disease (NAFLD) is emerging as the most common chronic liver disease worldwide and is closely associated with obesity, insulin resistance, type 2 diabetes mellitus, dyslipidemia, and metabolic syndrome. Our objective was to evaluate the association between metabolic syndrome and NAFLD among adult patients attending a tertiary care hospital. Methods: A hospital-based cross-sectional study was conducted in the Department of General Medicine, Index Medical College Hospital & Research Centre, Indore over 12 months. A total of 140 adult patients were enrolled and divided into NAFLD and non-NAFLD groups based on ultrasonographic assessment. Metabolic syndrome was diagnosed using Modified NCEP ATP III criteria. Results: Of 140 participants, 92 (65.7%) had NAFLD. Metabolic syndrome was significantly more prevalent among NAFLD patients than non-NAFLD patients (77.2% vs 31.3%; $\chi 2=28.4$, $p<0.001$). NAFLD patients had significantly higher BMI and waist circumference ($p<0.001$). Central obesity (82.6%), hyperglycemia (66.3%) and hypertension (63.0%) were the commonest components among NAFLD patients, and the prevalence of metabolic syndrome rose with increasing NAFLD grade, from 64.3% in Grade I to 93.3% in Grade III ($p=0.004$). Conclusion: Metabolic syndrome is strongly and significantly associated with the presence and severity of NAFLD. Early screening of high-risk individuals may reduce disease progression and long-term hepatic complications.***

**Keywords:** NAFLD, Metabolic Syndrome, Obesity, Insulin Resistance, Fatty Liver, Type 2 Diabetes Mellitus

## 1. Introduction

Non-Alcoholic Fatty Liver Disease (NAFLD) is characterized by excessive fat accumulation in hepatocytes in the absence of significant alcohol consumption. It represents a spectrum ranging from simple steatosis to non-alcoholic steatohepatitis, fibrosis, cirrhosis, and hepatocellular carcinoma.

The prevalence of NAFLD has increased substantially over the past two decades owing to rising rates of obesity, sedentary lifestyle, and metabolic syndrome. Metabolic syndrome comprises central obesity, hypertension, impaired glucose metabolism, hypertriglyceridemia, and reduced HDL cholesterol. Insulin resistance is considered the principal mechanism linking metabolic syndrome with NAFLD.

India is witnessing a rapid epidemiological transition with increasing prevalence of diabetes and obesity, making NAFLD an important public health concern. The present study was undertaken to evaluate the association of metabolic syndrome with NAFLD among adult patients attending a tertiary care hospital, and to determine the relationship between individual metabolic syndrome components and NAFLD severity.

## 2. Methods

This hospital-based cross-sectional observational study was conducted in the Department of General Medicine, Index Medical College Hospital & Research Centre, Indore over a period of 12 months. A total of 140 adult patients (≥18 years) who provided written informed consent and underwent abdominal ultrasonography were enrolled. Patients with significant alcohol consumption, Hepatitis B or C infection, known chronic liver disease, pregnancy, or drug-induced liver injury were excluded.

Age, gender, body mass index (BMI), waist circumference, blood pressure, fasting blood glucose, HbA1c, lipid profile, liver function tests, and ultrasonographic grading of fatty liver were recorded for each participant. Metabolic syndrome was diagnosed using Modified NCEP ATP III criteria- presence of ≥3 of: waist circumference >90 cm (men)/>80 cm (women); triglycerides ≥150 mg/dL; HDL <40 mg/dL (men)/<50 mg/dL (women); blood pressure ≥130/85 mmHg; and fasting glucose ≥100 mg/dL.

Data were analyzed using SPSS version 26. Continuous variables were expressed as mean ± SD and compared using Student's t-test; categorical variables were expressed as frequencies/percentages and compared using the Chi-square test. Logistic regression was used to assess independent predictors of NAFLD. $p<0.05$ was considered significant.

## 3. Results

Of the 140 patients enrolled, NAFLD was diagnosed on ultrasonography in 92 (65.7%); the remaining 48 (34.3%) had

no sonographic evidence of fatty liver. NAFLD patients were significantly older and had significantly higher BMI and waist circumference than non-NAFLD patients, while gender distribution was comparable between groups (Table-I).

**Table I:** Demographic and Anthropometric Characteristics (n=140)

| Variable | NAFLD (n=92) | Non-NAFLD (n=48) | P value |
|---|---|---|---|
| Age (yrs) | 48.6±11.2 | 41.3±10.5 | 0.002 |
| Male, n (%) | 54(58.7) | 25(52.1) | 0.46 |
| Female, n (%) | 38(41.3) | 23(47.9) | 0.46 |
| BMI (kg/m²) | 29.1±3.8 | 24.8±2.9 | <0.001 |
| Waist circ. (cm) | 98.4±8.2 | 84.7±7.6 | <0.001 |

*Values are mean±SD or n(%).*

Metabolic syndrome was present in 86/140 (61.4%) overall, and was significantly more frequent among NAFLD patients (71/92, 77.2%) than non-NAFLD patients (15/48, 31.3%) ($\chi 2=28.4$, $p<0.001$) (Table-II).

**Table II:** Association of Metabolic Syndrome with NAFLD

| MetSyn | NAFLD (n=92) | Non-NAFLD (n=48) | Total |
|---|---|---|---|
| Present | 71(77.2) | 15(31.3) | 86 |
| Absent | 21(22.8) | 33(68.7) | 54 |

*$\chi 2=28.4$, $p<0.001$.*

Among NAFLD patients, central obesity was the most frequent metabolic syndrome component (82.6%), followed by hyperglycemia (66.3%), hypertension (63.0%), hypertriglyceridemia (59.8%), and low HDL (53.3%) (Table-III).

**Table III:** Components of Metabolic Syndrome among NAFLD Patients (n=92)

| Component | Frequency, n (%) |
|---|---|
| Central obesity | 76(82.6) |
| Hypertension | 58(63.0) |
| Hyperglycemia | 61(66.3) |
| Hypertriglyceridemia | 55(59.8) |
| Low HDL | 49(53.3) |

Metabolic syndrome prevalence rose progressively with NAFLD grade: 64.3% in Grade I, 85.7% in Grade II, and 93.3% in Grade III (p=0.004), indicating a graded, severity-dependent association (Table-IV).

**Table IV:** NAFLD Severity and Metabolic Syndrome

| Grade | MetSyn Present | MetSyn Absent |
|---|---|---|
| I (n=42) | 27(64.3) | 15(35.7) |
| II (n=35) | 30(85.7) | 5(14.3) |
| III (n=15) | 14(93.3) | 1(6.7) |

*p=0.004 (test for trend).*

## 4. Discussion

In this study, NAFLD was detected in nearly two-thirds of patients, and metabolic syndrome was significantly more common among NAFLD than non-NAFLD patients, with almost four-fifths of NAFLD patients fulfilling metabolic syndrome criteria. NAFLD patients also had significantly higher BMI and waist circumference, with central obesity, hyperglycemia and hypertension emerging as the dominant metabolic syndrome components, supporting the view that NAFLD is the hepatic manifestation of metabolic syndrome and insulin resistance.

The graded rise in metabolic syndrome prevalence with increasing NAFLD grade- from about two-thirds in Grade I to over nine-tenths in Grade III- suggests a progressive metabolic burden paralleling worsening hepatic steatosis, consistent with existing literature linking obesity, diabetes, and dyslipidemia with NAFLD severity.

Limitations include the single-center setting, cross-sectional design precluding causal inference, and ultrasonographic (rather than histological) diagnosis of NAFLD, which may underestimate mild steatosis. Larger, longitudinal, multicentric studies are recommended.

## 5. Conclusion

Metabolic syndrome is significantly associated with both the presence and severity of NAFLD. Central obesity, hyperglycemia, hypertension, and dyslipidemia are major determinants of fatty liver disease in this population.

## 6. Recommendation

Routine screening for NAFLD is recommended among patients with metabolic syndrome, and vice versa, to allow early diagnosis and timely lifestyle or pharmacological intervention, thereby reducing long-term hepatic and cardiometabolic complications.

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