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Prevalence of Non-alcoholic Fatty Liver Disease (NAFLD) and Its Association with Metabolic Syndrome in Adult Patients

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ABSTRACT

Background: Non-alcoholic fatty liver disease (NAFLD) has become one of the most common chronic liver disorders worldwide and is closely linked to metabolic abnormalities. Its increasing prevalence parallels the rising burden of obesity, type 2 diabetes mellitus and metabolic syndrome, making NAFLD a significant public health concern.

Methods: This cross-sectional study was conducted among adult patients attending general medicine outpatient clinics (n=500). Hepatic steatosis was identified using abdominal ultrasonography. Metabolic syndrome was defined according to the harmonized criteria proposed by ATP III/IDF/AHA. Data regarding inclusion and exclusion criteria, clinical and laboratory parameters, and statistical analysis, including multivariable logistic regression, were systematically collected and analyzed.

Results: The overall prevalence of NAFLD was 42%. Patients with metabolic syndrome had a significantly higher prevalence of NAFLD compared to those without metabolic syndrome (71.1% vs 20.2%; p<0.001). Multivariable analysis showed that metabolic syndrome was independently associated with NAFLD (adjusted OR 3.8, 95% CI 2.5–5.7). Individual components of metabolic syndrome, including central obesity, elevated fasting glucose, and hypertriglyceridemia, were also significantly associated with NAFLD.

Conclusion: NAFLD is highly prevalent among adult clinic attendees and demonstrates a strong association with metabolic syndrome and its components. Identification of metabolic syndrome may facilitate early detection and management of NAFLD, thereby reducing the risk of progression to non-alcoholic steatohepatitis and advanced liver disease.

Key-words: Non-alcoholic fatty liver disease, Metabolic syndrome, Prevalence, Ultrasonography, Epidemiology

INTRODUCTION

Non-alcoholic fatty liver disease is currently the most common chronic liver disorder globally and encompasses a wide clinical spectrum ranging from simple hepatic steatosis to non-alcoholic steatohepatitis (NASH), fibrosis, cirrhosis and hepatocellular carcinoma [1].

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The prevalence of NAFLD has risen markedly over the past two decades, closely mirroring the global increase in obesity, type 2 diabetes mellitus, and metabolic syndrome [2]. Metabolic syndrome consists of a constellation of interrelated metabolic abnormalities, including central obesity, insulin resistance, dyslipidaemia, and hypertension, which collectively increase the risk of cardiovascular disease and diabetes [3]. NAFLD is increasingly regarded as the hepatic manifestation of metabolic syndrome, with insulin resistance playing a pivotal role in its development [4]. Numerous epidemiological studies have demonstrated a strong association between NAFLD and individual

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components of metabolic syndrome, particularly obesity and type 2 diabetes mellitus [5]. Worldwide, NAFLD affects approximately one-quarter of the adult population, with higher prevalence reported in South Asia, the Middle East, and urban settings [6]. In India, recent studies and meta-analyses have reported prevalence rates ranging from 30% to 45% among adults, including a substantial proportion of non-obese individuals, underscoring the growing burden of NAFLD in developing countries [7]. The coexistence of NAFLD and metabolic syndrome further increases the risk of cardiovascular morbidity and mortality, making NAFLD a significant public health issue [8]. Because NAFLD is often asymptomatic in its early stages, it frequently remains undiagnosed. Early recognition of NAFLD in individuals with metabolic syndrome offers an opportunity for timely lifestyle and therapeutic interventions that may prevent disease progression and long-term complications [9]. However, clinic-based data examining the prevalence of NAFLD and its association with metabolic syndrome using standardized diagnostic criteria remain limited. Therefore, this study was conducted to assess the prevalence of NAFLD among adult patients and to evaluate its association with metabolic syndrome and its individual components in a clinical setting [10].

MATERIALS AND METHODS

Place of study- This Cross-sectional observational study was performed at the general medicine outpatient clinics of a tertiary care Indian Hospital.

Inclusion criteria

- ✓ Adults aged ≥18 years presenting to general medicine outpatient clinics.
- ✓ Able and willing to provide written informed consent.
- ✓ Underwent abdominal ultrasonography as part of clinical assessment (or study protocol).
- ✓ At least one recent fasting blood sample available (glucose, lipids, liver enzymes) within 3 months of ultrasound.

Exclusion criteria

- ✓ Excess alcohol intake >30 g/day for men and >20 g/day for women (history).
- ✓ Pregnancy.
- ✓ Inadequate ultrasound visualization of the liver.
- ✓ Known chronic liver disease (viral hepatitis B or C, autoimmune liver disease, hemochromatosis) documented by prior testing.
- ✓ Use of drugs known to cause hepatic steatosis (e.g., amiodarone, methotrexate, corticosteroids) in the prior 6 months.

Rationale: These exclusions isolate NAFLD (fatty liver not due to alcohol or other causes). Definitions follow standard practice guidance.

Definitions

NAFLD: presence of hepatic steatosis on abdominal ultrasound in the absence of secondary causes (alcohol, medications, other liver disease). Ultrasonography grading as per standard criteria (mild/moderate/severe).

Metabolic syndrome (MetS): defined using the harmonized 2009 joint interim statement criteria (presence of any 3 of 5: central obesity by waist circumference per population cutoffs, elevated triglycerides ≥150 mg/dL, reduced HDL-C <40 mg/dL in men or <50 mg/dL in women, raised blood pressure ≥130/85 mmHg or on antihypertensive treatment, raised fasting glucose ≥100 mg/dL or diagnosed diabetes).

Data collection- Demographic data (age, sex), anthropometrics (weight, height, waist circumference), blood pressure, laboratory tests (fasting glucose, lipid profile, ALT, AST), alcohol use, medication history, and ultrasound results were recorded on standardized forms.

Sample size- Sample size should be calculated based on the expected NAFLD prevalence in the target population and the desired precision.

Statistical Analysis- Data were analyzed using standard statistical software. Continuous variables were expressed as mean±standard deviation or median (IQR), and categorical variables as frequencies and percentages. Comparisons between NAFLD and non-NAFLD groups were performed using Student's t-test or Mann–Whitney U test for continuous variables and chi-square or Fisher's exact test for categorical variables. Variables with $p<0.10$ on bivariate analysis and clinically relevant factors were included in multivariable logistic regression to identify independent predictors of NAFLD. Adjusted odds ratios with 95% confidence intervals were calculated, and a two-sided $p<0.05$ was considered statistically significant.

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RESULTS

A total of 500 adult patients were included in the study; among them overall prevalence of Non-alcoholic fatty liver disease was 42%. The mean age of participants was 45.3±12.1 years, with a slight male predominance (52%). The mean body mass index (BMI) was 26.4±4.5 kg/m². Metabolic syndrome was present in 175 participants (35%), and the overall mean alanine aminotransferase (ALT) level was 40.2±22.8 U/L (Table 1).

Table 1: Participant Basic Characteristics

Characteristic	Value
Mean age (years)	45.3±12.1
Male sex, n (%)	260 (52%)
Mean BMI (kg/m²)	26.4±4.5
Metabolic syndrome, n (%)	175 (35%)
Mean ALT (U/L)	40.2±22.8

Metabolic syndrome was significantly more prevalent among patients with NAFLD compared to those without NAFLD (p<0.001). Similarly, diabetes mellitus was observed in 28.1% of NAFLD patients compared to 7.9% in the non-NAFLD group (p<0.001). Hypertension was present in individuals with NAFLD, significantly higher than in those without NAFLD (p<0.001). Hypertriglyceridaemia was also more common among NAFLD patients (p<0.001) (Table 2).

Table 2: Metabolic parameters by NAFLD status

Parameter	NAFLD (n=210)	No NAFLD (n=290)	p-value
MetS prevalence, n (%)	150 (71.4%)	25 (8.6%)	<0.001
Diabetes mellitus, n (%)	59 (28.1%)	23 (7.9%)	<0.001
Hypertension, n (%)	67 (31.9%)	40 (13.8%)	<0.001
Hypertriglyceridaemia, n (%)	78 (37.1%)	34 (11.7%)	<0.001

The presence of metabolic syndrome was independently associated with NAFLD (p=0.0001). Increasing BMI was also a significant predictor, with a 12% increase in odds of NAFLD per unit increase in BMI (p=0.001). Age showed a borderline association with NAFLD (adjusted OR= 1.02 per year; p=0.08), while male sex was not significantly associated with NAFLD (p=0.45) (Table 3).

Table 3: Multivariable logistic regression for predictors of NAFLD

Variable	Adjusted OR (95% CI)	p-value
Metabolic syndrome	3.8 (2.5 – 5.7)	0.0001
BMI (per kg/m²)	1.12 (1.05 – 1.19)	0.001
Age (per year)	1.02 (1.00 – 1.04)	0.08
Male sex	1.10 (0.80 – 1.60)	0.45

Among the 210 patients diagnosed with NAFLD, ultrasonographic grading of hepatic steatosis is detailed in Table 4. Mild steatosis was the most common finding (57%), followed by moderate steatosis (31%). Severe steatosis was identified in 12% of patients.

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Table 4: Ultrasonography severity of steatosis (by NAFLD cases)

Steatosis grade	n (%) among NAFLD
Mild	120 (57%)
Moderate	65 (31%)
Severe	25 (12%)

Fig. 1 illustrates the prevalence of NAFLD according to metabolic syndrome status, demonstrating a markedly higher proportion of NAFLD among participants with metabolic syndrome compared to those without metabolic syndrome.

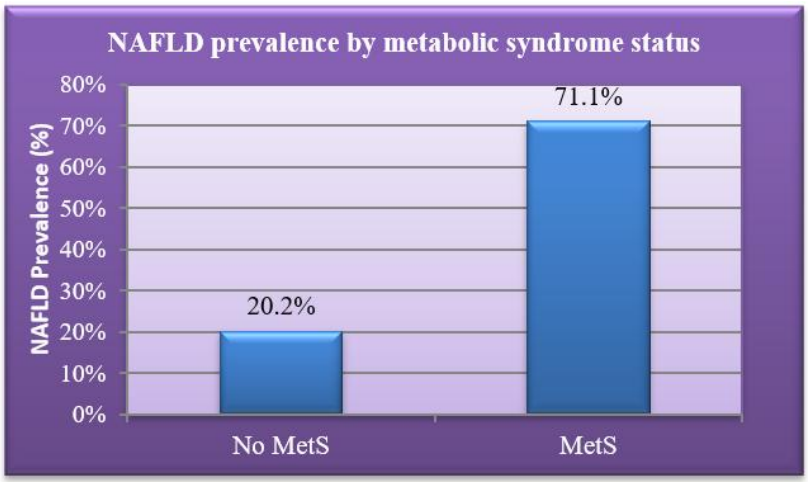

Fig. 1: NAFLD prevalence by metabolic syndrome status

Fig. 2 shows the distribution of ALT levels across predefined ranges in patients with and without NAFLD, with a higher frequency of elevated ALT levels observed among individuals with NAFLD compared to those without NAFLD.

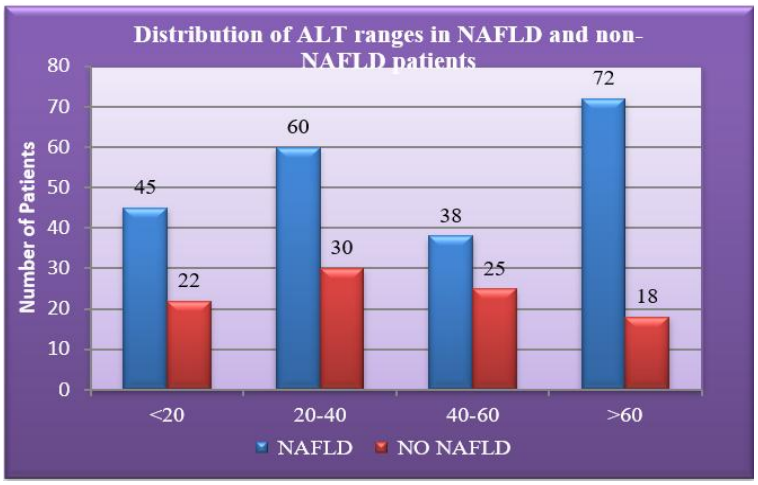

Fig. 2: Distribution of alanine aminotransferase (ALT) levels across predefined ALT ranges among patients with and without non-alcoholic fatty liver disease (NAFLD)

DISCUSSION

The findings of the present study indicate a high prevalence of non-alcoholic fatty liver disease among adult patients, with a markedly greater burden observed in individuals with metabolic syndrome. These results further support the close link between NAFLD and metabolic syndrome and reinforce the concept of NAFLD as a hepatic manifestation of systemic metabolic dysfunction [11]. The prevalence of NAFLD observed in this study is consistent with previous

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population-based and clinic-based studies reporting prevalence rates between 25% and 45% worldwide [12]. Similar to earlier reports, NAFLD was considerably more common among patients with metabolic syndrome, highlighting the combined influence of insulin resistance, central obesity and hepatic fat accumulation [13]. Insulin resistance is central to the pathophysiology of NAFLD, leading to increased delivery of free fatty acids to the liver, enhanced hepatic lipogenesis and reduced lipid oxidation [14]. This mechanistic framework explains the strong association observed between NAFLD and metabolic syndrome components such as diabetes mellitus, dyslipidaemia and hypertension. Comparable associations have been reported in large cohort studies and meta-analyses [15]. In the present study, metabolic syndrome emerged as an independent predictor of NAFLD even after adjustment for age and body mass index, in line with findings from previous studies [16]. Furthermore, accumulating evidence suggests a bidirectional relationship, whereby NAFLD not only results from metabolic syndrome but also contributes to the future development of metabolic syndrome and type 2 diabetes mellitus [17]. Patients with NAFLD in this study more frequently exhibited elevated alanine aminotransferase levels; however, normal liver enzyme values did not exclude the presence of NAFLD. This finding highlights the limitations of biochemical markers alone and underscores the importance of imaging techniques such as ultrasonography for NAFLD detection [18]. Clinically, the strong association between NAFLD and metabolic syndrome emphasizes the need for routine screening of NAFLD in patients with metabolic syndrome, as well as comprehensive metabolic evaluation in patients diagnosed with NAFLD [19]. Lifestyle modification, including weight reduction, dietary changes and increased physical activity, remains the cornerstone of NAFLD management and has been shown to improve both hepatic steatosis and metabolic parameters [20]. This study has certain limitations. The cross-sectional design limits causal interpretation, and the use of ultrasonography may underestimate mild steatosis and does not allow assessment of liver fibrosis. Nevertheless, the study provides valuable clinic-based evidence highlighting the strong association between NAFLD and metabolic syndrome in adult patients [21].

CONCLUSIONS

Non-alcoholic fatty liver disease is highly prevalent among adult populations and demonstrates a strong and independent association with metabolic syndrome and its individual components. Given that metabolic syndrome identifies individuals at high risk for NAFLD, systematic evaluation for hepatic steatosis and fibrosis should be considered in these patients. Early diagnosis and comprehensive management of cardiometabolic risk factors, including weight reduction, glycaemic control, lipid management, blood pressure control and lifestyle modification, are essential to reduce the burden of NAFLD-related liver disease and associated cardiovascular complications. Enhanced clinician awareness and public health strategies are crucial for effective screening and management of NAFLD among adults with metabolic syndrome.

CONTRIBUTION OF AUTHORS

Research concept- Netaji Shivaji Garad, Kalpana Arjunrao Deshmukh
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