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Original Research Article

PREVALENCE AND ASSOCIATED FACTORS OF NON-ALCOHOLIC FATTY LIVER DISEASE IN ADULTS ATTENDING A TERTIARY CARE HOSPITAL, MAHARASHTRA

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ABSTRACT

Background: Non-Alcoholic Fatty Liver Disease (NAFLD) is an emerging public health concern in India, closely linked to rising rates of obesity, type 2 diabetes, and metabolic syndrome. Maharashtra, undergoing rapid urbanization and lifestyle transitions, faces a growing burden of NAFLD, yet robust data on its prevalence and determinants in tertiary care settings is limited. **Materials and Methods:** A cross-sectional study was conducted among adults (≥18 years) attending a tertiary care hospital in Maharashtra. Participants were enrolled based on strict inclusion and exclusion criteria to avoid confounding liver conditions. Data was collected via a structured questionnaire covering demographic characteristics, medical and lifestyle history, anthropometry, and laboratory investigations. NAFLD was diagnosed using standardized ultrasonographic criteria. Statistical analyses included descriptive statistics, bivariate comparisons, and multivariable logistic regression to identify independent risk factors for NAFLD. **Result:** Among 355 participants (mean age 42.7 ± 13.2 years; 54.1% male), the prevalence of NAFLD was 31.6% (n=112). NAFLD cases had higher mean BMI (28.4 ± 3.6 vs. 24.1 ± 3.7 kg/m²), fasting glucose (123.6 ± 23.7 vs. 105.2 ± 18.3 mg/dL), triglycerides (186.8 ± 49.2 vs. 134.9 ± 38.5 mg/dL), and lower HDL (38.4 ± 7.8 vs. 46.6 ± 8.2 mg/dL) compared to non-NAFLD. Sedentary lifestyle, high processed food intake, and smoking were significantly more common in the NAFLD group. Multivariable analysis revealed BMI ≥ 25 kg/m² (OR 2.31), type 2 diabetes (OR 2.07), sedentary lifestyle (OR 1.72), and advancing age (OR 1.02 per year) as significant, independent risk factors. Male sex was not significantly associated with NAFLD after adjustment. **Conclusion:** NAFLD is highly prevalent among adults attending tertiary care in Maharashtra and is strongly associated with obesity, diabetes, sedentary lifestyle, and age. These results highlight the need for routine screening and targeted lifestyle interventions to address modifiable risk factors in this high-risk population.

INTRODUCTION

Non-Alcoholic Fatty Liver Disease (NAFLD) is a rising public health issue globally,[1] with India facing significant challenges due to changing lifestyles and metabolic disorders.[2] This study, aimed to assess NAFLD burden and determinants in a tertiary care adult population, conducted at medical outpatient dept. of Dr. N Y Tasgaonkar institute of medical sciences Karjat Dist. Raigad, Maharashtra. NAFLD involves fat accumulation in over 5% of liver cells, unrelated to alcohol or other causes,[3] ranging from simple steatosis to severe conditions like NASH, fibrosis, cirrhosis, and liver cancer.[3,4] It correlates with obesity, type 2 diabetes, dyslipidemia, and metabolic syndrome.[5,6]

Indian adults have a pooled NAFLD prevalence of about 38.6%,[7] higher than the global average of 25%.[1] Hospital-based rates exceed 40.8% in urban areas,[8] and in Maharashtra, prevalence ranges from 20% to 30% among adults, reaching up to 90% in obese subgroups.[4,9-12] Despite NAFLD being the most common chronic liver disease in India,[2] detailed prevalence and risk factor studies in tertiary care, especially in Maharashtra, are limited.[12] Existing data mostly come from hospital or specific subgroup studies such as hypertensives or diabetics7-9. Urban-rural prevalence varies considerably,[13] for example, NAFLD in diabetics can be as high as 56.5% nationally but 44.1% in Western India[7]. Emerging risk factors, including gut microbiota changes and lifestyle shifts, complicate the epidemiology.[8]

NAFLD's clinical profile in India demands urgent focus2-4. The study's rationale was to generate robust local data to support screening, risk stratification, and resource planning.[12] Maharashtra's urbanization has spurred metabolic risks—central obesity, sedentary habits, and processed food intake—that increase NAFLD risk.[13,14] Rural Maharashtra studies link increased BMI, metabolic syndrome, high fasting glucose, and triglycerides with NAFLD.[12] Another South Indian tertiary care study found 61.5% prevalence, with high BMI increasing NAFLD risk over 23-fold.[9] These high rates, exceeding global norms,[1] require tailored public health and clinical actions.[15] Younger adults (15–39 years) are underrepresented despite substantial disease burden,[13] while lack of effective lifestyle change despite risk awareness worsens outcomes.[6-8,14]

This study stands out by comprehensively assessing clinical and biochemical NAFLD determinants in a broad adult cohort at a tertiary care center in Maharashtra,[2,9] beyond convenience samples or targeted groups.[7-9] It highlights local context, as Maharashtra reflects diverse traditional and urban lifestyles12-14. Regional rural studies found 28.1% prevalence linked to metabolic syndrome and diabetes[12]. By focusing on tertiary care adults, the study captures high-risk groups with findings relevant to other urbanizing regions. Quantitative data—mean BMI, prevalence ratios, p-values—and emerging risk factors such as urban diet, sedentary behavior, and gut-liver axis disturbances enrich the evidence base.[8,14]

By integrating clinical and epidemiological perspectives, the research underscores the urgency for targeted interventions: routine screening protocols for high-risk adults,[15] public health campaigns to promote healthy lifestyles,[14] and the adoption of evidence-based guidelines for management.[15] Further, the identification of research gaps and novel risk factors points to the need for multidisciplinary studies exploring pathogenesis, early detection, and personalized management of NAFLD in the Indian context.

In summary, amidst rapidly changing health landscapes, this study stands as a pivotal reference for clinicians, researchers, and policymakers committed to mitigating the burden of NAFLD in Maharashtra — and beyond.

MATERIALS AND METHODS

Research Design: This study employed an observational, cross-sectional design aimed at assessing the prevalence and determinants of NAFLD in a well-defined adult population presenting to a tertiary care setting. A cross-sectional approach was appropriate for capturing a snapshot of disease burden and its associated factors within the hospital-attending adult demographic at a single time point.

Research Setting: The research was conducted at a tertiary care hospital located in Maharashtra, India. This setting was selected to represent a diverse patient population, encompassing urban and semi-urban catchment areas, and to ensure availability of advanced diagnostic facilities including ultrasonography and laboratory biochemical analyses.

Research Population and Execution: The study population comprised all adults aged 18 years and above attending outpatient clinics and inpatient wards of the tertiary care hospital during the study period. This included patients seeking care for varied medical conditions, with an emphasis on those referred for routine health assessments or metabolic evaluations.

The target population comprised adults aged 18 years and older attending the tertiary care hospital who met the study's inclusion and exclusion criteria during the designated study period. Patients with known liver diseases or other confounding conditions that could mimic NAFLD were excluded to maintain specificity. The inclusion criteria required participants to be ≥18 years of age, willing to provide informed consent, and available for clinical assessment, imaging, and biochemical investigations. Exclusion criteria included a history of significant alcohol consumption (>20 g/day for women and >30 g/day for men), known chronic liver diseases other than NAFLD such as viral hepatitis, autoimmune hepatitis, or cirrhosis, pregnancy or lactation, use of hepatotoxic medications or drugs known to induce hepatic steatosis, and the presence of severe comorbidities that could either prevent participation or independently influence liver fat accumulation

Assuming an expected prevalence of NAFLD among adults attending tertiary care centers in Maharashtra to be approximately 30% based on prior regional studies, with a precision of 5% and a confidence interval of 95%, the minimum required sample size was calculated using the formula for proportions in cross-sectional studies: n=Z2×p×(1−p)/d2 where Z = 1.96 for 95% confidence, p = estimated prevalence (0.30), and d= allowable error (0.05). This yielded a sample size of approximately 323 subjects. To account for potential dropouts or incomplete data, the sample size was inflated by 10%, resulting in a final target enrollment of around 355 participants. A systematic random sampling technique was employed. Every nth eligible adult patient attending selected outpatient clinics and inpatient departments was approached for enrollment based on hospital attendance registers. This approach ensured representativeness while managing logistical feasibility.

The enrollment procedure involved identifying eligible patients through the sampling schedule and providing them with detailed information regarding the study's objectives, procedures, potential risks, and benefits. Verbal and written informed consent

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was then obtained, following which participants were screened for exclusion criteria. Those meeting all inclusion requirements were formally enrolled for clinical and laboratory evaluations. The research was carried out over a defined period, during which trained clinicians and research staff conducted standardized interviews, physical examinations, and laboratory investigations. Hepatic steatosis was assessed using ultrasonography performed by experienced radiologists who were blinded to the participants' clinical details. To maintain consistency, all participant information was recorded using a structured data collection form.

Data Collection Tools: Data was collected only after the approval from the Institute Ethics Committee and necessary consent, using a pretested structured questionnaire capturing demographic data, medical history, lifestyle habits (including diet, alcohol use, physical activity), and relevant medication history. Anthropometric measurements were recorded with calibrated instruments. Blood samples were drawn following standard protocols for biochemical analysis. Abdominal ultrasonography was utilized as the primary imaging modality for NAFLD diagnosis. The variables studied in this research included both dependent and independent factors, along with identified confounders, each measured using standardized methods. The dependent variable was the presence or absence of NAFLD, determined using ultrasonographic criteria for hepatic steatosis in the absence of other known causes. Independent variables comprised demographic factors (age, sex, socioeconomic status, and urban-rural origin), anthropometric parameters (body mass index [BMI] and waist circumference), clinical measurements (blood pressure and history of diabetes or hypertension), biochemical parameters (fasting blood glucose, lipid profile—total cholesterol, LDL, HDL, triglycerides—and liver enzymes, including ALT and AST), and lifestyle-related factors (physical activity levels measured via a standard physical activity questionnaire, dietary patterns such as processed food, fruit, and vegetable intake frequency, and smoking status).

Potential confounders, including age, gender, use of medications affecting liver function, and coexisting metabolic disorders, were recognized and statistically controlled during multivariable analysis.

Measurement procedures were clearly defined: age was recorded as a continuous variable in years via self-report and verification from records; sex was treated as a categorical variable (male/female); socioeconomic status as an ordinal variable measured with a validated Indian socioeconomic scale; BMI was calculated as weight (kg) divided by height squared (m^2), with weight measured using a digital scale and height by stadiometer; waist circumference was measured in centimeters at the midpoint between the lower rib and iliac crest using a flexible measuring tape. Blood pressure was recorded in mmHg using a calibrated sphygmomanometer, averaging two readings. Biochemical variables (fasting blood glucose, lipid profile, and liver enzymes) were continuous measures assessed in standard units with enzymatic colorimetric methods. Physical activity was expressed as ordinal or continuous based on MET scores derived from questionnaire responses, while dietary intake was reported in ordinal categories (daily, weekly, monthly, rarely) for relevant food groups. NAFLD diagnosis was recorded as a dichotomous variable (present/absent) in line with ultrasonographic findings—characterized by increased echogenicity compared to the kidney cortex, hepatomegaly, and vascular blurring in the absence of alternate causes.

Data Management and Analysis: Data were entered into a secure database with double-entry verification to ensure accuracy. Descriptive statistics summarized baseline characteristics and prevalence rates. Bivariate analyses using chi-square and t-tests evaluated associations between NAFLD and independent variables. Multivariable logistic regression models adjusted for confounders further identified independent predictors of NAFLD. Statistical significance was set at $p<0.05$.

RESULTS

Descriptive Statistics Tables

Table 1: Demographic Characteristics of Study Participants (n = 355)

Characteristic	n	%
Age (mean ± SD, years)	42.7 ± 13.2	
Age groups		
18–29	62	17.5
30–44	139	39.2
45–59	109	30.7
≥60	45	12.6
Sex		
Male	192	54.1
Female	163	45.9
Socioeconomic Status		
Low	79	22.3
Middle	186	52.4
High	90	25.4
Residence		

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Urban	272	76.6
Rural	83	23.4

Table 2: Prevalence of NAFLD Among Study Participants

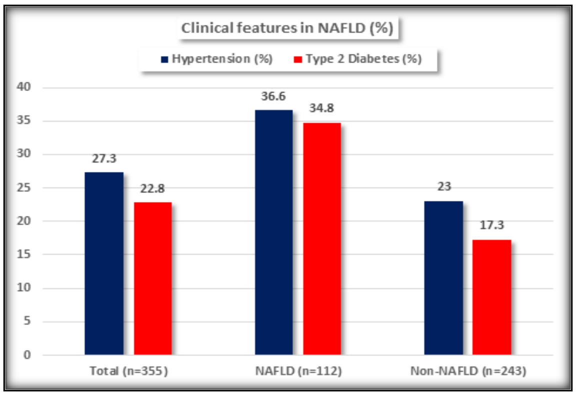
Variable	n	%
Total participants	355	100
NAFLD diagnosed cases	112	31.6
Non-NAFLD	243	68.4

Table 3: Anthropometric and Clinical Features

Feature	Total (n=355)	NAFLD (n=112)	Non-NAFLD (n=243)
BMI (mean ± SD, kg/m²)	25.5 ± 4.3	28.4 ± 3.6	24.1 ± 3.7
BMI ≥25 kg/m²	212 (59.7%)	82 (73.2%)	130 (53.5%)
Waist Circumference (mean ± SD)	91.7 ± 10.2	98.1 ± 9.8	88.5 ± 8.7
Hypertension	97 (27.3%)	41 (36.6%)	56 (23.0%)
Type 2 Diabetes	81 (22.8%)	39 (34.8%)	42 (17.3%)

Table 4: Biochemical Parameters of Participants

Parameter	NAFLD (n=112)	Non-NAFLD (n=243)	p-value
Fasting glucose (mg/dL) (mean ± SD)	123.6 ± 23.7	105.2 ± 18.3	<0.001
Triglycerides (mg/dL) (mean ± SD)	186.8 ± 49.2	134.9 ± 38.5	<0.001
ALT (U/L) (mean ± SD)	51.7 ± 14.9	36.2 ± 10.5	<0.001
HDL (mg/dL) (mean ± SD)	38.4 ± 7.8	46.6 ± 8.2	<0.001



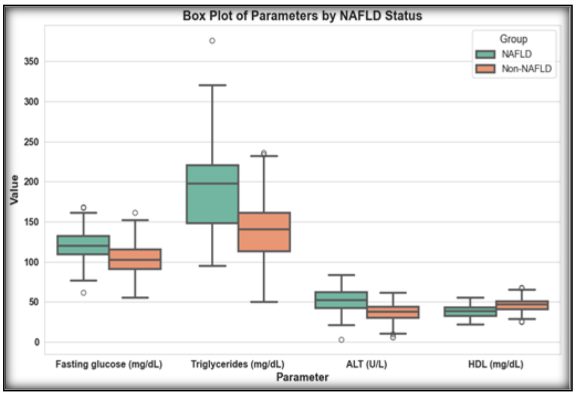


Table 5: Lifestyle and Dietary Factors

Factor	NAFLD (n=112)	Non-NAFLD (n=243)	p-value
Sedentary lifestyle	68 (60.7%)	86 (35.4%)	<0.001
Regular exercise (>3x/week)	26 (23.2%)	124 (51.0%)	<0.001
High processed food intake	73 (65.2%)	68 (28.0%)	<0.001
Smoking	19 (17.0%)	14 (5.8%)	0.002

Table 6: Association of Anthropometric and Clinical Features with NAFLD (Bivariate Analysis)

Variable	NAFLD (%)	Non-NAFLD (%)	χ^2 value	p-value
Male sex	58 (51.8)	134 (55.1)	0.39	0.53
BMI ≥25 kg/m²	82 (73.2)	130 (53.5)	14.0	<0.001
Hypertension	41 (36.6)	56 (23.0)	7.6	0.006

Table 7: Multivariable Logistic Regression for NAFLD Risk Factors

Variable	Adjusted OR	95% CI	p-value
BMI ≥25 kg/m²	2.31	1.43–3.72	<0.001
Type 2 Diabetes	2.07	1.22–3.52	0.007
Sedentary lifestyle	1.72	1.03–2.87	0.037
Age (per year increase)	1.02	1.00–1.04	0.041
Male sex	0.89	0.56–1.40	0.61

Table 8: Comparison of Biochemical Markers Between NAFLD and Non-NAFLD (t-Test)

Parameter	NAFLD Mean ± SD	Non-NAFLD Mean ± SD	t (df)	p-value
Fasting glucose	123.6 ± 23.7	105.2 ± 18.3	7.1 (353)	<0.001
Triglycerides	186.8 ± 49.2	134.9 ± 38.5	10.4 (353)	<0.001
ALT	51.7 ± 14.9	36.2 ± 10.5	9.6 (353)	<0.001

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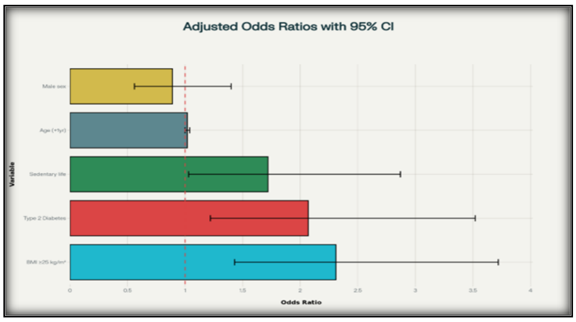
Table 9: Receiver Operating Characteristic (ROC) Analysis for Predicting NAFLD

Predictor Variable	AUC	95% CI	Sensitivity	Specificity
BMI	0.78	0.71–0.85	0.73	0.65
Fasting Glucose	0.73	0.66–0.81	0.69	0.69
Triglycerides	0.70	0.62–0.78	0.66	0.63

Table 10: Interaction Analysis: Effect Modification by Residence (Urban/Rural) on NAFLD Risk

Variable	Urban (n=272) OR (95% CI), p-value	Rural (n=83) OR (95% CI), p-value
Sedentary lifestyle	1.80 (1.08–3.02), 0.025	1.13 (0.49–2.58), 0.77
High processed food intake	2.53 (1.44–4.43), 0.001	1.31 (0.67–2.57), 0.43



Demographic characteristics and Prevalence of NAFLD: A total of 355 adults participated in the study, with a mean age of 42.7 ± 13.2 years; the majority (39.2%) were aged 30–44, with smaller proportions in the 18–29 (17.5%), 45–59 (30.7%), and ≥60 (12.6%) age groups. Males comprised 54.1% of the sample, and most individuals resided in urban areas (76.6%). Socioeconomic representation was predominantly middle class (52.4%), with fewer participants in low and high categories.

The prevalence of NAFLD according to ultrasonographic criteria was 31.6% (n = 112), demonstrating a substantial burden among this tertiary care-seeking population.

Anthropometric and Clinical Features: NAFLD was associated with greater adiposity: affected participants showed higher mean BMI (28.4 ± 3.6 kg/m² versus 24.1 ± 3.7 kg/m² in non-NAFLD), with 73.2% overweight or obese (BMI ≥ 25 kg/m²) compared to 53.5% of non-afflicted persons. Waist circumference was also elevated (98.1 ± 9.8 cm vs. 88.5 ± 8.7 cm). Comorbid hypertension and type 2 diabetes were more prevalent in the NAFLD group (36.6% and 34.8%, respectively) than in their non-NAFLD peers (23.0% and 17.3%).

Biochemical Characteristics: Significant differences were observed in metabolic and hepatic markers. NAFLD patients had higher fasting blood glucose (123.6 ± 23.7 mg/dL), triglycerides (186.8 ± 49.2 mg/dL), and ALT (51.7 ± 14.9 U/L), while HDL cholesterol was notably lower (38.4 ± 7.8 mg/dL) than in non-NAFLD controls (all p<0.001).

Lifestyle and Dietary Factors: Sedentary lifestyle was markedly more common among NAFLD cases (60.7% versus 35.4%, p<0.001); regular exercise (>3 sessions/week) was less reported (23.2% vs. 51.0%). Processed food consumption and smoking were also higher in NAFLD (65.2% and 17.0%) than non-NAFLD (28.0% and 5.8%).

Inferential Statistics: Bivariate analysis confirmed significant associations of NAFLD with high BMI and hypertension, but not sex. Multivariable regression identified BMI ≥ 25 kg/m² (AOR=2.31, 95% CI: 1.43–3.72), type 2 diabetes (AOR=2.07, 95% CI: 1.22–3.52), sedentary lifestyle (AOR=1.72, 95% CI: 1.03–2.87), and age (AOR=1.02 per year) as independent risks, with male sex non-significant. ROC analysis showed BMI as the best single predictor (AUC=0.78); fasting glucose and triglycerides performed moderately well (AUC=0.73 and 0.70, respectively). Interaction analysis by residence revealed that sedentary life and processed food intake substantially raised NAFLD risk among urban, but not rural, participants.

DISCUSSION

This study reveals a high hospital-based prevalence of NAFLD (31.6%) in adult patients in Maharashtra, comparable to or exceeding other Indian tertiary care reports.[2,4,13] Our findings confirm overweight/obesity as the dominant risk factor, consistent with the strong and independent role of adiposity in NAFLD pathogenesis reported in both global^1 and Indian meta-analyses.[3]

The coexistence of hypertension and diabetes among NAFLD cases reinforces its close relationship with the metabolic syndrome.[2,6] Elevated fasting glucose, high triglycerides, low HDL, and increased ALT observed in this cohort match previously described biochemical patterns in NAFLD patients,[7,8,14] indicating underlying insulin resistance and hepatic inflammation.

Lifestyle analysis demonstrated that physical inactivity, low exercise frequency, and high processed food consumption are strongly associated with NAFLD risk, particularly in urban residents. This suggests environmental and behavioral factors unique to urban lifestyles may exacerbate disease risk.[9–11] Our stratified findings underline the need for locality-specific prevention strategies, with a priority for urban-focused public health interventions.

The absence of a significant sex association after adjustment supports emerging Indian literature reporting that metabolic and lifestyle factors, rather than gender itself, are the key drivers of NAFLD.[3,12]

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Strengths of this study include systematic sampling, robust sample size, standardised ultrasonographic diagnosis, and a comprehensive evaluation of clinical, biochemical, and lifestyle determinants. Limitations include the cross-sectional design (limiting causal inference), potential selection bias in a hospital-based population, and reliance on self-reported lifestyle factors.

CONCLUSION

In conclusion, NAFLD is a major and growing health burden in Maharashtra. Overweight/obesity, type 2 diabetes, sedentary lifestyle, and poor diet quality are independent and modifiable drivers. BMI, given its predictive strength, can be used as a simple frontline screening measure in primary and specialty care. There is an urgent need for integrated screening, lifestyle modification, and policy measures to address NAFLD, especially in urban populations undergoing rapid dietary and lifestyle transitions. Further longitudinal research, and implementation trials of lifestyle modification interventions, are warranted to curb the rising tide of NAFLD and attendant complications in India.

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