

Non-alcoholic fatty liver disease (NAFLD): A comparative study of clinico-socio-demographic characteristics among two diverse Indian population

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ABSTRACT

Objectives. The prevalence of nonalcoholic fatty liver disease (NAFLD) is increasing not only in India but also globally. The aim of this observational study was to determine the clinico-pathological findings of NAFLD patients in two different geographic populations in India.

Material and methods. This hospital-based cross-sectional study involved 140 consecutive patients with NAFLD from four centers, primarily diagnosed by ultrasound in Uttar Pradesh (Varanasi) and Odisha (Khordha). Clinical and socio-demographic data were collected from each patient of both the states and were compared.

Outcomes. The study findings revealed that most of NAFLD patients were males (71.4%), aged around 39.6 ± 10.86 years, with BMI indicating overweight (27.68 ± 4.25 Kg/m²). Patients from Uttar Pradesh (UP) had non-significantly higher rates of elevated transaminase levels [SGOT/SGPT- 40.2 (41.53)/47.35(60.93) IU/L], compared to those from Odisha [SGOT/SGPT-26(23.15)/29(45.40) IU/L]. Too cases of Odisha had non-significantly higher mean triglyceride levels compared to patients of UP. There was a significant difference in family type in-between the 2 regions ($p=0.000$), with Odisha having more number of nuclear families compared to UP. Cases from Odisha had non-significantly higher per capita monthly income (41.891 ± 43.23 INR) compared to UP (34.276 ± 27.66 INR). Statistically significant dietary preferences, were noticed in-between the 2 states with majority from Odisha favoring non-vegetarian diets (90.6%) compared to Uttar Pradesh (75.06%).

Conclusions. Patients from Odisha had higher per capita monthly income, history of higher non-vegetarian diet consumption, higher hypertriglyceridemia and lesser transaminases compared to cases from Uttar Pradesh.

Keywords: NAFLD, overweight, dietary choices, LFT, risk factors, socio-economic status, regional differences

INTRODUCTION

Nonalcoholic fatty liver disease (NAFLD) is the most common chronic liver disease worldwide. This metabolic disorder is characterized by excessive fat accumulation (>5 %) in hepatocytes. The spectrum of NAFLD includes nonalcoholic fatty liver (NAFL), nonalcoholic steato-hepatitis (NASH) and cirrhosis of the liv-

er [1]. Moreover, with the increased prevalence of NAFLD, there has been an increase in other socio-economic burdens (such as income, education, employment, social support etc.) on families of patients. Some studies have also shown that abnormalities in liver related parameters may be associated with increased risk of cardiac and diabetes related complications with markedly increased economic burden on society [2].

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Nonalcoholic Fatty Liver Disease (NAFLD) affects approximately one fourth to one third of global population. India being the seventh-largest (by land volume area) and most populous country in the world had prevalence of NAFLD at rate of 9% to 53% [3,4]. Consistent with the national trend, the prevalence of NAFLD in Odisha varied from 10-33% as per prior studies [5–7]. NAFLD is a multifactorial disease [8]. Due to economic development, westernization of dietary history and sedentary lifestyle in India, prevalence of NAFLD is gradually increasing in India [9]. Although NAFLD can be caused due to multiple etiological factors, it was somehow difficult to conclude the specific causes among different population hailing from different geographical area. Study from United States suggested that NAFLD-associated depression can be an important risk factor for increased mortality [10].

Non-Alcoholic Fatty Liver Disease (NAFLD) is a pervasive health concern with an alarming global impact. This study aimed to delve into the nuanced landscape of NAFLD prevalence, focusing on regional variations within 2 Indian states such as Odisha (Eastern region) and Uttar Pradesh (Northern region). NAFLD is known to affect any individual irrespective of body mass index (BMI), presenting a unique challenge for diagnosis and management. By focusing on NAFLD prevalence in diverse geographic areas, this study aims to uncover regional disparities and understand the factors influencing this chronic condition. Understanding these variations is vital for tailoring effective prevention and management strategies, potentially improving public health interventions.

MATERIAL AND MATERIALS

This multicenter cross-sectional study was conducted in tertiary healthcare centers, both government and private, using a hospital-based approach. Data were collected through self-prepared questionnaire interviews. The study included consecutive NAFLD cases diagnosed ultrasonographically and evaluated by physicians. It was conducted in Odisha (Khordha) and Uttar Pradesh (Varanasi), with patients from multiple hospitals in each state enrolled in the study.

Ethical approval

Data collection was carried out from 28th March to 1st August 2023 after approval was obtained from the Institutional Ethics Committee and written informed consent from each participant.

Exclusion and inclusion criteria

Total 140 ultrasonographically diagnosed NAFLD patients aged 18 to 65 years were included in the

study and analyzed. Cases with cirrhosis, hepatocellular carcinoma, pregnancy, lactation, chronic viral infection related liver diseases, history of significant alcohol consumption, use of specific medications (e.g. estrogens containing compounds, amiodarone, valproate, tamoxifen), were excluded from the study.

The variables like socio-demographic profiles (gender, age, family members, income, education, occupation etc.), anthropometric variables [height, weight, body mass index (BMI), waist, hip and abdomen circumference], and biochemical parameters such as liver function test (LFT), lipid profile, complete blood count (CBC) and ultrasonography abdomen and pelvis were subjected to each participants to assess different parameters and hepatic steatosis grade.

Statistical analysis

Statistical Package for the social Sciences (SPSS) Version 23.0 was used to enter and analysis the data. Categorical variables were presented as frequencies (Percentage), while continuous variables were expressed as mean (\pm standard deviation) or median (IQR) as appropriate. To compare characteristics between various groups within the study population, we used the Chi-square test for discrete variables and one way ANOVA for continuous type of variables.

RESULTS

A total of 140 cases (64 cases from Odisha and 76 cases from Uttar Pradesh) diagnosed with NAFLD were initially enrolled for the study. The analysis on various characteristics among the study population is described (Table 1), providing a unique snapshot of various characteristics within the studied population in Odisha and Uttar Pradesh among a combined total of 140 cases.

It was observed that the gender distribution NAFLD is more prevalent among males than the females with a fraction of 71.6%. Furthermore, an increased fractional distribution of 35.9% females was affected in Odisha compared to Uttar Pradesh at 22.4%, where NAFLD was more common among males (77.6%). By comparing data types of family were significant on both the states at $p=0.000$. In Odisha nuclear families make up 98.4% of the total study group, where as in Uttar Pradesh a fraction of 34.2% Joint families were more common compared to those in Odisha. There was also a difference in family size, with an average of 4.2 members per family in Odisha and 6.81 members per family in Uttar Pradesh. Regarding academic background a small proportion had received education (3.6%), with Odisha (6.3%) surpassing Uttar Pradesh (1.3%). The secondary education rates were similar between the two states (33.6%) while the tertiary education level (62.9%)

TABLE 1. Socio-demographic characteristics of NAFLD patients

Characteristics		Odisha - 64 Cases (%)	Uttar Pradesh- 76 Cases (%)	Total (140 Cases)	Significance p -value
Gender	Male	(41)64.1	(59)77.6	(100)71.4	0.077
	Female	(23)35.9	(17)22.4	(40)28.6	
Education	Primary	(04)6.3	(01)1.3	(05)3.6	0.270
	Secondary	(22)34.4	(25)32.9	(47)33.6	
	Tertiary	(38)59.4	(50)65.8	(88)62.9	
Marital Status	Married	(57)89.1	(59)77.6	(116)82.9	0.074
	Unmarried	(07)10.9	(17)22.4	(24)17.1	
Types of activity	Sedentary	(57)89.1	(62)81.6	(119)85	0.217
	Moderate	(07)10.9	(14)18.4	(21)15	
Types of Family	Nuclear	(63)98.4	(50)65.8	(113)80.7	0.000
	Joint	(01)1.6	(26)34.2	(27)19.3	
Area	Rural	(13)20.3	(30)39.5	(43)30.7	0.049
	Semi-Urban	(31)48.4	(29)38.2	(60)42.9	
	Urban	(20)31.3	(17)22.4	(37) 26.4	
Religion	Hindu	(63)98.4	(72)94.7	(135)96.4	0.240
	Muslim	(01)1.6	(04)5.3	(05)3.6	

Data were shown in frequencies and percentage; p: Shows Significance level; NS: Non significant value; if $p > 0.05$ shows data were Non-significant, if $p < 0.05$ shows data were significant.

TABLE 2. Common symptoms showing among NAFLD patients

Associated disorders/ symptoms among NAFLD		In Odisha (64) (%)	In Uttar Pradesh (76) (%)	Total	p -value
Diabetes	Yes	15(23.4%)	06 (7.9%)	21 (15%)	0.010
	No	49 (76.6%)	70 (92.1%)	119 (85%)	
Hypertension	Yes	14(21.9%)	10(13.2%)	24(17.1%)	0.173
	No	50(78.1%)	66(86.8%)	116 (82.9%)	
Dyslipidemia	Yes	25(39.1%)	25(32.9%)	50(35.7%)	0.448
	No	39 (60.9%)	51 (67.1%)	90(64.3%)	
Gas/Bloating	Yes	44(68.8%)	44(57.9%)	88(62.9%)	0.401
	No	18(28.1%)	28(36.8%)	46(32.9%)	
	Sometimes	02(3.1%)	04(5.3%)	06(4.3%)	
Dyspepsia	Yes	15(23.4%)	26(34.2%)	41(29.3%)	0.163
	No	49(76.6%)	50(65.8%)	99(70.7%)	
Abdominal discomfort	Yes	31(48.4%)	33(43.4%)	64(45.7%)	0.436
	No	32(50%)	43(56.6%)	75(53.6%)	
	Sometimes	01(1.6%)	0(0)	1(0.7%)	
Loss of appetite	Yes	16(25%)	28(36.8%)	44(31.4%)	0.133
	No	48(75%)	48(63.2%)	96(68.6%)	
Stool (Not clear)	Clear	30(46.9%)	41(53.9%)	71(50.7%)	0.008
	Loose	01 (1.6%)	08(10.5%)	09 (6.4%)	
	Not clear	29(45.3%)	17(22.4%)	46 (32.9%)	
	Constipation	04 (6.3%)	10 (13.2%)	14 (10%)	
Fatigue	Yes	38(59.4%)	51(67.1%)	89 (63.6%)	0.344
	No	26(40.6%)	25(32.9%)	51(36.4%)	
Daily exercise	Never	49(76.6%)	50(65.8%)	99(70.7%)	0.622
	Rarely	7(10.9%)	9(11.8%)	16(11.4%)	
	15-30min	5(7.8%)	11(14.5%)	16(11.4%)	
	30-45 min	0(0%)	1(1.3%)	1(0.7%)	
	45-60 min	2(3.1%)	2(3.1%)	4(2.9%)	

was greater in Uttar Pradesh (65.8%) than in Odisha (59.4%). In regard to marital status, majority cases were married (82.9%) with Odisha having a greater percentage of married study population (89.1%) compared to them in Uttar Pradesh (77.6%). In consideration of physical activity levels, 85% study groups were engaged in sedentary activities, with a larger proportion in Odisha (89.1%) than in Uttar Pradesh (81.6%). Moderate activity is reported by 15% of the population. This percentage is slightly greater in Uttar Pradesh (18.4%) than in Odisha (10.9%). Regarding residential preferences, 20.3% of individuals in Odisha opt for rural living compared to 39.5% in Uttar Pradesh. Semi-urban residents account for 48.4% and 38.2% in Odisha and Uttar Pradesh respectively, while urban dwellers represent 31.3% and 22.4% in the two states. A significant difference in residential area distribution was observed between the states ($p=0.049$). In respect to religion, 96.4% were Hindus, more in Odisha (98.4%) than in Uttar Pradesh (94.7%). Muslims constitute only 3.6% of study community, whereas Uttar Pradesh (5.3%) having more percentile of Muslim population compared to them in Odisha (1.6%) (Table 1). Therefore, no significant difference was observed on religious basis between both the states.

The common symptoms among NAFLD Patients in frequencies and percentage, include that p-value < 0.05 shows data were significant and p value > 0.05 shows N.S.-non significant illustrated (Table 2).

A comprehensive analysis of health indicators between Odisha and Uttar Pradesh revealed significant regional differences as shown above. First, the incidence of diabetes was notably greater in Odisha (23.4%) than in Uttar Pradesh (7.9%), indicating a potential regional distinction in NAFLD patients. Similarly, hypertension was more prevalent in Odisha (21.9%) than in Uttar Pradesh (13.2%). The common lipid disorder dyslipidemia is slightly more prevalent in Odisha (39.6%) than in Uttar Pradesh

Associated disorders/ symptoms among NAFLD	In Odisha (64) (%)	In Uttar Pradesh (76) (%)	Total	p -value	
Daily exercise	5-10g/day	(0)0	(7)9.2	(07)5	
	10-20g/day	(06)9.4	(12)15.8	(18)12.9	
	>20g/day	(01)1.6	(0)0	(01)0.7	
	Sometimes	(07)10.9	(03)3.9	(10)7.1	
Grade of Fatty Liver	0	(25)53.2	(17)29.8	(42)40.4	0.109
	1	(11)23.4	(19)33.3	(30)28.8	
	2	(07)14.9	(15)26.3	(22)21.2	
	3	(04)8.5	(06)10.5	(10)9.6	

The above table shows common symptoms among NAFLD patients in frequencies and percentage, include that p-value <0.05 shows data were significant and p-value >0.05 shows N.S.-non significant.

either never exercised or did so infrequently, emphasizing low physical activity levels within both populations. Collectively, these findings indicate potential regional disparities in health factors and lifestyle choices that can impact NAFLD incidence.

In terms of dietary preferences, 90.6% of the study populations from Odisha were non-vegetarians, whereas 75% cases from Uttar Pradesh were on non-vegetarian diets. In Odisha, the majority of cases (76.6%) never engaged in daily exercise, followed by 10.9% who rarely exercised and 7.8% cases do exercise for 15-30 minutes. In Uttar Pradesh, 65.8% of participants never exercised daily, 11.8% rarely did and 14.5% engaged in 15-30 minutes of exercise (Table 2). Overall, significant proportion of cases from both the regions reported either never or rarely exercising, emphasizing a need for increased physical activity promotion.

In relation to fatty liver grades between Odisha and Uttar Pradesh, notable disparities emerged as grade 0 (Showing Initial phase of fatty liver with mild fatty infiltration) fatty liver was more prevalent in Odisha (53.2%) than in Uttar Pradesh (29.8%). However, Uttar Pradesh surpassed Odisha in Grade 1, with 33.3% compared to 23.4% for Odisha. This trend continued for Grade 2 too, where Uttar Pradesh had a higher percentage (26.3%) than Odisha (14.9%). For Grade 3, both states show relatively similar percentages, with Odisha at 8.5% and Uttar Pradesh at 10.5% in lower side. In summary, Grade 0 was predominated in Odisha which indicated that most of the patients had diagnosed fatty liver in their initial stages with ultrasonographically revealing only mild fatty infiltration of liver, whereas Uttar Pradesh had higher percentages of fatty liver in

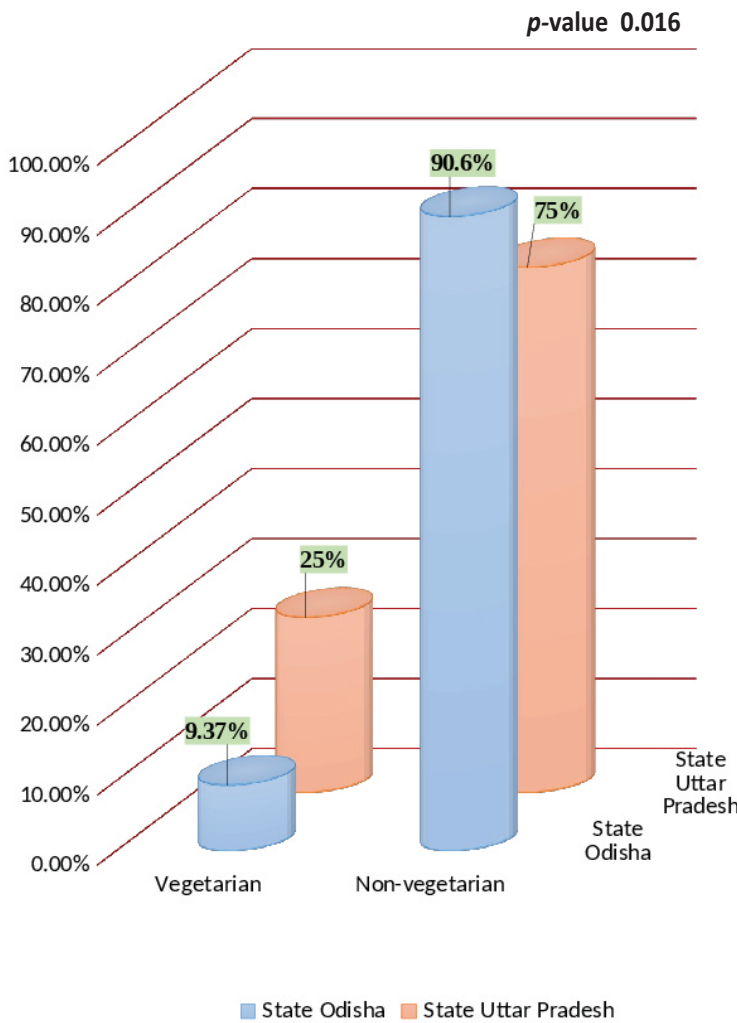


FIGURE 1. Dietary preferences of NAFLD patients from two states

(32.9%). Digestive issues, such as gas/bloating, are more frequently reported in Odisha (68.8%) than in Uttar Pradesh (57.9%) which are significant (p-value-0.0401). Fatigue is a common symptom in both regions, with 59.4% in Odisha and 67.1% in Uttar Pradesh experiencing it. Additionally, loss of appetite and abdominal discomfort are observed in NAFLD patients, with 64% and 44%, respectively experiencing these symptoms simultaneously (Table 2). The exercise frequency table revealed that majority (70.7%)

grades 1, 2, and 3 (Mild to Severe) compared to Odisha (Figure 1).

These percentages illustrate the dietary preferences in both states, with a notable difference in the proportion of vegetarians and non-vegetarians. In Odisha, a small proportion (9.37%) of the population follows a vegetarian diet, while the majority (90.62%) opts for a non-vegetarian diet. That may be due to coastal region having more options for non-veg food & local culture in Odisha. In Uttar Pradesh, a quarter

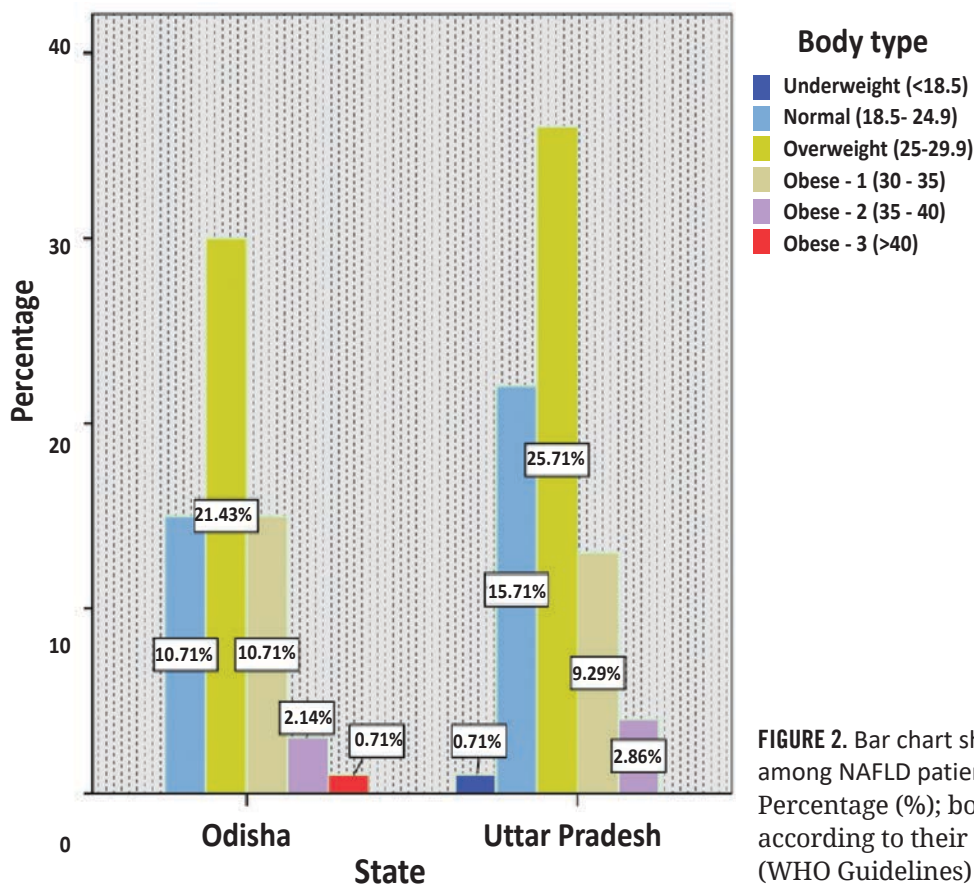


FIGURE 2. Bar chart showing state-wise body type among NAFLD patients Percentage (%); body types were divided according to their BMI; BMI-Body Mass Index (WHO Guidelines)

(25.00%) of the population chooses a vegetarian diet, while the majority (75.00%) prefers a non-vegetarian diet (Figure 1). The observed p-value was 0.016 which indicates a statistically significant difference in dietary preferences between the two states, with Uttar Pradesh having a more substantial vegetarian population compared to Odisha (Figure 2).

The table reveals the distribution of physical anthropometry data on basis of BMI from Odisha and Uttar Pradesh, expressed in percentages: Showing most of the Individuals from both the states falling under Overweight to Obese category. These patterns may stem from dietary habits, lifestyle choices, and socio-economic factors specific to each region.

In comparing liver health indicators between Uttar Pradesh and Odisha, minimal variations were observed. Uttar Pradesh exhibited slightly higher Serum glutamic-oxaloacetic transaminase (SGOT) [40.2(41.53)] and Serum glutamic pyruvic transaminase (SGPT) [47.35(60.93)] levels compared to Odisha [SGOT: 26 (23.15), SGPT: 29(45.40)], that were in normal range. However, Odisha showed higher triglyceride levels [184.70(85)] than Uttar Pradesh [164.05 (116.29)], while total cholesterol levels were slightly elevated in Odisha [194.10(46.05)] compared to Uttar Pradesh [184.84(66.85)] however, both were in normal range including these two parameters HDL and

TABLE 3. Biochemical parameters along with liver size of NAFLD patients

Parameters	Patients from Odisha (Median ± IQR)*	Patients from UP (Median ± IQR)*	p-value
SGOT	26 (23.15)(n=25)	40.2(41.53) (n=18)	0.742
SGPT	29(45.40) (n=25)	47.35(60.93) (n=18)	0.659
TGs	184.70(85)(n=25)	164.05(116.29)(n=18)	0.636
TC	194.10(46.05) (n=25)	184.84(66.85) (n=18)	0.777
HDL	40.60(7.80) (n=25)	41.15 (15.77) (n=18)	0.143
LDL	113.60 (41.85) (n=25)	120.95 (80.25) (n=18)	0.317
VLDL	37(18.03)(n=25)	32.80 (23.34) (n=18)	0.391
Liver Size (in c. m.)	14 (2.40)(n=33)	15.20 (2.80)(n=39)	0.132

*Data were mentioned in median (IQR -Inter-quartile range). p-value shows significance level. If $p > 0.05$ shows data were Non-significant, if $p < 0.05$ shows data were significant.

SGOT: Serum glutamic-oxaloacetic transaminase, SGPT: Serum glutamic pyruvic transaminase, TGs: Triglycerides, TC: Total Cholesterol, HDL: High density lipoprotein, LDL: Low density lipoprotein, VLDL: Very low density lipoprotein

LDL cholesterol with minimal differences between the two regions interestingly. VLDL range were elevated in Odisha [37(18.03)] than UP [15.20 (2.80)] despite of non-significant difference. Liver size was slightly smaller in Odisha [14 (2.40)] than in Uttar Pradesh [15.20 (2.80)] (Table 3).

DISCUSSION

Over recent decades, NAFLD has gained significant recognition globally, with both emerging and

developed nations experiencing a rise in its prevalence among the general populace. NAFLD, characterized by excessive fat buildup in the liver, has emerged as a leading cause of diffuse liver disease. Particularly, hepatic steatosis is pivotal in the progression of fibrosis associated with NAFLD. This growing awareness underscores the importance of understanding NAFLD's multifaceted nature and its implications for public health strategies aimed at prevention and management. Study found that the presence of metabolic abnormalities in non-obese NAFLD patients may lead to insulin resistance, indicating adverse outcomes related to NAFLD in these individuals for progression of NAFLD (11). NAFLD is often a challenge to determine the social and demographic characters biochemically and clinic pathologically. According to the objectives, it was found that most of the NAFLD patients were married males residing in nuclear families in semi-urban to urban areas, reflecting their accessibility to resources, which was corroborated by the study conducted by [12]. The contrast in nuclear family prevalence between Odisha and Uttar Pradesh among NAFLD patients highlights diverse socio-cultural and economic influences. Factors like urbanization and economic opportunities lead to more nuclear families in Odisha, shaping healthcare choices. In Uttar Pradesh, cultural emphasis on joint families affects support systems and decision-making for NAFLD management. Additionally, clinical symptoms such as diabetes and bowel-related issues were more prevalent among NAFLD patients in Odisha relative to those in Uttar Pradesh. Moreover, factors on dietary intake patterns show more non-vegetarian observed among Odisha than UP. That might be due to the geographical variation and the ease of availability in coastal areas. However, there was NAFLD diversity in these two states. However, most of the patients were obese, followed by non-obese, suggesting the expected association between T2DM and NAFLD as it is proven that patients with T2DM and pre-diabetes have a chance of progressing fibrosis shown by serial pathological findings [13]. Furthermore, the above findings suggest potential biological and socio-cultural influences on NAFLD prevalence, including differences in chromosomal makeup, sex hormone levels, and lifestyle factors impacting disease pathogenesis, as suggested by [14]. In the current study, it was found that patients from Uttar Pradesh (UP) the mean value of SGPT was 47.35, compared to those from Odisha, it was 29 had non-significantly higher rates of elevated transaminase levels with $p\text{-value} > 0.005$. The variation in SGPT, also known as ALT, and the levels among individuals across different geographic locations can be attributed to several factors such as dietary patterns, the prevalence rate of liver-related diseases such as viral hepatitis, ALD, and NAFLD [15]. Further-

more, ethnicity, genetic factors, environmental toxins, and pollutants impact liver function and enzyme levels.

A previous report revealed that the major prevalence of ultrasonographically diagnosed Non-Alcoholic Fatty Liver Disease (NAFLD), along with elevated alanine transaminase levels and fibrosis determined through Transient Elastography (TE), among both urban and rural populations in North India by [16] were observed which was corroborated with the current study. Furthermore, a prospective study G. Maconi et al. revealed that the prevalence of elevated intestinal gas levels among patients with steatosis and elevated ALT serum levels was nearly twice that observed in patients with steatosis and normal ALT levels. Significant correlation between fat accumulation in tissue and intestinal gas formation, which was similar to the findings the current study.

Limitations of the study

The study primarily focuses on two states, Odisha and Uttar Pradesh, which may not be representative of NAFLD characteristics across all regions of India or globally. The findings may not generalize to populations outside these specific geographical areas. The total sample size of 140 cases (64 from Odisha and 76 from Uttar Pradesh) might be considered small for drawing broad conclusions about NAFLD prevalence and characteristics, especially given the diversity within these states and potential variations in healthcare access and awareness. The study reports a significant gender distribution imbalance, with 71.6% of cases being male. This skew could impact the generalizability of findings, as NAFLD might manifest differently in females, who are underrepresented in the study. While the study identifies regional differences in health indicators like diabetes and hypertension, it doesn't delve into causative factors or longitudinal trends, limiting the depth of understanding about NAFLD in these populations.

CONCLUSIONS

The study delved into non-alcoholic fatty liver disease (NAFLD) across two distinct geographical regions, uncovering a similar prevalence among both gender groups. Remarkably, males in both states were more susceptible, crucially among the married individuals. In Odisha, where there's a better socio-economic profile, a prevalence of non-vegetarianism, and a majority residing in urban to semi-urban areas within nuclear families, liver enlargement without a specific grade was more widespread. Meanwhile, in Uttar Pradesh, where more males were vegetarian and a higher percentage was overweight compared to Odisha, NAFLD cases were diagnosed at later stages. Clinically, most individuals in

both states were asymptomatic, experiencing common symptoms like fatigue, abdominal pain, unclear stool, and gas/bloating. Biochemically, cases from Uttar Pradesh had slightly higher liver enzyme levels, whereas Odisha exhibited elevated triglyceride and cholesterol levels with a marginally smaller liver size. These regional variations suggest diverse health profiles and risk factors for NAFLD within these populations.

In general, NAFLD is influenced by a complex interplay of genetic predisposition, shared environment and lifestyle, and influence on family dynam-

ics. If one family member adopts unhealthy habits, others may be more likely to follow suit. In nuclear families, where there may be closer relationships and more shared experiences compared to extended families, these dynamics could potentially exacerbate the risk of NAFLD among family members. Moreover, limited social support in nuclear families may give a close support system but lack the broader social networks present in extended families that may impact protectiveness against NAFLD by providing healthy behaviors and access to conditional resources.

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