

Original Article

Study on Risk Factors of Non Alcoholic Fatty Liver Disease in Patients Attending NGMCTH

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Abstract: Excessive and abnormal fat deposition in the liver cells among non-alcoholic populations is considered as Non Alcoholic Fatty Liver Disease (NAFLD). Radiology detects fatty liver early and accurately, further lipid profile testing checks for abnormalities in Total Cholesterol, HDL, LDL, and Triglycerides in different categories. This study examined the profile of risk factors of NAFLD patients attending NGMCTH. The analytical hospital based cross-sectional study was conducted over a period of one year in patients sent for routine ultrasonography for the assessment of abdominal pathology. Total patients enrolled after exclusion were 90. Diagnosis and grading of fatty liver was done on the basis of USG finding of abdomen. According to the findings of our research, all individuals had an increase in their alanine transaminase levels, whereas 46 patients had an increase in their aspartate transaminase levels. As was the case with our own research, Sandal discovered a substantial correlation between NAFLD and ALT. The results indicated that out of a total of 90 individuals diagnosed with NAFLD, 33 patients were diabetic and 18 patients were hypertensive. A total of 25 patients had symptoms of metabolic syndrome. According to the findings of the study, the prevalence of diabetes was 48.5%, and the prevalence of hypertension was 52%. Comparable to the findings of our own research, the study found that the prevalence of metabolic syndrome in individuals with NAFLD was 32.74 percent. In addition, our paper emphasizes the connection between non-alcoholic fatty liver disease (NAFLD) and characteristics of the metabolic syndrome. According to numerous reports, nonalcoholic fatty liver disease (NAFLD) is associated with obesity, diabetes, hypertension, and hyperlipidemia.

Keywords: Risk Factors, Fatty Liver Disease, Patients, Attending NG MCTH

1. INTRODUCTION

Nonalcoholic fatty liver disease (NAFLD) is defined as the accumulation of hepatic fat, as evidenced by radiologic or histologic examination, in the absence of a coexisting etiology of chronic liver disease or secondary cause of steatosis (including drugs, significant alcohol consumption, or inherited or acquired metabolic states) [1]. The spectrum of NAFLD encompasses two subtypes, nonalcoholic fatty liver (NAFL) and nonalcoholic steatohepatitis (NASH) [2]. NAFL is defined as the presence of 5% hepatic steatosis without evidence of hepatocellular injury in the form of hepatocyte ballooning [3]. NASH is defined as the presence of 5% hepatic steatosis and inflammation with hepatocyte injury (e.g., ballooning), with or without any fibrosis. Because the majority of patients with NAFLD are asymptomatic, the prevalence of NAFLD is not completely well defined globally, although several studies have suggested a wide range of prevalence rates of 2.8% to 46% [4]. A recent systematic review and meta-

analysis has estimated the global prevalence of NAFLD, as diagnosed by imaging in the absence of significant alcohol use, to be approximately 25%, with the highest prevalence in the Middle East and South America and the lowest prevalence in Africa [5]. The prevalence of NAFLD, specifically NASH is common in diabetes with frequency of 60% to 76% NAFLD and 22% NASH [6]. Metabolic co-morbidities associated with a diagnosis NAFLD included obesity (51.34%), type 2 diabetes (22.51%), hyperlipidemia (69.16%), hypertension (39.34%), and the metabolic syndrome (42.54%) [6]. The overall global prevalence of NAFLD diagnosed by imaging is around 25.24%. The highest prevalence of NAFLD is reported from the Middle East 31.79% and South America 30.45% whereas the lowest prevalence rate is reported from Africa 13.48% [7]. Non-alcoholic fatty liver is strongly associated with obesity, insulin resistance, hypertension and dyslipidemia. It is now regarded as the hepatic manifestation of metabolic syndrome [8]. It is difficult to distinguish fatty liver disease due to alcohol intake and NAFLD. Histological features present in all or most cases of NAFLD are macrovesicular steatosis, lobular inflammation, hepatocytes necrosis, ballooning hepatocytes degeneration and fibrosis. Additionally, Mallory Denk bodies, glycogenated nuclei and stainable iron are observed with varied frequencies [9]. It is difficult to distinguish alcoholic fatty liver from NAFLD histologically but more fibro-occlusive venous lesions and bile stasis in alcoholic steatohepatitis [10]. NASH is defined as the combination of steatosis with lobular inflammation and hepatocytes ballooning that may or may not be associated with hepatocytes necrosis [11]. In most patients some degree of fibrosis is present [12]. Cirrhosis maybe present among 20% of NASH patients. In patients with NASH, 57% had fibrosis and 17% had cirrhosis at the time of their initial liver biopsy and rest were normal [13]. Currently used techniques for hepatic imaging are, ultrasonography (USG), computerized tomography (CT) and magnetic resonance imaging (MRI) [14]. Liver biopsy is the most promising technique for the detection of fatty liver. However, it is invasive, painful and requires 6 hours of bed rest. It may be associated with mortality in few cases [15]. Non-alcoholic fatty liver can be graded on the basis of severity of fat deposition Minimal diffuse increase in the fine echoes where liver appears bright compared to the cortex of the kidney. However, there is normal visualization of diaphragm and intrahepatic vessel borders. Moderate diffuse increase in the fine echoes [16]. Slightly impaired visualization of the intrahepatic vessels and diaphragm [17]. Marked increase in the fine echoes, poor or no visualization of intrahepatic vessels and diaphragm and poor penetration of the posterior, segment of the right lobe of the liver Non-alcoholic fatty liver disease has emerged as the most common liver problem in the western world and is a clinic pathologic entity increasingly recognized as a major health burden in developed countries [18]. Many studies regarding risk factor on NAFLD had been conducted in India, Pakistan, China and Bangladesh However, there is no any major study done in mid-western region of Nepal regarding risk factors of non-alcoholic fatty liver disease and there is no information on the prevalence of individual risk factor of NAFLD [19]. So, this study is going to be conducted with the aim to study the risk factors of NAFLD and to study the profile of risk factors of NAFLD patients attending NGMCTH [20].

2. MATERIALS & METHOD

Hospital based observational study, the study was conducted in the Department of Internal Medicine of Nepalgunj Medical College, Teaching Hospital, Kolhapur, Nepal. Sample size calculation for qualitative variable was used. The minimum sample size to be taken was 87 cases, however, the total number of cases in our study were 90. Non-random sampling technique was applied. First 90 consecutive with clinical, biochemical and sonographer evidence of NAFLD in the study after obtaining informed consent. All the patients of age more than 18 years admitted in medical ward or attending the medicine OPD of NGMCTH diagnosed with fatty liver by USG (abdomen and pelvis) who fulfilled the inclusion criteria were enrolled and evaluated. Informed written consent was obtained and detail clinical history and physical examination was made in each patient and data were filled in preform. The collected data were edited, classified, coded and tabulated for organizing the individual piece of

information. The data was entered into Microsoft excel and analyzed in the Statistical Package for Social Sciences version 25. Different graphs and tables were made and analysis of association of variables was done by using one-way ANOVA. After the end of investigations all data were categorized and tabulated. All the risk factors categorized strictly according to the criteria outlined earlier. Incomplete data were discarded.

3. RESULTS & DISCUSSION

3.1 Results Interpretations

Total sample size was 90, the distribution of demographics of sample is given by the following graphs:

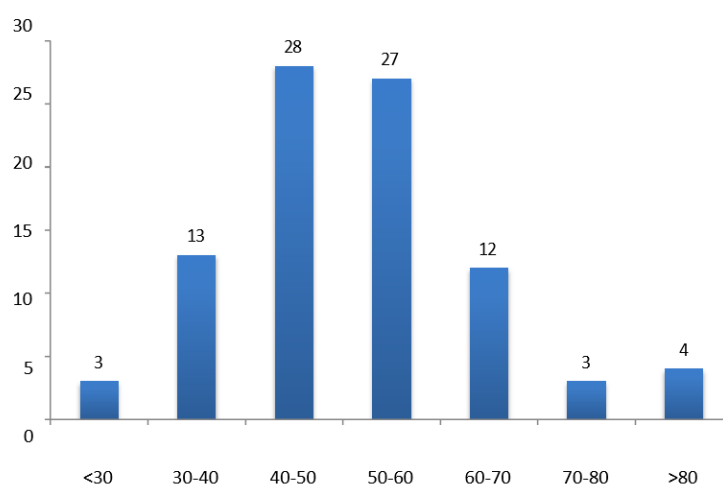


Figure 01: Distribution of Age

In this study majority of the patients were of age group 40-50 followed by 50-60 years.

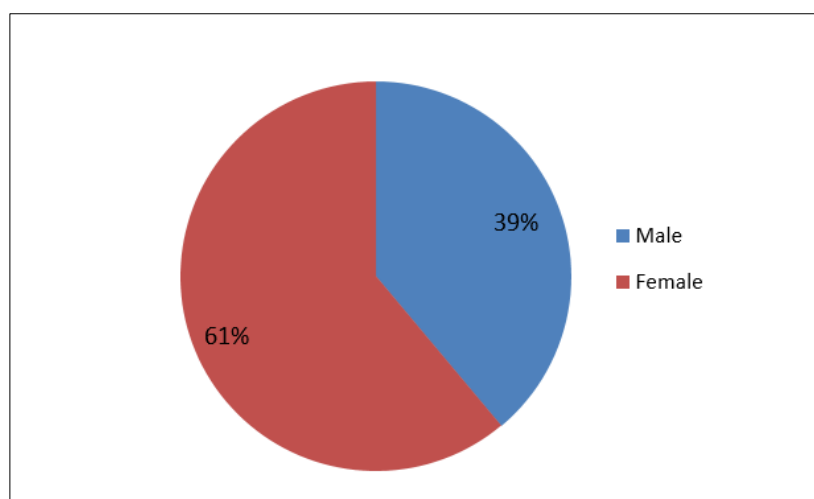


Figure 02: Gender Distribution of Study

Out of 90 patients males were 35 (38.89%) and females were 55 (61.11%) as shown in chart number 2.

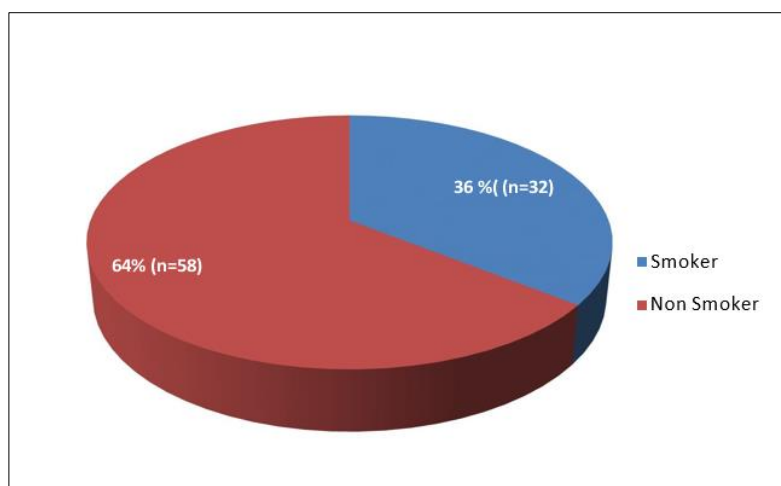


Figure 03: Smoking habit among the patients diagnosed with NAFALD

Table 4: Distribution of Body Mass Index (BMI) among patients diagnosed with NAFLD

BMI(kg/m ²)	Frequency	Percentage (%)
Underweight (<18.5)	0	0
Normal Range (18.5-22.99)	17	18.9
Overweight (23-24.99)	12	13.3
Obese Class I(25-29.99)	44	48.9
Obese Class II (>=30)	17	18.9
Total	90	100.0

Table showing majority of patients were fell in obese class I. Patients with normal BMI and class II obesity were having similar frequency. Overweight was found in 12(13.3%) cases.

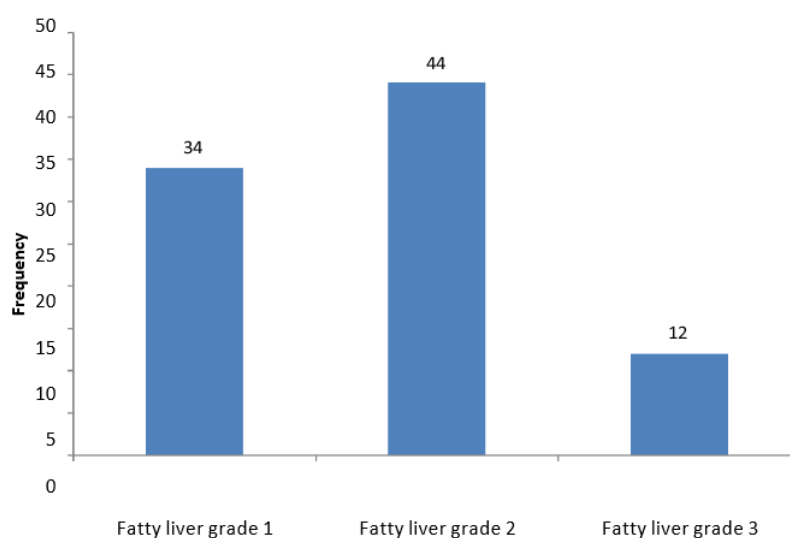


Figure 04: Distribution of different grades of NAFLD diagnosed patients

Figure showing frequency of different grade of fatty liver. Grade II fatty liver outnumber the most 44 (48.88%).

Table 5: Value of serum lipid profile among NAFLD patients

Lipid Profile	Number	Percentage (%)
LDL Cholesterol (Mean $\pm$SD : 121.26$\pm$40.33, Minimum: 50, Maximum: 225)		
Optimal (<100)	30	33.3
Near optimal (100-129)	25	27.8
Borderline high (130-159)	10	11.1
High (160-189)	21	23.3
Very high (Very high)	4	4.4
HDL Cholesterol (Mean $\pm$SD : 43.01$\pm$ 9.18, Minimum: 25, Maximum: 68)		
Low (<40)	30	33.3
Normal (40-60)	57	63.3
High ($\geq$ 60)	3	3.3
Total Cholesterol (Mean $\pm$ SD: 212.49$\pm$ 44.25, Minimum: 139, Maximum: 325)		
Desirable (<200)	43	47.8
Borderline high (200-239)	16	17.8
High ($\geq$ 240)	31	34.4
Triglycerides (Mean $\pm$ SD; 238.77 $\pm$ 53.34)	Minimum ;134	Maximum;390
Normal (<150)	10	11.11%
High ($\geq$ 150)	80	88.88%

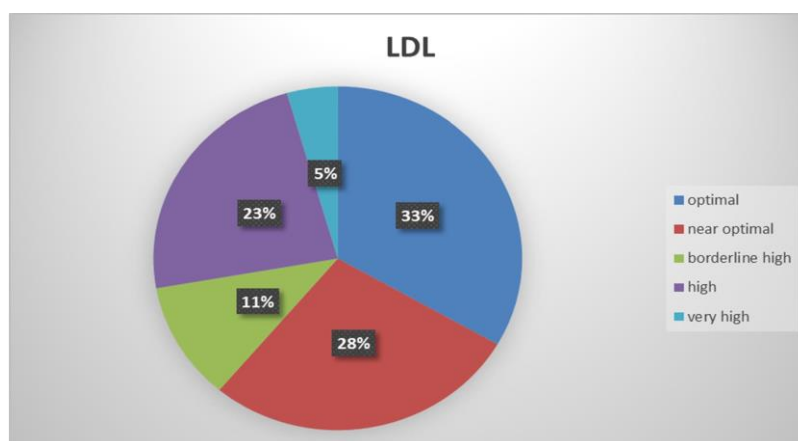


Figure 05: Distribution of Low Density Lipoprotein (LDL) in patients with NAFLD (mg/dl)

In the lipid profile report it was found that 30 patients (33.3%) had optimal LDL. LDL level was near optimal in 25 (27.8%) cases, borderline high in 10 (11.1%), high in 21 (23.3%) cases and very high in 4 (4.4%) cases.

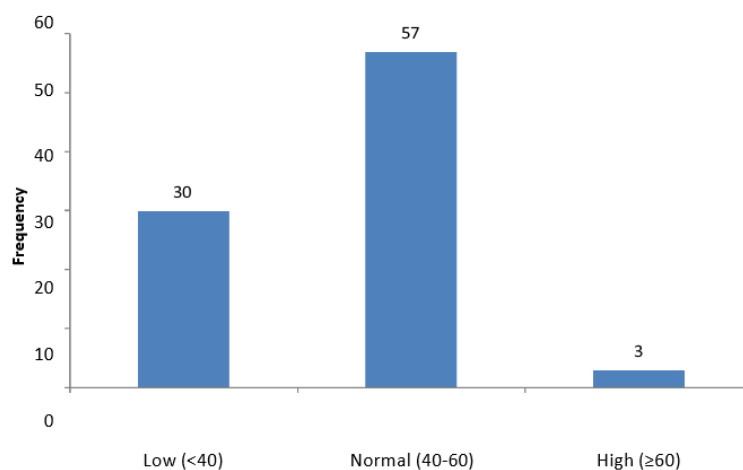


Figure 06: Distribution of High Density Lipoprotein (HDL) in patients with NAFLD (mg/dl)

Fasting lipid profile report showed that 30 patients (33.33%) had low HDL. HDL level was normal in 57 (63.33%) patients and 3 patient (3.33%) had high level of HDL.

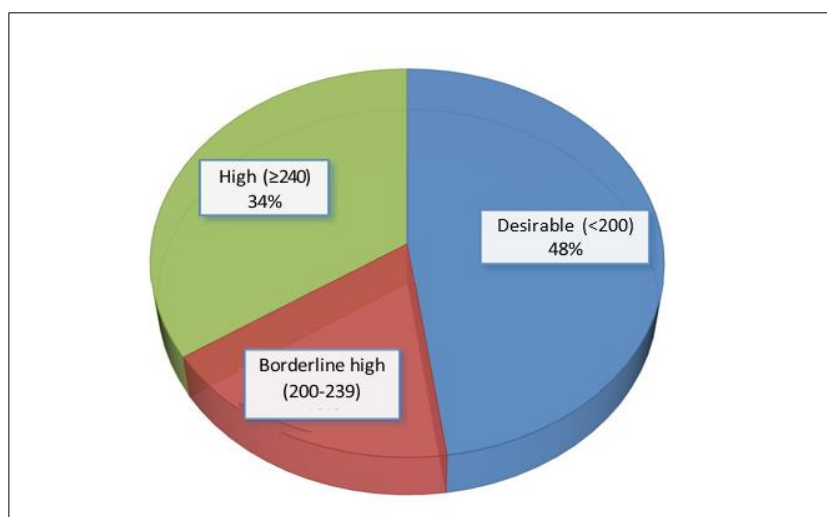


Figure 07: Distribution of Cholesterol in patients with NAFLD (mg/dl)

Out of 90 patients we found that 43 patients (47.77%) had desirable Cholesterol. 16 (17.77%) patients had borderline high cholesterol and 31 patient (34.44%) had high level of Cholesterol. It was found that 80 patients (88.88) had high Triglycerides and 10 patients (11.11%) had normal level of triglycerides.

Table 6: Relation between grading of fatty liver and Triglyceride

USG Grades	Number (%)	Mean TG	SD
Grade I	34 (37.77%)	189.50	43.63
Grade II	44 (48.88%)	264.23	33.406
Grade III	12(13.33%)	285.00	53.341

As depicted in table value of TG found increased with increase in grade of fatty liver.

Table 7: Relation between grading of fatty liver and LDL

USG Grades	Number (%)	Mean LDL	SD
Grade I	34 (37.77%)	102.99	34.55
Grade II	44 (48.88%)	126.66	41.944
Grade III	12(13.33%)	153.25	20.964

As depicted in table value of LDL found increased with increase in grade of fatty liver.

Table 8: Relation between grading of fatty liver and total cholesterol

USG Grades	Number (%)	Mean TC	SD
Grade I	34 (37.77%)	189.62	33.472
Grade II	44 (48.88%)	219.14	46.88
Grade III	12(13.33%)	252.92	17.763

As depicted in table value of Total cholesterol found increased with increase in grade of fatty liver.

Table 9: Co-morbidities associated with NAFLD

		Number (N)	Percentage (%)
DM	Yes	33	36.7
HTN	Yes	18	20.0
IHD	Yes	4	4.4
Metabolic syndrome	Yes	25	27.77

Among total 90 NAFLD patients, diabetes was more common in majorities 33(36.7%). Rest with decreasing order of frequencies were as follows. MS 25(27.77%), HTN 18(20.0%) and IHD 4(4.4%).

Table 10: ALT level

	Frequency	Percent (%)
5-40 mg/dl	31	34.4
>40 mg/dl	59	65.6
Total	90	100.0

Table 11: AST level

	Frequency	Percent (%)
5-40 mg/dl	44	48.9
>40 mg/dl	46	51.1
Total	90	100.0

Table showing value of both ALT and AST was higher among NAFLD in majorities.

Table 12: Waist Circumference in Male (n=35)

	Frequency	Percent (%)
Normal	26	74.3
Abnormal	9	25.7
Total	35	100

Table 13: Waist Circumference in Female (n=55)

	Frequency	Percent (%)
Normal	29	52.7
Abnormal	26	47.3
Total	55	100

3.2 DISCUSSION

The most common chronic liver disease in the West is nonalcoholic fatty liver disease (NAFLD), which is also rising alarmingly in South Asia, hitting an epidemic proportion of 30 percent in the last two decades due to obesity and metabolic syndrome (MS) epidemics in younger South Asians [21]. Many studies regarding risk factor on non-alcoholic fatty liver disease had been conducted in India, Pakistan, China and Bangladesh However, there is no any major study done in mid-western region of Nepal regarding risk factors of non- alcoholic fatty liver disease so this study was conducted with the aim to study the risk factors of NAFLD and to find the prevalence of individual risk factor on NAFLD in patients attending NGMCTH [22]. This study is first of its kind in this region. The information received after conducting this study will be helpful for knowledge regarding NAFLD [23]. It's a common risk factor which further might be helpful for reducing the burden of disease and its future complications [24]. The mean age of the patients in the study was 51.86 ± 12.76 years (males= 52.29 ± 13.243) years and females = 51.52 ± 12.681 years) [25]. The majority of patients 28 (31.11%) were of age group 40-50 years, followed by 27 (30.00%) patients between 50-60 years [26]. In our study minimum age of patient was 28 years and maximum age of the patient was 84 Our study is similar to the study by Medaling who quoted the largest percentage of people with fatty liver disease are in their fourth to fifth decade of life [27]. Sedentary life styles, urbanization along with Presences of co-morbidities like obesity, Diabetes and HTN further contributing the Higher frequencies [28]. Our study shows slightly female preponderance with female: male ratio of 1.57:1. Our results are comparable to other studies also [29]. Contrary to this study, Mohan showed the male preponderance (men: 35. 1% vs. women: 29.1%) and Singh also showed male preponderance where out of 632 consecutive NAFLD patients, 484 (76.6%) were males and 148 (23.4%) were females. Since, most of the males in this region have a history of significant alcohol consumption they were excluded from this study. Also NAFLD may be attributed to natural changes in female physiology, such as insulin resistance, central obesity, adipose distribution and sex hormones [30]. In our study, patients with NAFLD as per BMI grade, most fell under obese class

I 44 (48.9%), followed by 17 (18.9%) class II obesity, and 12 (13.3%) were overweight [31]. Unchill reported in their study, majority were overweight (52.8%) and 24.8% were obese. Contrary to our study the highest number of patients were in overweight group, this is because we have followed WHO Asia pacific BMI classification. There was statistically significant association between BMI and NAFLD grading. Similar results were reported by Ruhr CE where statistical significance was seen between NAFLD and BMI ($p=0.034$) [32]. Showed significant association of BMI with NAFLD. The findings in these studies correlate quite well with our study showing higher incidence of NAFLD in people with increase in BMI. In this study out of total 90 NAFLD patients we found that 32 patients (36%) were smokers and 58 patients (64%) were non-smokers [33]. Study reported significant relation between fatty liver with smoking. The fatty liver disease incidence increased significantly among the nondrinkers as the number of cigarettes smoked increased ($p = 0.001$) [34]. So Cigarette smoking may be a significant risk factor associated with NAFLD onset in nondrinkers. In our study, as per sinology report majority had grade II fatty liver 44 (48.88%), followed by grade I 34 (37.77%) then grade III 12 (13.33%). Medaling reported in his study Grade I fatty liver in 47.1%, Grade II in 42.8% and Grade III in 10%. Showed that the fatty liver grade I was observed in 55.1%, grade II in 32.7% and grade III in 12.2% of the patients. In our study greater number of cases with Grade II NAFLD might be due to late hospital presentation because of geographical and socio-economic barriers. Lack of health awareness among the population in this region prevents them from seeking medical attention early in our study, the mean value of serum triglycerides was 238.77 ± 53.34 mg/dl, LDL cholesterol was 121.26 ± 40.33 , HDL was 43.01 ± 9.18 and total cholesterol was 212.49 ± 44.25 . Our study showed that increased triglycerides was seen in 88.88%, low HDL was in 33.33%, total cholesterol was border line high in 17.8% and high in 34.4 %, and LDL Cholesterol was borderline high 11.1 %, high in 23.3% and very high in 4.4%.

4. CONCLUSIONS

According to the findings of our research, all individuals had an increase in their alanine transaminase levels, whereas 46 patients had an increase in their aspartate transaminase levels. As was the case with our own research, Sandal discovered a substantial correlation between NAFLD and ALT. The results indicated that out of a total of 90 individuals diagnosed with NAFLD, 33 patients were diabetic and 18 patients were hypertensive. A total of 25 patients had symptoms of metabolic syndrome. According to the findings of the study, the prevalence of diabetes was 48.5%, and the prevalence of hypertension was 52%. Comparable to the findings of our own research, the study found that the prevalence of metabolic syndrome in individuals with NAFLD was 32.74 percent. In addition, our paper emphasizes the connection between non-alcoholic fatty liver disease (NAFLD) and characteristics of the metabolic syndrome. According to numerous reports, nonalcoholic fatty liver disease (NAFLD) is associated with obesity, diabetes, hypertension, and hyperlipidemia. The education of patients with non-alcoholic fatty liver disease (NAFLD) about the association between metabolic syndrome and complications, as well as the possible ways to prevent these complications, such as engaging in regular physical activity, maintaining a normal body mass index (BMI) by gradually reducing their weight, and maintaining adequate control of blood pressure, sugar, and lipids, is of the utmost importance.

REFERENCES

- [1] Suárez, M., Gil-Rojas, S., Martínez-Blanco, P., Torres, A. M., Ramón, A., Blasco-Segura, P., ... & Mateo, J. (2024). Machine Learning-Based Assessment of Survival and Risk Factors in Non-Alcoholic Fatty Liver Disease-Related Hepatocellular Carcinoma for Optimized Patient Management. *Cancers*, 16(6), 1114.
- [2] AkbariRad, M., Pezeshki Rad, M., Nobakht, H., Moodi Ghalibaf, A., Firoozi, A., Torshizian, A., ... & Sadeghi, M. (2024). Prevalence, characteristics, and risk factors of non-alcoholic fatty liver disease in North East of Iran: a population-based study. *BMC gastroenterology*, 24(1), 212.
- [3] Du, X., Hu, J., Xue, J., Zhuang, Y., Tang, X., & Xu, Z. (2024). Rate and Associated Factors of Fatigue in Chinese Patients with Non-Alcoholic Fatty Liver Disease: A Cross-Sectional Survey. *International Journal of General Medicine*, 2945-2953.
- [4] Younossi, Z. M., Paik, J. M., Stepanova, M., Ong, J., Alqahtani, S., & Henry, L. (2024). Clinical profiles and mortality rates are similar for metabolic dysfunction-associated steatotic liver disease and non-alcoholic fatty liver disease. *Journal of hepatology*, 80(5), 694-701.
- [5] Souza, M., Diaz, I., Barchetta, I., & Mantovani, A. (2024). Gastrointestinal cancers in lean individuals with non-alcoholic fatty liver disease: a systematic review and meta-analysis. *Liver International*, 44(1), 6-14.
- [6] Paulino, P. J. I. V., Cuthrell, K. M., & Tzenios, N. (2024). Non Alcoholic Fatty Liver Disease; Disease Burden, Management, and Future Perspectives. *International Research Journal of Gastroenterology and Hepatology*, 7(1), 1-13.
- [7] Thomas, J. A., Kendall, B. J., El-Serag, H. B., Thrift, A. P., & Macdonald, G. A. (2024). Hepatocellular and extrahepatic cancer risk in people with non-alcoholic fatty liver disease. *The Lancet Gastroenterology & Hepatology*, 9(2), 159-169.
- [8] De, A., Bhagat, N., Mehta, M., Taneja, S., & Duseja, A. (2024). Metabolic dysfunction-associated steatotic liver disease (MASLD) definition is better than MAFLD criteria for lean patients with NAFLD. *Journal of hepatology*, 80(2), e61-e62.
- [9] Parsa, R. S. M., Aryaeian, N., Mokhtare, M., Kaviani-pour, F., Janani, L., Agah, S., & Moradi, N. (2024). The Effects of Saffron (*Crocus sativus* L) Supplementation on Cardiovascular Risk Factors, Liver Steatosis, and Fibrosis in Patients With Non-Alcoholic Fatty Liver Disease: A Randomised, Double-Blind, Placebo-Controlled Study. *Journal of Herbal Medicine*, 45, 100877.
- [10] Ruan, S., Yuan, X., Liu, J., Zhang, Q., & Ye, X. (2024). Predictors of high cardiovascular risk among nonobese patients with type 2 diabetes and non-alcoholic fatty liver disease in a Chinese population. *Diabetes, Metabolic Syndrome and Obesity*, 493-506.
- [11] Anushiravani, A., Kasaeian, A., & Oskouie, I. M. (2024). Genetic and Lifestyle Risk Factors of Metabolic Dysfunction-Associated Fatty Liver Disease and Its Relationship with Premature Coronary Artery Disease: A Study on the Pars Cohort. *Archives of Iranian Medicine*, 27(5), 248.
- [12] Raksha Rimal, Anu Kafle, Arju Sah, Ankur Bista, Anshu Yadav & Sampada Khatiwada (2024). Comparative Study of Hematological Parameters among First-Time Blood Donors & Repeat Blood Donors of Kathmandu Valley. *Dinkum Journal of Medical Innovations*, 3(04):302-312.
- [13] Dorostghol, M., Gharibvand, M. M., Hanafi, M. G., & Motamedfar, A. (2024). Comparison of size of the liver between patients with non-alcoholic fatty liver disease and healthy controls. *Journal of Family Medicine and Primary Care*, 13(2), 425-430.
- [14] Abosheaishaa, H., Hussein, M., Ghallab, M., Abdelhamid, M., Balassiano, N., Ahammed, M.

- R., ... & Nassar, M. (2024). Association between non-alcoholic fatty liver disease and coronary artery disease outcomes: A systematic review and meta-analysis. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 102938.
- [15] Wongtrakul, W., Charatcharoenwitthaya, N., & Charatcharoenwitthaya, P. (2024). Lean non-alcoholic fatty liver disease and the risk of all-cause mortality: An updated meta-analysis. *Annals of Hepatology*, 29(3), 101288.
- [16] Chen, L., Tao, X., Zeng, M., Mi, Y., & Xu, L. (2024). Clinical and histological features under different nomenclatures of fatty liver disease: NAFLD, MAFLD, MASLD and MetALD. *Journal of Hepatology*, 80(2), e64-e66.
- [17] Ebrahimzadeh, A., Mohseni, S., Safargar, M., Mohtashamian, A., Niknam, S., Bakhoda, M., ... & Sohrabi, Z. (2024). Curcumin effects on glycaemic indices, lipid profile, blood pressure, inflammatory markers and anthropometric measurements of non-alcoholic fatty liver disease patients: A systematic review and meta-analysis of randomized clinical trials. *Complementary Therapies in Medicine*, 103025.
- [18] Fukunaga, S., Mukasa, M., Nakane, T., Nakano, D., Tsutsumi, T., Chou, T., ... & Kawaguchi, T. (2024). Impact of non-obese metabolic dysfunction-associated fatty liver disease on risk factors for the recurrence of esophageal squamous cell carcinoma treated with endoscopic submucosal dissection: A multicenter study. *Hepatology Research*, 54(2), 201-212.
- [19] Sidra Liaqat & Muhammad Umar (2023). Analyzing the Durability and Efficacy of Integrating Routine Impulsive Hepatitis B and C Testing In Real-Life Situations. *Dinkum Journal of Medical Innovations*, 2(09):318-324.
- [20] Tokushige, K. (2024). New concept in fatty liver diseases. *Hepatology Research*, 54(2), 125-130.
- [21] Arafa, A., Kashima, R., Matsumoto, C., & Kokubo, Y. (2024). Fatty liver index as a proxy for non-alcoholic fatty liver disease and the risk of stroke and coronary heart disease: The suite study. *Journal of Stroke and Cerebrovascular Diseases*, 33(1), 107495.
- [22] Kanwal, F., Neuschwander-Tetri, B. A., Loomba, R., & Rinella, M. E. (2024). Metabolic dysfunction-associated steatotic liver disease: Update and impact of new nomenclature on the American Association for the Study of Liver Diseases practice guidance on nonalcoholic fatty liver disease. *Hepatology*, 79(5), 1212-1219.
- [23] Arslan, A. Y., Celik, S., Amin, F., Caylak, I., Kesapli, I., Kilic, I. B., ... & Yilmaz, Y. (2024). Prevalence, determinants, and fibrosis risk stratification of metabolic-associated fatty liver disease in a Turkish primary care setting: A retrospective study. In *Hepatology Forum* (Vol. 5, No. 2, p. 63). Turkish Association for the Study of the Liver.
- [24] Sogabe, M., Okahis, T., Kagawa, M., Sei, M., Ueda, H., Yokoyama, R., ... & Takayama, T. (2024). Association of variabilities in body mass index and waist circumference with newly achieved remission of metabolic dysfunction-associated fatty liver disease. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 18(5), 103036.
- [25] Mansour, A., Pourhassan, S., Gerami, H., Mohajeri-Tehrani, M. R., Salahshour, M., Abbasi, A., ... & Sajjadi-Jazi, S. M. (2024). Regional fat distribution and hepatic fibrosis and steatosis severity in patients with nonalcoholic fatty liver disease and type 2 diabetes. *Obesity Science & Practice*, 10(4), e777.
- [26] Moore, E., Patanwala, I., Jafari, A., Davies, I. G., Kirwan, R. P., Newson, L., ... & Lane, K. E. (2024). A systematic review and meta-analysis of randomized controlled trials to evaluate plant-based omega-3 polyunsaturated fatty acids in nonalcoholic fatty liver disease patient biomarkers and parameters. *Nutrition Reviews*, 82(2), 143-165.
- [27] Xue, Y., Peng, Y., Zhang, L., Ba, Y., Jin, G., & Liu, G. (2024). Effect of different exercise

- modalities on nonalcoholic fatty liver disease: A systematic review and network meta-analysis. *Scientific Reports*, 14(1), 6212.
- [28] Wang, S., Lin, X., Zhu, C., Dong, Y., Guo, Y., Xie, Z., ... & Chen, M. (2024). Association between nonalcoholic fatty liver disease and increased glucose-to-albumin ratio in adults without diabetes. *Frontiers in Endocrinology*, 14, 1287916.
- [29] Feng, G., Valenti, L., Wong, V. W. S., Fouad, Y. M., Yilmaz, Y., Kim, W., ... & Zheng, M. H. (2024). Recompensation in cirrhosis: unravelling the evolving natural history of nonalcoholic fatty liver disease. *Nature Reviews Gastroenterology & Hepatology*, 21(1), 46-56.
- [30] Fang, Z., Shen, G., Wang, Y., Hong, F., Tang, X., Zeng, Y., ... & Gao, G. (2024). Elevated Kallistatin promotes the occurrence and progression of non-alcoholic fatty liver disease. *Signal Transduction and Targeted Therapy*, 9(1), 66.
- [31] Yang, K., Zeng, J., Wu, H., Liu, H., Ding, Z., Liang, W., ... & Dong, F. (2024). Nonalcoholic fatty liver disease: changes in gut microbiota and blood lipids. *Journal of Clinical and Translational Hepatology*, 12(4), 333.
- [32] Younossi, Z. M., & Henry, L. (2024). Understanding the burden of nonalcoholic fatty liver disease: time for action. *Diabetes Spectrum*, 37(1), 9-19.
- [33] Mohammadian, K., Fakhar, F., Keramat, S., & Stanek, A. (2024). The Role of Antioxidants in the Treatment of Metabolic Dysfunction-Associated Fatty Liver Disease: A Systematic Review. *Antioxidants*, 13(7), 797.
- [34] Vakilpour, A., Amini-Salehi, E., Soltani Moghadam, A., Keivanlou, M. H., Letafatkar, N., Habibi, A., ... & Samethadka Nayak, S. (2024). The effects of gut microbiome manipulation on glycemic indices in patients with non-alcoholic fatty liver disease: a comprehensive umbrella review. *Nutrition & Diabetes*, 14(1), 25.
- [35] Maresca, R., Mignini, I., Varca, S., Calvez, V., Termite, F., Esposto, G., ... & Zocco, M. A. (2024). Inflammatory Bowel Diseases and Non-Alcoholic Fatty Liver Disease: Piecing a Complex Puzzle Together. *International Journal of Molecular Sciences*, 25(6), 3278.