Original Article

Pattern of Lipid Profile and Blood Pressure in Patients with Non-alcoholic Fatty Liver Disease (NAFLD)

Chowdhury MFK[1], Zaman KMU[2], Hasan MA[3], Amin MA[4], Saha KP[5], Ashrafuzzaman M[6], Islam N[7], Ghosh CK[8]

Conflict of Interest: None
Received: 06.09.2020
Accepted: 16.03.2021
www.banglajol.info/index.php/JSSMC

Abstract

Background: *Non-alcoholic fatty liver disease (NAFLD) is associated with metabolic syndrome (MS) such as hypertension, type 2 diabetes mellitus, dyslipidaemia and obesity. NAFLD is considered as hepatic manifestation of metabolic syndrome (MS).*

Objectives: *The aim of this study was to see the pattern of lipid profile and blood pressure in NAFLD patients.*

Materials and methods: *This cross sectional study was carried out in the department of gastroenterology, BSMMU, Dhaka, Bangladesh from October 2016 to March 2017. A total of 100 patients included in this study underwent abdominal ultrasonography after excluding known case of liver disease with other etiology.*

Results: *The study population were categorized as NAFLD and normal group on the basis of abdominal ultrasonography. NAFLD and normal subjects were 55% and 45% respectively. The mean age was 41.34 + 10.88 years. Male were 62% and 38% were female.40% of study subjects were overweight, 23% were obese and 37% had normal bodyweight. Body mass index (BMI) was higher in NAFLD group; 25.10 ± 1.75 vs 21.64 ± 2.62 , P < 0.001). Dyslipidemia was present in 47% of study population. Total cholesterol (TC) (195.5±45.98 vs 140.33±47.86 mg/dl, P < 0.001), Low density lipoprotein-cholesterol (LDL-C) (120.28±43.95 vs 95.15±44.90 mg/dl, P < 0.001) and Triglyceride (TG) (230.50 ± 48.96 vs 148.40±46.43 mg/dl , P < 0.001) was higher and High density Lipoprotein (HDL) (32.69±5.49 vs 39.91±5.74 mg/dl, P < 0.001) was lower in NAFLD group in comparison to normal group. Systolic and diastolic blood pressure (BP) was also significantly higher in NAFLD group (135±12 vs 121±9 mm Hg , P < 0.001) and 82±4 vs 74±3 mm Hg (P < 0.001) respectively.*

Conclusion: *Higher prevalence of dyslipidemia was found in NAFLD patients. TC, LDL-C , TG and blood pressure was significantly higher in NAFLD patient in comparison to normal group.*

Key Words:
NAFLD, Lipid Profile, Metabolic syndrome, Blood pressure.

[J Shaheed Suhrawardy Med Coll 2021; 13(1): 68-74]
DOI: https://doi.org/10.3329/jssmc.v13i1.60935

1. Dr. Md. Fazlul Karim Chowdhury, Registrar, Sheikh Russel National Gastroliver Institute and Hospital, Mohakhali, Dhaka
2. Dr. Khandkar Mahabub-Uz-Zaman, Assistant registrar, Sheikh Russel National Gastroliver Institute and Hospital, Mohakhali, Dhaka.
3. Dr. Md. Abual Hasan, Juniror consultant (Medicine), Sadar Hospital. Jhalokathi.
4. Dr. Md. Al-Amin, Assistant registrar, National Institute of Cardiovascular Disease and Hospital, Dhaka.
5. Dr. Krishna Pada Saha, Junior Consultant (Surgery), Dept. of Colorectal Surgery, BSMMU, Shahbag, Dhaka.
6. Dr. Md. Ashrafuzzaman, Junior Consultant (Medicine), Sadar Hospital, Jhenaidah.
7. Dr. Nazia Islam, Lecturer (Pathology), Shaheed Suhrawardy Medical College, Dhaka.
8. Dr. Chanchal Kumar Ghosh, Associate Professor, Department of Gastroenterology . BSMMU, Shahbag, Dhaka.

Correspondence to: Dr. Md. Fazlul Karim Chowdhury, Registrar, Sheikh Russel National Gastroliver Institute and Hospital, Mohakhali, Dhaka-1212. Mobile: 01716330906. E-mail: chanchal4234@gmail.com. ORCHID id 0000-0003-3800-187X.

Introduction

Non-alcoholic fatty liver disease (NAFLD) includes a spectrum of disorders ranging from the simple fatty liver to non-alcoholic steatohepatitis (NASH), with increasing fibrosis leading to cirrhosis and ultimately leads to hepatocellular carcinoma (HCC).[1] The prevalence of NAFLD is alarmingly growing worldwide in adult and children/adolescent populations, with a bidirectional association between NAFLD and metabolic syndrome.[2] Dyslipidaemia, Hypertension, Obesity, insulin resistance, type 2 diabetes mellitus are the most relevant metabolic conditions related to this spectrumof diseases.[1,2]

High triglyceride (TG) and low high-density lipoprotein cholesterol (HDL-C) levels predisposes patients to artherosclerosis[3]. About 20–80% of NAFLD patients also have dyslipidemia.[4] A Common change in the metabolic

profile among patients with T2DM, MS, and obesity is dyslipidemia, suggesting a close relationship between T2DM, MS, and obesity and NAFLD.NASH significantly raises the level of oxidized low-density lipoprotein cholesterol (LDL-C). High LDL-C is a well-established risk factor for arthrosclerosis.[5] The most common form of dyslipidemia in NAFLD patients is atherogenic dyslipidemia, which is characterized by hyper-triglyceridemia, low HDL-C levels, and high LDL-C levels.[6] Long standing dyslipidemia may increase the expression and activity of sterol regulatory element binding protein-1c, a transcription factor, which adversely affects the profiles of lipid and lipoprotein synthesis in the liver, including increased TG, LDL, and very low-density lipoprotein (VLDL) levels and decreased HDL-C levels.[7,8] There is a strong link between insulin resistance and metabolic dyslipidemia in T2DM. The increase of free fatty acid (FFA) flux occurs if insulin resistance develops.. The increased FFA level boosts TG and VLDL production as well as triggers oxidative stress and lipid peroxidation, all of which are closely associated with the development of NAFLD.[9,10] Consequently, this physiological dysfunction also increases the risk for atherogenesis, thereby predisposing patients to cardiovascular diseases (CVDs). In addition, circulating adipokines and cytokines as well as associated lipotoxicity, mitochondrial dysfunction, oxidative stress, and endoplasmic reticulum stress are involved in steatosis.[11]

Hypertension is one of the most common cardiovascular diseases (CVD) with increasing prevalence around the worldwide.[12] Non-alcoholic fatty liver disease has been considered as a pathological change of the liver which could be a risk factor for CVD and metabolic syndrome.[13] As an important component of the metabolic syndrome, hypertension is prevalent in patients with NAFLD.[14,15] The development of NAFLD is associated with key components of the metabolic syndrome both in adults and children. Individuals with NAFLD typically have high level of blood pressure, body mass index (BMI), waist circumference, and insulin resistance.[16] Non-alcoholic fatty liver disease (NAFLD) not only promotes the development of severe liver diseases but also the increase of blood pressure. Several studies reported that NAFLD is associated with hypertension or prehypertension among different kinds of population in various regions.[17-21]

Hypertension, a multifactorial disorder resulting from the interplay between genetic predisposition and environmental risk factors, is a growing public health problem that affects about 30% of the general population.[22] Emerging epidemiological evidence has demonstrated that about 49.5% of patients with hypertension have NAFLD, and the prevalence of hypertension is significantly higher in individuals with NAFLD than the general population.[23,24,25] NAFLD may induce multiple systemic adverse effects including inflammation, renin-angotensin system (RAS) – sympathetic nervous system (SNS) activation and insulin resistance (IR), which are critical pathophysiological mechanisms leading to the development of hypertension.[26,27] Several studies have shown that NAFLD seems to be independently associated with an increased risk of prehypertension and hypertension.[28,29,30]

This study was designed to see the pattern of lipid profile and blood pressure level among the NAFLD patients attending at a tertiary level hospital. This will help us to know the association of lipid profile abnormalities and blood pressure level, which help us for the earlier identification of dyslipidemia and hypertension and better management at early period.

Methods

This cross sectional study was carried out in the department of gastroenterology, BSMMU, Dhaka, Bangladesh, who underwent abdominal ultrasonography during the period of October 2016 to march 2017. A total of 100 patients attended at inpatient and outpatient department of gastroenterology of BSMMU were selected for the study. Body weight, height, Body mass index (BMI) was calculated for every patients. Blood pressure was measured with maintaining appropriate method. Abdominal ultrasonography, Viral markers including HBsAg, Anti HCV, abdominal ultrasonography, liver biochemical tests including ALT, AST, GGT, Serum Albumin, TSH and serum creatinine was done. Those with serological markers of hepatitis B or C virus, alcohol consumption greater than 140 g/week, known liver disease because of another etiology, history of cancer / taking chemotherapy, pregnant women, the patients taking diuretics, low dose aspirin, cyclosporine, pyrazinamide, ethambutol, allopurinol, febuxostat, known case of renal failure or gout were excluded in this study.Written informed consent were obtained from all participants.

The definition of NAFLD requires that

a. There is evidence of hepatic steatosis by ultrasonography and
b. There is no causes for secondary hepatic fat accumulation such as significant alcohol consumption[33].

Body mass index (BMI)[32] is the Weight in kilograms divided by the height in metres squared.

Normal reference range	: 18.5-24.9 kg/m^2
Over Weight	: 25-29.9 kg/m^2
Obese	: > 30 kg/m^2

For serum lipid reference level, National Cholesterol Education Programme (NCEP) Adult Treatment Panel III (ATP III) guideline has been referred.

According to NCEP-ATP III guidelines[33]

a. hypercholesterolemia is defined as total cholesterol > 200mg/dl
b. high LDL :
When value > 100 mg / dl,
c. hypertriglyceridemia as TG > 150 mg/dl
d. low HDL: when value < 40 mg/dl.

Hypertension defined as[34]

a. Grade 1 hypertension (mild) : Systolic BP 140-159 mmHg/Diastolic BP 90-99 mmHg
b. Grade 2 hypertension (moderate) : Systolic BP 160-179 mmHg/Diastolic BP 100-109 mmHg
c. Grade 3 hypertension (Severe) : Systolic BP > 180 mmHg/Diastolic BP >110 mmHg

Statistical Analysis

Numerical variables were presented as mean ± SD. Gender was expressed in male female ratio. Categorical variables were expressed in percentage. All statistical analyses were performed using SPSS version 23. Distribution of the data were tested with Shapiro Wilk test with a significance level of d" 0.05. Only Age was normally distributed. All other numerical variables were non-normally distributed. During comparison of two independent numerical variable, student's t test and Mann Whitney U test were used for normally and non-normally distributed data respectively. Two set of categorical variables were tested using Chi-Square test and Fisher's exact test. A 2-tailed value of P d" 0.05 was considered statistically significant for all analysis.

Results

A total of 100 patients were studied. Of them NFALD was diagnosed in 55% by abdominal ultrasonography (Figure 1). Mean age of the study participants was 41.34 ±10.88 years. Number of male was 1.63 times higher than female. Demographic parameters are shown in Table I. Forty seven percent of study population had one or more abnormal serum lipid parameters. BMI was higher in NAFLD group (P < 0.001). 39% of participants in NAFLD group was dyslipidemic whereas only 8% of normal group was dyslipidemic (Table II). Total cholesterol (TC), triglyceride (TG) and low density lipoprotein (LDL) was significantly higher in NAFLD group (P < 0.001). High density lipoprtein (HDL) was lower in NAFLD patients in comparison to normal group (p < 0.001) (Table III). Both the systolic and diastolic blood pressure were also higher in NAFLD group in comparison with normal group (p < 0.001) (Table IV).

Table-I

Demographic parameters (n=100)

Age (years)	
Mean ± SD	41.34±10.88
Range	20-70
Male: female	1.63:1
BMI	
Mean ± SD	25.75 ± 2.36
18.5-24.9	37%
25-29.9	40%
≥30	23%

BMI- body mass index

Table-II

Distribution of subjects according to serum lipid profile across NAFLD (n=55) and normal group (n=45).

Lipid profile status	Frequency NAFLD(%)[a]	Normal group(%)[a]	Total
Normal	16 (29.09%)	37 (82.22%)	53
Dyslipidemia	39 (70.91%)	08 (17.78%)	47
Total	55 (100%)	45 (100%)	100

Dyslipidemia was defined by presence of one or more than one abnormal serum lipid concentration

According to liver ultrasonography findings patients were categorized as Non Alcoholic Fatty Liver Disease-NAFLD (fatty liver) and normal liver

a: Represents percentage of subjects in the respective category

Table-III

Comparison of means of BMI and lipid profile parameters between NAFLD (n=55) and Normal group (n=45)

Variables	NAFLD (n=55)	Normal group (n=45)	P value*
BMI	25.10 ± 1.75	21.64 ± 2.62	<0.001
Dyslipidemia, n (%)	39 (70.91%)	8 (17.78%)	
Lipid profile parameters(mg/dl)			
TC	195.5±45.98	140.33±47.86	<0.001
TG	230.50 ± 48.96	148.40±46.43	<0.001
LDL-C	120.28±43.95	95.15±44.90	<0.001
HDL-C	32.69±5.49	39.91±5.74	<0.001

According to liver sonography findings patients were categorized as Non Alcoholic Fatty Liver Disease-NAFLD (fatty liver) and normal liver

BMI : Body Mass Index expressed in kg/m^2

TC : Total cholesterol

TG : Triglyceride

LDL-C: Low Density Lipoprotein Cholesterol.

HDL-C: High Density Lipoprotein Cholesterol.

P value d" 0.05 was considered statistically significant. Data was analyzed by 2 tailed t test

*Student's t-test was used

Table-IV

Comparison of means of systolic BP and diastolic BP between NAFLD (n=55) and Normal group (n=45)

Variables	SBP	DBP	P value*
Systolic BP (mmHg)	135±12	121±9	<0.001
Diastolic BP (mmHg)	82±4	74±3	<0.001

P value ≤0.05 was considered statistically significant. Data was analyzed by 2 tailed t test

*Student's t-test was used

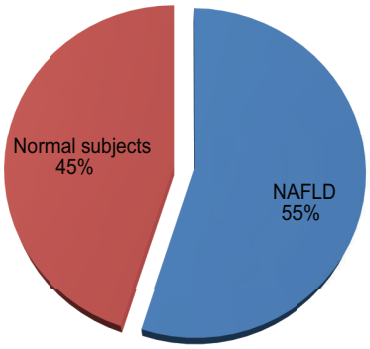

Figure1: *Distribution of patients according to liver ultrasound findings (n=100)*

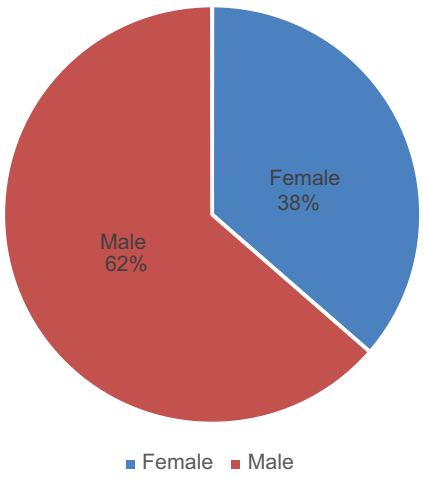

Figure 2 : *Distribution of patients by sex (n=100)*

Discussion

This hospital based observational study was undertaken to see the pattern of lipid profile and blood pressure level in NAFLD patients.A total number of 100 patients who fulfilled the inclusion and exclusion criteria attended at department of Gastroenterology during the period of October'2016 to March'2017 were enrolled in this study.

The present study findings were discussed and compared with previously published relevant studies. Most of the study subjects hailed from different districts of Bangladesh.

In this current study it was observed that the mean age was found 41.34±10.88 years with range from 20-70 years (Table-1).The majority of population were found between 36-45 years (33%). Out of this 100 subjects 62% were male and 38% were female (Figure-1). A large study (N-1320) was conducted by Kurataet al[35] in 2005 showed that the majority of population between 35-48 years there were 60% male and 40% were female.In this study out of 100 study patients 55% were found to have fatty liver on ultrasound scan of liver and they were grouped as NAFLD. 45% of respondents were normal on ultrasound scan of liver and fall in another group, termed as normal group. Among NAFLD people 35 patients (63.63%) were male and 20 patients (36.37%) were female. Among Normal subjects 27 patients (60%) were male and 18 patients (40%) were female. In a recent study Colleredoet al[36] 2003 showed 53% of study population were NAFLD and 47% of study population were normal groups .60% were male and 40% were female.

Most of the study population (40%) had BMI between 25-29.9 kg/m^2 ; 23% of study population had BMI e"30 kg/m^2.The mean BMI of NAFLD group was 25.10 ± 1.75 kg/m^2 and in normal group it was 21.64 ± 2.62 kg/m^2 (Table-3). The difference between these two groups was statistically significant (p value<0.001).Western pacific regions of WHO states that BMI>23 kg/m^2 in Asian population is associated with adverse metabolic outcome. In one study Baba et al[37] 2007 showed mean BMI of NAFLD patients were 28.30±2.96 kg/m2. Another study done by Zelber-sagiS et al[38] in 2006 showed strong association between BMI and NAFLD.

In this study, 53% had normal serum lipid profile and 47% had dyslipidemia. In NAFLD group, dyslipidemia and normal serum lipid profile status was 70.91% and 29.09%% respectively. In normal group, dyslipidemia was 17.78% and normal serum lipid profile was 82.22% (Table-2).

Result of this study showed that the level of LDL-C, total cholesterol and TG were significantly higher in NAFLD group than normal group. The mean TG level in NAFLD group was 230.50±48.96 mg/dl and in normal group the mean TG level was 148.40±46.43 mg/dl. The mean HDL-C level in NAFLD group was 32.69±5.49 mg/dl in normal group the mean HDL-C level was 39.91±5.74 mg/dl. The difference of mean between two groups was statistically significant (P value<0.001). Statistically significant difference of mean of LDL-C and total cholesterol was

also found in NAFLD group compared to normal group (Table-3).This findings were in agreement with the previous studyc onducted by Bugianesiet al[39]in 2004.

In a study conducted by Santhoshakumari et al[40] patients with NAFLD had higher TC, LDL, and TG and lower HDL as compared to the control group In another study, again mean LDL and TC was higher than the normal range among NAFLD subjects[41]. Further ,Novakovic et al.,[42] in Servia , compared chemical parameters with NAFLD and found that there is significant relationship between TG, LDL, TC and inverse relationship with HDL in the group.The study done by Pardhe[43] as well as Jain et al [44] indicated similar result.

In this study the mean systolic blood pressure in NAFLD group was 135±12 mm hg and mean diastolic blood pressure was 74±3 mm hg (Table 4). The difference between these two group was statistically significant (P value<0.001). In the present study ,the mean SBP and DBP in the NAFLD group was higher than that of normal group, where individuals with higher systolic and diastolic blood pressure indicated higher risk of developing NAFLD and a significant relationship was observed between BP and NAFLD. These findings were consistent with previous studies[45]conducted by Kleiner et.al 2005. This result was in accordance with the findings of a number of studies[40,41,43,44].

Limitations:

In this study only the ultrasonography was used to diagnose NAFLD where liver biopsy is the gold standard for this purpose. Liver biopsy was not done because of its invasiveness, risk of complications and high cost. On the other hand, abdominal ultrasonography is a non-invasive, low risk, simple, relatively low-cost ,and easily available method.

Conclusion:

Our study showed, NAFLD patients are more dyslipidemic and having higher systolic and diastolic blood pressure compared to normal population. Thus, implementation of therapeutic strategy for dyslipidemia and hypertension with lipid lowering and antihypertensive agents may mitigate the risk of CVD in NAFLD patients.

References

1 De Minicis S, Day C, Svegliati-Baroni G. From NAFLD to NASH and HCC: pathogenetic mechanisms and therapeutic insights. Curr Pharm Des 2013; 19: 5239-5249 [PMID: 23394093 DOI: 10.2174/1 381612811319290006] 2 Schwimmer JB, Deutsch R, Kahen T, Lavine JE, Stanley C, Behling C. Prevalence of fatty liver in children and adolescents. Pediatrics 2006; 118: 1388-1393 [PMID: 17015527 DOI: 10.1542/ peds.2006-1212]

2 Schwimmer JB, Deutsch R, Kahen T, Lavine JE, Stanley C, Behling C. Prevalence of fatty liver in children and adolescents. Pediatrics 2006; 118: 1388-1393 [PMID: 17015527 DOI: 10.1542/ peds.2006-1212]

3. Targher G, Day CP, Bonora E. Risk of cardiovascular disease in patients with nonalcoholic fatty liver disease. N Engl J Med 2010;363:1341–1350. doi: 10.1056/NEJMra0912063.

4. Souza MR, Diniz MF, Medeiros JE, Araujo MS. Metabolic syndrome and risk factors for non-alcoholic fatty liver disease. ArqGastroenterol 2012;49:89– 96.

5. Norris AL, Steinberger J, Steffen LM, Metzig AM, Schwarzenberg SJ, Kelly AS. Circulating oxidized LDL and inflammation in extreme pediatric obesity. Obesity 2011;19:1415–1419. doi: 10.1038/oby.2011.21.

6 .Sahebkar A1, Chew GT, Watts GF. New peroxisome proliferator-activated receptor agonists: potential treatments for atherogenic dyslipidemia and non-alcoholic fatty liver disease. Expert OpinPharmacother 2014, 15:493– 503. doi: 10.1517/14656566.2014.876992.

7. Ahmed MH, Abu EO, Byrne CD. Non-Alcoholic Fatty Liver Disease (NAFLD): new challenge for general practitioners and important burden for health authorities? Prim Care Diabetes 2010;4:129–137. doi: 10.1016/j.pcd.2010. 02.004.

8. Gawrieh S, Baye TM, Carless M, Wallace J, Komorowski R, Kleiner DE, et al. Hepatic gene networks in morbidly obese patients with nonalcoholic fatty liver disease. ObesSurg 2010;20:1698–1709. doi: 10.1007/s11695-010- 0171-6.

9. Alkhouri N, Eng K, Lopez R, Nobili V. Non-high-density lipoprotein cholesterol (non-HDL-C) levels in children with nonalcoholic fatty liver disease (NAFLD). Springerplus 2014;3:407. doi: 10.1186/2193-1801-3-407.

10. Cao W, Zhao C, Shen C, Wang Y. Cytokeratin 18, alanine aminotransferase, platelets and triglycerides predict the presence of nonalcoholic steatohepatitis. PLOS One 2013;8:e82092. doi: 10.1371/journal.pone.0082092

11. Koppe SW. Obesity and the liver: nonalcoholic fatty liver disease. Transl Res 2014, 164:312–322. doi: 10.1016/ j.trsl.2014.06.008. [26] Angulo P. Nonalcoholic fatty liver disease. N Engl J Med 2002;346:1221– 1231. [27] Speliotes EK, Massaro JM, Hoffmann U, Vasan RS, Meigs JB, Sahani DV, et al.

12. Yach D, Hawkes C, Gould CL and Hofman KJ. The global burden of chronic diseases: overcoming impediments to prevention and control. JAMA 2004; 291: 2616-2622.

13. Karbasi-Afshar R, Saburi A and Khedmat H. Cardiovascular disorders in the context of nonalcoholic Fatty liver disease: a literature review. J Tehran Heart Cent 2014; 9: 1-8.

14. Fan JG, Saibara T, Chitturi S, Kim BI, Sung JJ, Chutaputti A; Asia-Pacific Working Party for NAFLD. What are the risk factors and settings for non-alcoholic fatty liver disease in AsiaPacific? J GastroenterolHepatol 2007; 22: 794-800.

15. Friis-Liby I, Aldenborg F, Jerlstad P, Rundstrom K and Bjornsson E. High prevalence of metabolic complications in patients with non-alcoholic fatty liver disease. Scand J Gastroenterol 2004; 39: 864-869.

16. Ayonrinde OT, Olynyk JK, Beilin LJ, Mori TA, Pennell CE, de Klerk N, Oddy WH, Shipman P and Adams LA. Gender-specific differences in adipose distribution and adipocytokines influence adolescent nonalcoholic fatty liver disease. Hepatology 2011; 53: 800-809.

17. Ryoo JH, Ham WT, Choi JM, Kang MA, An SH, Lee JK, Shin HC and Park SK. Clinical significance of non-alcoholic fatty liver disease as a risk factor for prehypertension. J Korean Med Sci 2014; 29: 973-979.

18. Ryoo JH, Suh YJ, Shin HC, Cho YK, Choi JM and Park SK. Clinical association between non-alcoholic fatty liver disease and the development of hypertension. J GastroenterolHepatol 2014; 29: 1926-1931.

19. Lopez-Suarez A, Guerrero JM, Elvira-Gonzalez J, Beltran-Robles M, Canas-Hormigo F and Bascunana-Quirell A. Nonalcoholic fatty liver disease is associated with blood pressure in hypertensive and nonhypertensive individuals from the general population with normal levels of alanine aminotransferase. Eur J GastroenterolHepatol 2011; 23: 1011-1017.

20. Feng RN, Du SS, Wang C, Li YC, Liu LY, Guo FC and Sun CH. Lean-non-alcoholic fatty liver disease increases risk for metabolic disorders in a normal weight Chinese population. World J Gastroenterol 2014; 20: 17932-17940.

21. Fu JF, Shi HB, Liu LR, Jiang P, Liang L, Wang CL and Liu XY. Non-alcoholic fatty liver disease: an early mediator predicting metabolic syndrome in obese children? World J Gastroenterol 2011; 17: 735-742.

22. Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Dennison HC, DePalma SM, Gidding S, Jamerson KA, Jones DW, et al.. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines.**Hypertension**. 2018; 71:e13–e115. doi: 10.1161/HYP.0000000000

23. López-Suárez A, Guerrero JM, Elvira-González J, Beltrán-Robles M, Cañas-Hormigo F, Bascuñana-Quirell A. Nonalcoholic fatty liver disease is associated with blood pressure in hypertensive and nonhypertensive individuals from the general population with normal levels of alanine aminotransferase.Eur J GastroenterolHepatol. 2011; 23:1011–1017. doi: 10.1097/MEG.0b013e32834b8d52CrossrefMedlineGoogle Scholar

24. Feng RN, Du SS, Wang C, Li YC, Liu LY, Guo FC, Sun CH. Lean-non-alcoholic fatty liver disease increases risk for metabolic disorders in a normal weight Chinese population.World J Gastroenterol. 2014; 20:17932–17940. doi: 10.3748/wjg.v20.i47.17932 CrossrefMedline Google Scholar

25. Lorbeer R, Bayerl C, Auweter S, Rospleszcz S, Lieb W, Meisinger C, Heier M, Peters A, Bamberg F, Hetterich H. Association between MRI-derived hepatic fat fraction and blood pressure in participants without history of cardiovascular disease.**JHypertens**. 2017; 35:737–744. doi: 10.1097/H

26. Lonardo A, Nascimbeni F, Mantovani A, Targher G. Hypertension, diabetes, atherosclerosis and NASH: cause or consequence?JHepatol. 2018; 68:335–352. doi: 10.1016/j.jhep.2017.09.021CrossrefMedlineGoogle Scholar

27. Oikonomou D, Georgiopoulos G, Katsi V, Kourek C, Tsioufis C, Alexopoulou A, Koutli E, Tousoulis D. Non-alcoholic fatty liver disease and hypertension: coprevalent or correlated?Eur J GastroenterolHepatol. 2018; 30:979–985. doi: 10.1097/MEG.0000000000001191CrossrefMedlineGoogle Scholar

28. Stranges S, Trevisan M, Dorn JM, Dmochowski J, Donahue RP. Body fat distribution, liver enzymes, and risk of hypertension: evidence from the Western New York Study.Hypertension. 2005; 46:1186–1193. doi: 10.1161/01.HYP.0000185688.81320.4dLinkGoogle Scholar

29. Bonnet F, Gastaldelli A, Pihan-Le Bars F, Natali A, Roussel R, Petrie J, Tichet J, Marre M, Fromenty B, Balkau B; D.E.S.I.R., RISC Study Groups. Gamma-glutamyltransferase, fatty liver index and hepatic insulin resistance are associated with incident hypertension in two longitudinal studies. J Hypertens. 2017; 35:493–500. doi: 10.1097/HJH.0000000000001204CrossrefMedlineGoogle Scholar

30. Zhou K, Cen J. The fatty liver index (FLI) and incident hypertension: a longitudinal study among Chinese population.Lipids Health Dis. 2018; 17:214. doi: 10.1186/s12944-018-0858-6CrossrefMedlineGoogle Scholar

31. Naga Chalasani,MD,FAGG,ZobairYounossi,The diagnosis and management of NAFLD: Practice guidelines by the American association of liver diseases 2005;15:1-19.

32. P.Hanlon.M.Byere JP H.Wilding HM Macdonald 'Environmental and nutritional factors in disease' Walker BR,Colledge NR Ralston HS,ed.India:Churchill Livingstone Elsevier.pp.117.

33. http://www.nhlbi.nih.gov/guidelines/cholesterol/index.htm as visited on 01/09/2016

34. D.E.Newby,N.RGrubb,A.Bradburry'Cardiovascular Disease' Walker BR,Colledge NR Ralston HS,ed.India:Churchill Livingstone Elsevier.p

35. Kurata A, Shigematsu Y, Higaki J. Sex-related differences in relations of uric acid to left ventricular hypertrophy and remodeling in Japanese hypertensive patients. Hypertens Res 2005;28:133–9.

36. Colloredo G, Guido M, Sonzogni A, Leandro G. Impact of liver biopsy size on histological evaluation of chronic viral hepatitis: the smaller the sample, the milder the disease. J Hepatol 2003;39:239–44.

37. Baba T, Amasaki Y, SodaM, Hida A, ImaizumiM, Ichimaru S, et al. Fatty liver and uric acid levels predict incident coronary heart disease but not stroke among atomic bomb survivors in Nagasaki. Hypertens Res 2007;30:823–9

38. Zelber-Sagi S, Nitzan-Kaluski D, Halpern Z, Oren R. Prevalence of primary non-alcoholic fatty liver disease in a population-based study and its association with biochemical and anthropometric measures. Liver Int. 2006;26(7):856-63.

39. Bugianesi E, Marchesini G. Uric acid levels and liver fibrosis in nonalcoholic fatty liver disease. Hepatology 2004;39:1749.

40. Santhoshakumari TMJ, Radhika G, Kanagavalli P. A study of anthropometric and lipid profile parameters in non-alcoholic fatty liver disease patients attending a tertiary care hospital at puducherry. *IOSR J Dent Med Sci (IOSR-JDMS)* 2017;16:33–7. [Google Scholar]

41. Cuenza LR, Razon TLJ, Dayrit JC. Correlation between severity of ultrasonographic nonalcoholic fatty liver disease and cardiometabolic risk among Filipino wellness patients. *J CardiovascThorac Res*. 2017;9:85–9. [PMC free article] [PubMed] [Google Scholar]

42. Novakovic T, Mekic M, Smilic L, Smilic T, Iniæ-Kostic B, Jovicevic L, et al. Anthropometric and biochemical

characteristics of patients with nonalcoholic fatty liver diagnosed by non-invasive diagnostic methods. *Med Arch.* 2014;68:22–6. [PMC free article] [PubMed] [Google Scholar]

43. Pardhe BD, Shakya S, Bhetwal A, Mathias J, Khanal PR, Pandit R, et al. Metabolic syndrome and biochemical changes among non-alcoholic fatty liver disease patients attending a tertiary care hospital of Nepal. *BMC Gastroenterol.* 2018;18:109. [PMC free article] [PubMed] [Google Scholar]

44. Jain P, Parate R, Dubey T, Jain R. Prevalence of NAFLD (non-alcoholic fatty liver disease) in metabolic syndrome and their correlation with various biochemical and serologic parameters for early detection and detecting patients of lean Nash (Non-alcoholic steatohepatitis) *Prevalence.* 2018;3:24–8. [Google Scholar]

45. Kleiner DE, Brunt EM, Van Natta M, Behling C, Contos MJ, Cummings OW, et al. Design and validation of a histological scoring system for nonalcoholic fatty liver disease. Hepatology 2005;411:313.