Epidemiologic Profile and Predictors of Fatty Liver (A Hospital-Based Study)

Abstract:

Background: Non-alcoholic fatty liver is the most common cause of chronic liver disease with increasing prevalence globally. Settings and design: The current study is an analytical case control study; conducted in ultrasonography outpatient clinic of Cairo University Hospital. Material and **Methods:** 150 consented fatty liver cases and 564 controls were screened for fatty liver infiltration using abdominal ultrasonography. Receiver Operating Characteristics (ROC) curve analysis was performed to explore the discriminant ability of the developed model.

Results: Among cases: 32.7%, 36% and 31.3% had mild, moderate and severe degree of fatty liver respectively. Cases showed significantly higher body mass index(BMI), waist circumference (WC), total cholesterol, triglyceride, low density liportein (LDL), and lower high density lipoprotein (HDL) than controls. Cases demonstrated higher prevalence of hypertension(11.3%vs 8.3% respectively), and significantly higher prevalence of diabetes(22% vs. 9.2%)(p=0.03).Severe fatty liver cases were significantly older and had significantly higher WC , BMI, significantly higher association with diabetes mellitus, significantly higher levels of total cholesterol, triglycerides and LDL than non-severe degree cases**.** The significant predictors of sever fatty liver were BMI, total cholesterol and LDL (P = <0.001, R^2 = 0.543).

Conclusion: The developed regression equation expressed good validation and calibration. It utilizes an algorithm that can quickly and easily address patients with of fatty liver. It would useful as a fast, inexpensive primary screening tool for severe fatty liver.

Key words: Fatty liver; predictors; regression model; algorithm

Introduction:

Non-alcoholic fatty liver disease (NAFLD) is the excessive accumulation of fat (steatosis) in ≥5% of hepatocytes in individuals who consume little or no alcohol. Steatosis eventually leads to cellular stress, injury and apoptosis [1]. It is a major cause of morbidity and mortality. It is the most common cause of chronic liver disease in many parts of the world and is a leading cause of liver transplant in the US. Its incidence and prevalence are rising globally parallel to the increasing rates of obesity and diabetes. It is associated with other components of the metabolic syndrome [2].

NAFLD affects about one third of the US general population. The prevalence in Europe, Middle East and Japan ranges from 20% to 30%.In China, the prevalence is 15–30%, and in India is16% to 32% [1]; however, limited data is available on the prevalence of NAFLD in Africa. A Nigerian study estimated the prevalence to be 9% [3]. In Egypt, a hospital-based study in Alexandria concluded that Fatty liver was prevalent in schoolchildren (15.8%) [4], also NAFLD was found in 52.17% of polycystic ovary syndrome (PCOS) patients [5].

It is now a global public health problem that requires the attention of policy makers to set plans for its prevention and control in countries where the prevalence is increasing [6].

The spectrum of pathologic changes in the liver ranges from simple steatosis to nonalcoholic steatohepatitis (NASH), early fibrosis, cirrhosis and may progress to hepatocellular carcinoma (HCC). It is the third most common risk factor for HCC after viral infection and alcohol [7].

Liver biopsy is a gold standard technique for diagnosis of hepatic steatosis. However, it cannot be used for screening due to its invasiveness and sampling risks. it is indicated after a diagnosis is established by non-invasive techniques. [8].

Controlled attenuation parameters (CAP) measured using transient elastography is a non invasive tool for the diagnosis and grading of hepatic steatosis. However, Its use as a screening tool is limited due to the high cost and limited availability [8]

Trans-abdominal ultrasound is commonly used imaging technique for fatty liver diagnosis. This is because it is an available, non-invasive and a low cost technique [9]. At ultrasonography, the diffuse fatty liver is characterized by hyper echogenicity of the liver parenchyma relative to the adjacent right kidney or spleen (so-called bright liver) [10]. Other features of fatty liver described by ultrasound are decreased visualization of vascular margins, attenuation of the ultrasound beam, loss of definition of the diaphragm, and hepatomegaly [11].

On the other hand, there are several limitations of ultrasonography that include its inability to distinguish between diffuse and focal hepatic steatosis. In addition, it is not a quantitative method, so it is not possible to distinguish between simple steatosis, advanced fibrosis, and early cirrhosis. It is limited by abdominal gas and body habitus, and it is non reproducible as it is operator dependent[12].

Despite the enormous work and resources spent on the study of NAFLD, no effective treatment is currently available [2].Therefore, it is essential to explore its epidemiological features and potentially preventable risk factors. Although screening is crucial especially in communities at risk, yet the high cost of testing, the risk of liver biopsy, and the low predictive value for non-invasive tests should be considered [13].

In the light of the information mentioned above, it is clear that a noninvasive, reliable, fast, and inexpensive tool for screening and staging of fatty liver is urgently needed. It would be useful particularly in clinics where ultrasound and or specialist is not available.

Patients and methods:

Study design: A hospital based case control analytical study.

Study setting: This study was conducted in ultrasonography outpatient clinic (under the supervision of Tropical Medicine Department) of Cairo University (Kasr-Alainy) Hospital.

Study period: from October 2013 till March 2016

Participants:

A- Cases

Eligibility criteria:

Inclusion criteria:

All attendants of the clinic who were confirmed to fulfill the criteria of bright liver through abdominal ultrasound were included.

Exclusion criteria:

-Patients with advanced comorbidities e.g., heart disease, renal failure.

- Patients with advanced hepatic disease (chronic hepatitis B or C were excluded to avoid any confounding factors.

-Patients with significant alcohol consumption (more than once per day for women, and more than twice per day for men)

- Patients receiving any medications that may induce hepatic steatosis.

B- Controls: Healthy relatives (as proved by abdominal ultrasonography) of the study participants; who approved to participate in the study. They matched to cases as regards age and sex.

Sampling:

Sampling type was non-probability purposive sampling including all patients that fit the criteria of fatty liver as detected by ultrasonography. In order to minimize variation in scans interpretation , and to ensure consistency, the same expert Tropical Medicine consultant performed and graded all the scans. The average number of patients detected to have fatty liver by the same consultant was three patients per week; accordingly, this sample was collected over a period of two years as the ultrasound list was assigned every other week for the same Tropical Medicine consultant. A total of 150 patients were recruited to the study. Individuals who proved free from any fatty liver infiltration were recruited as the control group with a total of 564 cross matched controls.

Study tools:

1- An interview questionnaire was designed to collect data. The questions were close ended and were pre-coded prior to data collection to facilitate data entry and analysis. It included socio-demographic data, smoking history, and history of co-morbidities.

2- Anthropometric assessment included:

The weight that was measured in kilograms using traditional (non-digital weighing scale).

The height which was measured in meters using full length stadiometer.

BMI was calculated as follows :BMI = $\frac{Weight\ (Kg)}{Height\ (m)^2}$. BMI was interpreted according to CDC 2015[14] .

3- Blood pressure was measured using mercury Sphygmomanometer. Blood pressure was interpreted according to Mayo clinic 2015 [15] .

4- Biochemical tests: All patients were subjected to measurements of:

Liver enzymes: aspartate aminotransferase (AST), and alanine aminotransferase (ALT). The cutoff points for normal liver enzymes were interpreted according to Mayo clinic 2015[16].

Lipid profile: triglycerides, total cholesterol, low density lipoprotein (LDL) and high density lipoprotein (HDL) were measured in (mg/dL). The cutoff points were interpreted according to Mayo clinic 2017 [17].

Virology markers: hepatitis B virus surface antigen (HBs Ag), HBV core antibody (HBc AbIg G) and hepatitis C virus antibodies (HCV Abs) (+VE/-VE).

Radiological investigations:

All participants were screened for fatty liver infiltration by abdominal ultrasonography (Famio5 TOSHIBA). The patients with fatty liver were classified into three groups according to the degree of their liver ultrasound echogenicity;

(1) The mild fatty liver was defined as a slight increase in liver echogenicity and the relative preservation of echoes from the walls of the portal vein.

(2) The moderate fatty liver was defined as moderate loss of echoes from the walls of the portal vein, particularly from the peripheral branches, and moderate diffuse abnormally bright echoes.

(3) The severe fatty liver was defined as a greater reduction in beam penetration, loss of echoes from most of the portal vein wall, and extensive, abnormally bright, echoes[18]. Beside hepatic echo pattern, liver size was also determined in addition to the other hepatic findings.

Data management and analysis:

All collected questionnaires were revised for completeness and consistency. Pre-coded data was entered on the computer using "Microsoft Office Excel Software" program for windows version 2010. Data was then

transferred to the Statistical Package of Social Science Software program, version 23 (SPSS) for statistical analysis.

Qualitative data was summarized using frequency and percentage, while quantitative data was checked for normality using Kolmogorov Smirnov test. Then normally distributed data was summarized using mean ± standard deviation and data that was not normally distributed was summarized using median and interquartile range (IQR).

Cases of fatty liver were classified into severe group vs. non severe group (mild and moderate fatty infiltration) for better comparison.

Comparison between groups was done using independent sample t-test for parametric quantitative data or Mann Whitney for non-parametric quantitative data, and Chi square test for qualitative variables. The logistic regression model was conducted to explore the significant predictors of fatty liver as well as sever form of fatty liver infiltration. Receiver Operating Characteristics (ROC) curve analysis was performed to explore the discriminant ability of the developed model. P values equal to or less than 0.05 were considered statistically significant. Graphs were used to illustrate some information.

Results:

The basic characteristics of the studied group were demonstrated in table 1, they include socio-demographic profile of both cases and controls. Age, sex and residence matching were obvious with no significant difference between cases and controls (p= 0.3, 0.9 and 0.3 respectively. An anthropometric assessment showed that cases exhibited significantly higher BMI and waist circumference (p<0.001**)**. Hypertension was more prevalent among cases than controls (11.3% vs. 8.3%); however no significant difference was detected. On the other hand, blood pressure measurement demonstrated a significant difference in both systolic and diastolic measurements being highest in cases but still within normal values. Diabetes mellitus was significantly more prevalent among cases than controls (22% vs. 9.2%) that was reflected on significantly elevated fasting blood sugar among them (p=0.03). Despite of that, the mean FBS among cases was in the normal range. Nearly one third of the cases had hepatomegaly, three cases suffered from splenomegaly and nine cases had calcular gall bladder. More than one third of cases had a moderate form of fatty infiltration (36%) as shown in figure 1. Studying lipid profile of recruited population revealed a significantly higher level of total cholesterol, triglyceride, and LDL (p<0.001) as well as a significantly lower level of HDL (p<0.001). Although a significant difference was detected as regards ALT level being highest among cases, it is still within normal range with a median and interquartile ranges of 27 (21 - 35) vs. 24 (18 - 31.5).Normal level of AST was observed among both groups.

The backward stepwise logistic regression model was demonstrated in table 2. The last step revealed that only BMI, systolic blood pressure, total cholesterol, triglycerides, LDLand HDL were the actual significant predictors for severe fatty liver (X^2 = 534.5,df= 6, P = <0.001, R^2 = 0.527).The model equation will be

Logit (P of fatty liver) =-30.818 + 0.679 (BMI) + 0.044 (SBP) + 0.014 (T. cholesterol) + 0.023 (Triglycerides) + 0.047 (LDL) - 0.110 (HDL)

ROC (receiver operating characteristics) curve analysis was performed to explore the discriminant ability of the predicted probability in differentiating fatty liver ; it revealed that area under the curve (AUC) was 0.979 with 95% CI (0.967 – 0.990). This means that the model equation expresses good discrimination.

The most suitable cut-off point in the predicted probability was 0.212 or more with sensitivity 92.7% (87.3-96.3), Specificity 94.0% (91.7-95.8), PPV 80.4% (74.6-85.0), and NPV 98.0% (96.5-98.8).

Comparing sever form of fatty liver versus other forms was presented in table 3. Among the socio-demographic characteristics only age was significantly different. Severe infiltration was more obvious with older age. The anthropometric assessment showed that severe cases exhibited significantly higher BMI and waist circumference than other forms (p<0.001& 0.007 respectively**)**. Hypertension was more prevalent among severe cases than other forms (14.9% vs. 9.7%); however no this difference was not statistically significant. Also, blood pressure measurement demonstrated no significant difference in both systolic and diastolic measurements which were within normal values. Diabetes mellitus was significantly more prevalent among severe cases than other forms (31.9% vs. 17.5%). Nearly half of the severe cases had hepatomegaly, 2 cases suffered from splenomegaly and all patients who had calcular gall bladder were belonging to non severe degree groups. Lipid profile analysis of patients revealed a significantly higher level of total cholesterol, triglyceride, and LDL (p<0.001), with lower , but not significant HDL level (p<0.08). Also, no significant difference was detected as regards ALT level and AST level in both groups (p= 0.9 and 0.7 respectively).

The backward stepwise logistic regression model was presented in table 4. The significant predictors of sever fatty liver were only BMI, Total cholesterol and LDL (X^2 = 117.5,df= 3, P = <0.001, R^2 = 0.543). The model equation will be

Logit (P of severe) =-25.717 + 0.440 (BMI) + 0.031 (T. cholesterol) + 0.023 (LDL)

ROC (receiver operating characteristics) curve analysis was performed to explore the discriminant ability of the predicted probability in differentiating severe fatty liver, it revealed that area under the curve (AUC) was 0.966 with 95% CI (0.941 – 0.990). This means that the model equation expresses good discrimination.

The most suitable cut-off point in the predicted probability was 0.236 or more with sensitivity 95.7% (85.5-99.5), Specificity 88.3% (80.5-93.8), PPV 78.9% (66.1-88.6), and NPV 97.8% (92.4-99.7).

Discussion:

In the current study, age was a significant risk factor for higher grades of fatty liver. This may be due to long duration of exposure to unhealthy dietary and life style factors. Similarly findings were reported by other studies [18,19, 20,21]. Contrary to that, other studies concluded that age was a non-significant predictor for fatty liver [22,23]. The discrepancy of age association with high prevalence of NAFLD as well as its complications may be attributed to the duration of disease rather than age.

Metabolic syndrome components are strongly associated NAFLD is [2].This was noticed in the current study. BMI and WC showed significantly higher mean values among cases than controls. It is noteworthy to mention that the mean BMI among all cases of NAFLD in the current study was in the obesity category (33.3 ± 4.3 Kg/m^2). Similar findings were reported by other studies such as the Egyptian study conducted by Hegazy and Mostafa, where the BMI in NALFD and NASH patients were in the obese category[24]. Similarly, Fu and colleagues concluded that overweight and obese persons had a high probability to develop fatty liver than subjects with normal BMI [25].On the contrary, a Japanese study found lower BMI among fatty liver patients [22]. This discrepancy may be due to demographic and dietary differences between Egyptian and Japanese population.

Additionally, this study's participants with severe fatty liver showed significantly higher WC, weight and BMI than those with non severe forms of the disease. This coincides with a study performed by Lin and colleagues, where BMI was found to be a significant independent predictor for different grades of fatty liver [18].

Furthermore, it was noticed that cases of NAFLD in the current study demonstrated statistically significant higher levels of lipid profile parameters compared to their matching controls. However, triglycerides and LDL levels among cases were the only two parameters in lipid profile that exceeded the cut off limits of Mayoclinic recommendations [17].

Comparing the lipid profile parameters among the different grades of fatty liver, it was noticed that participants with severe fatty liver demonstrated elevated and statistically significant higher levels of total cholesterol, triglycerides and LDL compared to participants with non-severe fatty liver. However, LDL levels

were above the recommendations in both groups. Also, HDL level was below the recommendations and lower among cases with severe fatty liver than those with non-severe forms. Similar findings were reported in another study; where elevated total cholesterol level, triglycerides and LDL, and decreased HDL were significantly associated with higher degree of fatty liver, but only total cholesterol and triglycerides were the independent predictors [18]. Also, high total cholesterol and triglycerides were associated with the development of NAFLD [22].

Liver biopsy is the gold standard for the diagnosis of NAFLD, but it is an invasive technique that can cause complications [26]. Ultrasound is an available accurate technique [27].In addition; laboratory and clinical parameters are not always consistent. About 70% of patients with NASH and significant fibrosis show normal liver enzymes **[28].** Furthermore, NAFLD is not necessarily accompanied by obesity and metabolic syndrome **[29].**

A reliable, non invasive tool for screening and staging of NAFLD is thus urgently needed. The current study utilizes an algorithm that can quickly and easily address patients with severe degrees of fatty liver. It would be useful as a primary screening tool for severe fatty liver that is fast and inexpensive; especially in clinics where ultrasound or a specialist are not available

Since bright liver is considered a silent precursor for a wide variety of non-communicable diseases like metabolic syndrome, liver cirrhosis and cancer liver, it is better to pick up those at risk as early as possible with a simple, fast and reliable tool to be adjusted for prompt treatment before permanent disorders occur. The current study provides an easy, simple and quick algorithm to predict higher degrees of fatty liver without the need for any trained personnel or advanced techniques. It is of a high predictive power with a coefficient of determination (R^2 = 0.543) despite using only three variables (BMI, total cholesterol and LDL) i.e. about fifty four percent of variability of occurrence of bright liver was explained by these three variables. In addition to that, the algorithm also reported high validity parameters in predicting bright liver (sensitivity 78.7%, specificity 94.2%, PPV 86.0%, NPV 90.7% and accuracy 89.3%). The area under the ROC curve was also so high (0.966 95% CI 0.941-0.990) with most suitable cut-off point ≥ 0.236 with sensitivity 95.7%, specificity 88.3%, PPV 78.9%, NPV 97.8% and accuracy 90.7%

Four other algorithms using biochemical and demographic parameters to assess liver steatosis are the SteatoTest [30], the Fatty Liver Index [31],Lin, et al Index [18] and Bedogni, et al Index [32].

In contrast to the Steato Test and Fatty Liver Index, the algorithm used in the current study was developed with data from fatty liver of apparently healthy participants and was intended for prediction of severe

stages of hepatic steatosis. Although its defect in predicting mild and moderate steatosis, it had a reasonable predictive power for the presence of severe steatosis. Lin et al Index was developed for predicting moderate to severe degrees of fatty liver, but had a sensitivity of 70.8%, a specificity of 85.2%, a PPV of 63.2%, and a NPV of 88.8% [18].

Conclusion: The current study provides an easy, simple and quick algorithm to predict higher degrees of fatty liver. It is of a high predictive power with a coefficient of determination (R^2 = 0.543) despite using only three variables (BMI, total cholesterol and LDL) i.e. about fifty four percent of variability of occurrence of bright liver was explained by these three variables. In addition to that, the algorithm also reported high validity parameters in predicting bright liver (sensitivity 78.7%, specificity 94.2%, PPV 86.0%, NPV 90.7% and accuracy 89.3%). The area under the ROC curve was also so high (0.966 95% CI 0.941-0.990) with most suitable cut-off point ≥ 0.236 with sensitivity 95.7%, specificity 88.3%, PPV 78.9%, NPV 97.8% and accuracy 90.7%.The method described in the current study utilizes an algorithm that can quickly and easily address patients with higher degrees of fatty liver.

Recommendations: Enhancing "Health Literacy" of the public is recommended as well as periodic screening of at risk groups for early detection of modifiable risk factors of fatty liver disease. Additionally, people with diabetes are advised to properly control their metabolic parameters .Further research is recommended in order to validate the algorithm developed in the current study on a large scale before dissemination to the outpatient clinics as an easy, non-invasive, applicable and accessible screening tool, especially when abdominal ultrasonography and or experts are not available.

Ethical consideration:

Administrative issues: This study was approved from both Public Health and Tropical Medicine Departments through Department Council meeting on July and August 2013 respectively. Approval from the ethical committee of Public Health Department was obtained as well.

Informed consent: The study was conducted after explaining the study objectives to the patients. Only those who agreed were included in the study. Verbal consents were obtained from all the study participants before starting to collect data. Confidentiality of obtained information was ensured. All subjects were treated according to the Helsinki Declaration of biomedical ethics [33].

Limitations of the study:

Inability to perform liver biopsy due to ethical consideration as this invasive maneuver needs strict indications and certain precautions.

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COMPETING INTERESTS: the authors declare no conflict of interest

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354 **Tables and graphs:**

355 **Table (1): Basic characteristics of the studied population**

Characteristics	Cases (150)	Control(564)	P value
Socio-demographic			
Age (years)	46.8 ± 9.1	46 ± 8.9	0.306*
Sex			
Male	58 (38.7)	219 (38.8)	0.971#
Female	92 (61.3)	345 (61.2)	
Residence			
Urban	131 (87.3)	472 (83.7)	0.273#
Rural	19 (12.7)	92 (16.3)	
Anthropometric measurement			
BMI (Kg/m^2)	33.3 ± 4.3	26.4 ± 2.8	**<0.001***
Waist circumference (cm)	109.6 ± 9.1	92.7 ± 12.2	**<0.001***
Co-morbidities			
Smokers	27 (18)	139 (24.6)	0.087#
Hypertension	17 (11.3)	47 (8.3)	0.253#
Systolic blood pressure (mmHg)	129.1 ± 18.1	118.4 ± 12.1	**<0.001***
Diastolic blood pressure(mmHg)	81.3 ± 12.3	79 ± 8.1	**0.026***
Diabetes mellitus	33 (22)	52 (9.2)	**<0.001#**
Sonographic findings			
Hepatomegaly	47 (31.3)	0 (0)	**<0.001#**
Laboratory investigation			
Total cholesterol (mg%)	199 ± 69.8	143.1 ± 30.1	**<0.001***
Triglycerides (mg%)	154.7 ± 55.8	102.7 ± 26.3	**<0.001***
LDL (mg%)	139 ± 40	89.3 ± 19.6	**<0.001***
HDL (mg%)	45.2 ± 9.8	56.7 ± 12.8	**<0.001***
Fasting blood sugar (mg%)	103.4 ± 34	96.8 ± 22.7	**0.027***
ALT (IU/L)	27 (21 - 35)	24 (18 - 31.5)	**0.011@**
AST (IU/L)	29 (22 - 37)	28 (22 - 36)	0.127@

*independent sample t-test, @Mann Whitney test, #Chi square test, qualitative variables described as n (%), quantitative variables described as mean ± standard deviationor median(interquartile range), LDL= Low-density lipoprotein, HDL= High-density lipoproteins, BMI= body mass index,ALT=Alanine Aminotransferase, and AST= Aspartate Aminotransferase

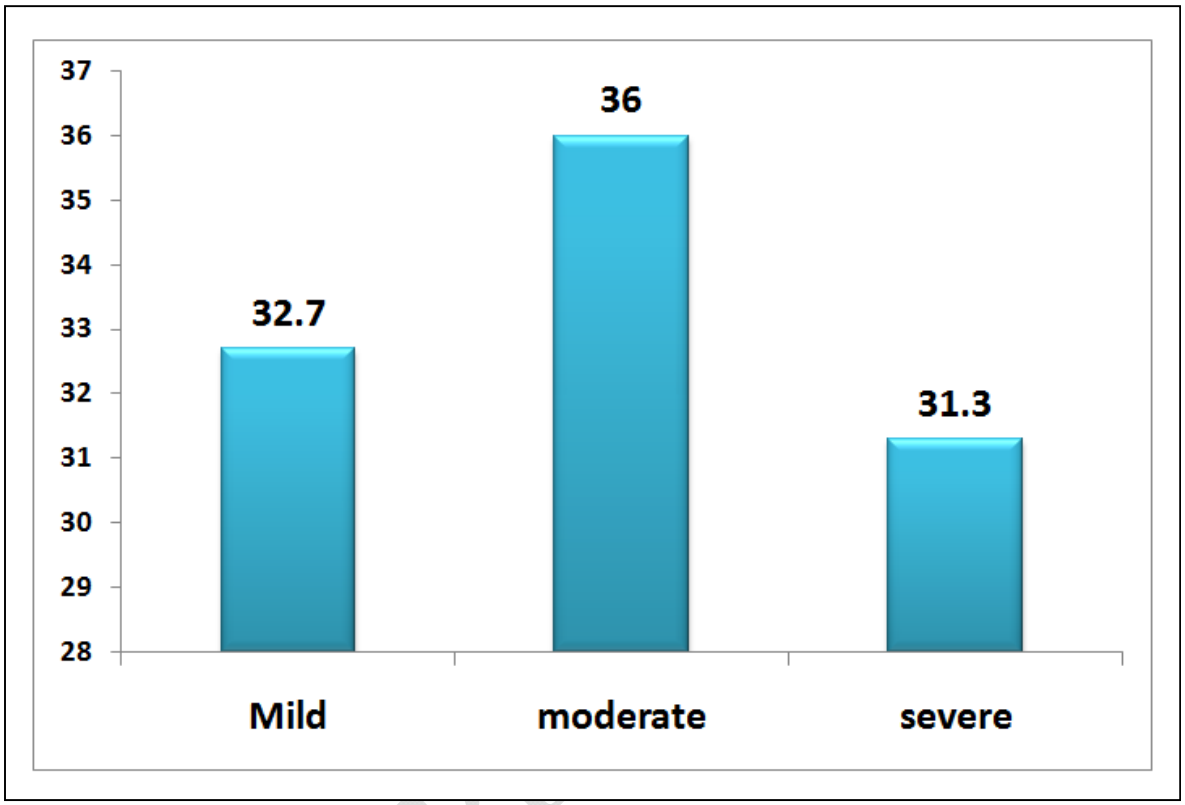

Figure (1): Percent distribution of fatty liver degrees among cases

Table (2): significant predictors of fatty liver

	OR	95% CI for OR	P value
BMI (Kg/m^2)	1.972	1.603-2.425	<0.001
Systolic blood pressure (mmHg)	1.045	1.021-1.070	<0.001
Total cholesterol (mg%)	1.014	1.002-1.026	0.018
Triglycerides (mg%)	1.023	1.008-1.038	0.003
LDL (mg%)	1.048	1.029-1.068	<0.001
HDL (mg%)	0.896	0.856-0.938	<0.001

LDL= Low-density lipoprotein, HDL= High-density lipoproteins,BMI= body mass index, OR= odds ratio, CI= confidence interval

366 **Table (3): Comparison between severe degree of fatty liver versus other degrees**

	Severe Fatty liver (n=47)	**Non-Severe Fatty liver (n=101)**	**P value**
Socio-demographic characteristics			
Age (years)	49.5 ± 8.4	45.6 ± 9.2	**0.016***
Sex			
Male	18 (38.3)	40 (38.8)	0.950#
Female	29 (61.7)	63 (61.2)	
Residence			
Urban	41 (87.2)	90 (87.4)	0.980#
Rural	6 (12.8)	13 (12.6)	
Anthropometric measurement			
BMI (Kg/m^2)	37.2 ± 3	31.5 ± 3.6	**<0.001***
Waist circumference (cm)	114.6 ± 7.9	107.7 ± 8.9	**0.007***
Co-morbidities			
Smokers	6 (12.8)	21 (20.4)	0.260#
Hypertension	7 (14.9)	10 (9.7)	0.353#
Systolic blood pressure (mmHg)	129.7 ± 18.7	128.8 ± 18	0.780*
Diastolic blood pressure(mmHg)	81.2 ± 11.9	81.4 ± 12.5	0.935*
Diabetes mellitus	15 (31.9)	18 (17.5)	**0.048**#
Sonographic findings			
Hepatomegaly	23 (48.9)	24 (23.3)	**0.002**#
Calcular Gall bladder	0 (0)	9 (8.7)	0.057#
Splenomegaly	2 (4.3)	1 (1)	0.231#
Laboratory investigation			
Total cholesterol (mg%)	265.4 ± 76.4	168.7 ± 39.1	**<0.001***
Triglycerides (mg%)	212.9 ± 66.1	128.2 ± 17.3	**<0.001***
LDL (mg%)	167.1 ± 34.5	126.1 ± 35.7	**<0.001***
HDL (mg%)	43.2 ± 9.3	46.2 ± 9.9	0.081*
Fasting blood sugar (mg%)	107.6 ± 36.2	101.5 ± 33	0.311*

ALT (IU/L)	27 (18 - 35)	27 (21 - 34)	0.913@
AST (IU/L)	28 (21 - 38)	29 (23 - 37)	0.703@

*independent sample t-test, @Mann Whitney test, #Chi square test, qualitative variables described as n (%), quantitative variables described as mean ± standard deviationor median(interquartile range), LDL= Low-density lipoprotein, HDL= High-density lipoproteins, BMI= body mass index, ALT=Alanine Aminotransferase, and AST= Aspartate Aminotransferase

Table (4): significant predictors of severe form of fatty liver

	OR	95% CI for OR	P value
BMI (Kg/m2)	1.553	1.269-1.899	<0.001
Total cholesterol (mg%)	1.032	1.016-1.048	<0.001
LDL (mg%)	1.023	1.007-1.040	0.006

LDL= Low-density lipoprotein, OR= odds ratio, CI= confidence interval

The model equation will be

Logit (P of severe) =-25.717 + 0.440 (**BMI**) + 0.031 (**T. cholesterol**) + 0.023 (**LDL**)

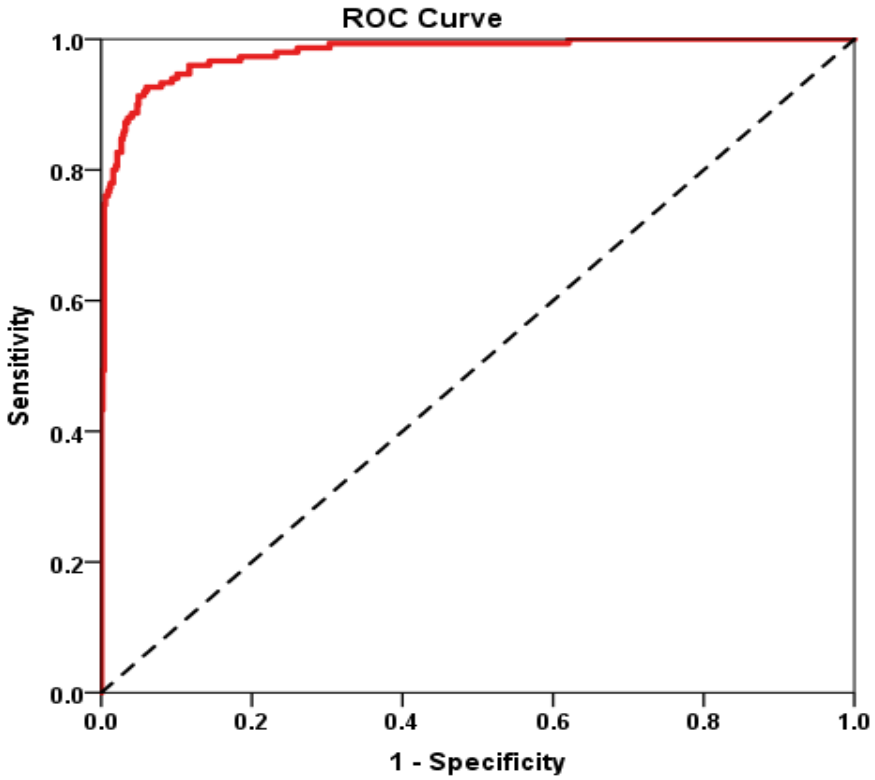

Figure (2a): ROC curve for the predicted probability to discriminate fatty liver

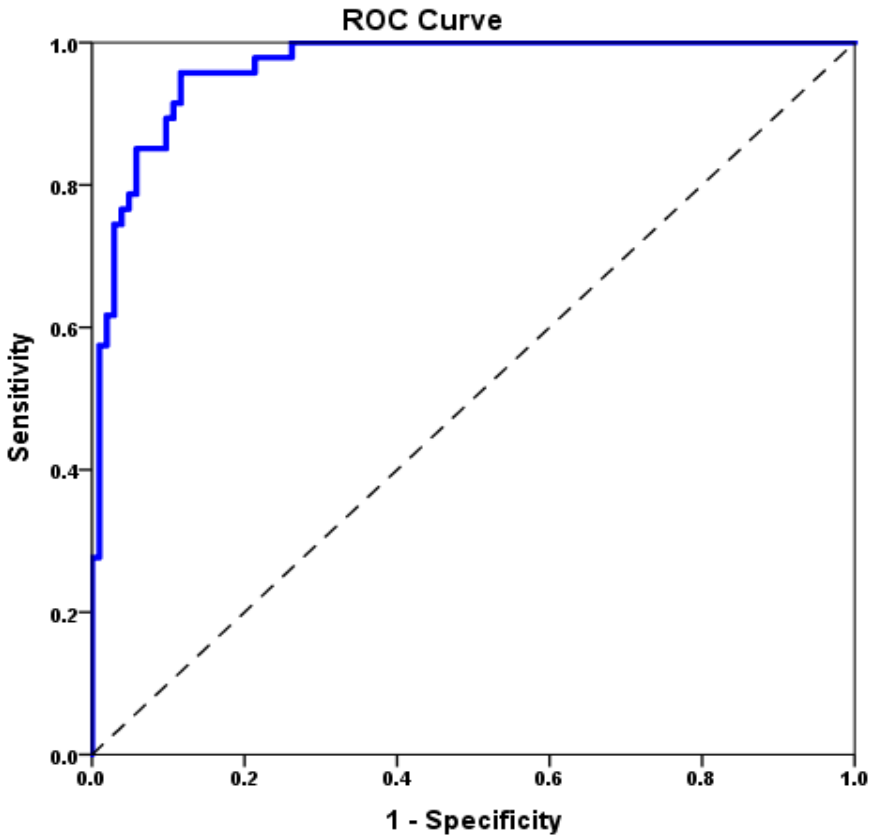

Figure (2b): ROC curve for the predicted probability to discriminate severe fatty liver