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Original article

Assessment of Liver Function Tests and Associated Risk Factors Among Diabetic Patients Attending Diabetes Clinic of Jimma University Specialized Hospital, Jimma, Ethiopia

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ABSTRACT:

Background: Patients having metabolic disorder like diabetes are more likely susceptible to liver diseases that cause the release of hepatic biomarkers. Determining those biomarkers will help in the early management of potential liver diseases; however, such studies are scarce in the present study areas. Thus, we aimed at assessing the prevalence of liver function tests and associated risk factors among diabetic patients. **Methods:** An institution based cross-sectional study was conducted. 376 diabetic patients who fulfilled the inclusion criteria were participated. 5ml venous blood was collected for liver function tests and anti-hepatitis C-virus (HCV) antibody detection from each diabetic patient. Descriptive statistics, bi-variate and multivariate logistic regression were performed using SPSS version 20 software. P-value less than 0.05 was considered as statistically significant. Result: Among 376 diabetic patients, 57.7% of them were found to have one or more abnormal liver function test results while 26.9% of them had at least two or more abnormal liver function test results. Out of 57.7% of diabetic patients, who had one or more abnormal liver function tests,23.9%, 20.5%,12.0%, 10.1%, 9.3% and 3.2% of them had abnormal serum concentration for aspartate amino-transferase (AST), both alanine amino-transferase (ALT) and alkaline phosphatase (ALP), total bilirubin, albumin, direct bilirubin and gamma glutamyl-transferase (GGT), respectively. Out of 376 diabetic patients, 1.6% of them were found to be positive for HCV. Out of 1.6% diabetic patients who were positive for HCV, 16.0% of them had abnormal serum concentrations for AST, ALT and ALP. Elevated ALT test result had statistically significant association (p <0.05) with increasing body mass index (BMI). Conclusion and recommendation: High prevalence of one or more abnormal liver function test results was indicated among diabetic patients. Assessment of liver function tests and associated factors among diabetic patients during early onset of diabetes and then follow up is necessary to control and properly manage liver diseases. Health education about the potential risk of liver diseases and way of prevention shall be provided to diabetic patients as well.

KEYWORDS: Diabetes mellitus, liver function tests, alanine amino-transferases, aspartate amino-transferases, bilirubin.

INTRODUCTION

Liver is the largest and functionally complex organ which is involved in a number of excretory, synthetic, and metabolic functions[1]. It is the only organ that has the capacity to get rid of `heme' waste products and has extensive synthetic capacity of biological compounds such as carbohydrates, lipids and proteins[2]. More than 90% of all protein and 100% of albumin synthesis occur in the liver and this is why low levels of serum proteins are resulted in extensive destruction of liver tissue[1,2]. The liver also plays a great role in maintaining stable blood glucose

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concentrations due to its ability to store glucose as glycogen through glycogenesis and degrade glycogen through glycogenolysis depending on the body's needs[3]. When the supply of glycogen becomes depleted, the liver will create glucose from non-sugar carbon substrates like pyruvate, lactate, and amino acids[1,3].

Liver function tests are tests that help to detect, diagnosis, and evaluate liver diseases[4]. Aspartate amino-transferase (AST) and alanine amino-transferase (ALT) are intracellular enzymes that are released from hepatocytes into plasma as a result of hepato-cellular membrane injury that directly causes extrusion of the cytosolic contents[1]. Alkaline phosphatase (ALP) and gamma glutamyl-transferase (GGT) are located predominantly on the canalicular membrane of the hepatocytes and released in to plasma during cholestasis[1,3]. But the elevated value of ALP for the presence of cholestatic disorder can be verified by elevated GGT. For instance, if ALP is elevated and GGT is correspondingly elevated, then the source of the elevated ALP is most likely the biliary tract[1].

Diabetes mellitus (DM) is a group of metabolic disorders characterized by a chronic hyperglycemic condition resulting from defects in insulin secretion, insulin action or both[4]. Hyperglycemia occurs due to increased rate of hepatic glucose output secondary to insulin resistance and diminished peripheral glucose uptake[5-7]. Insulin resistance results in enhanced hepatic gluconeogenesis and impaired hepatic lipid metabolism, which results in hepatic steatosis and liver injury[7,9]. Steatosis or fatty liver is the result of an intracellular accumulation of triglycerides due to increased up take of free fatty acids and de novo liponeogenesis in the hepatocytes[7,12]. Steatosis can cause fatty liver diseases in diabetic patients who had history of substantial alcohol consumption (alcoholic fatty liver diseases (AFLD)) or non-alcoholic fatty liver diseases (NAFLD) in those who did not have history of substantial alcohol consumption but had features on liver biopsy similar to alcoholic hepatitis[7,13]. The mechanism by which NAFLD is caused in diabetic patients is complex and not clear as most studies indicated, but it has been observed that fatty liver, obesity and insulin resistance act as co-factors to cause liver damage[7,13]. Certain studies indicated that chronic viral hepatitis and type-2 diabetes mellitus (T2DM) are linked due to specific hepatitis C virus (HCV) genotypes, particularly genotype 1 and 4, which are associated with insulin resistance, but the mechanisms by which these genotypes cause insulin resistant is not clearly known[8,9]. Overall, patients having metabolic disorder like diabetes are more likely susceptible to liver diseases that cause the releasing of hepatic biomarkers. Determining those biomarkers among diabetic patients will help in the early management of potential liver diseases; however, studies documenting those biomarkers are scarce in the present study areas. Thus, we aimed at assessing the prevalence of liver function tests and associated risk factors among diabetic patients attending chronic clinic.

MATERIALS AND METHODS

STUDY DESIGN AND SUBJECT

A facility-based cross-sectional study was conducted from March-June, 2014 among diabetic patients. A total of 376 DM patients who have been active for their routine follow-up at chronic illness clinic of Jimma University Specialized Hospital (JUSH) during study period, willing to participate and provided written consent were included in this study. But those DM patients who did not provide written consent and who had history of hospitalization for severe anemia and/or on treatment for known liver diseases were excluded.

ETHICAL CONSIDERATION

The study was reviewed and approved by ethical committee of college of health sciences of Jimma University (RPGD 451/2014). Each study participants had been informed about the objective of the study before any data collections. To ensure confidentiality of the data obtained from each study participants, the data were maintained by using codes rather than any other personal identifier and the data collected and results of laboratory tests were used only for the purpose of this research. Written consent was obtained from each study participants. The liver function test result of each study participant was given to them for consultation and to obtain proper treatment/management from their respective physician following their case.

DATA COLLECTION TECHNIQUES AND INSTRUMENTS

SOCIO-DEMOGRAPHIC AND CLINICAL DATA COLLECTION

Structured questionnaire was used to collect socio-demographic data (like age, sex, residence) and other clinically useful data such as types of diabetes, duration of diabetes and mode of treatment and this data was cross checked with each DM patients medical record for consistency. Anthropometric data was collected by measuring the height and weight of each diabetic patients using digital weight scale and their blood pressure was measured by using sphygmomanometer.

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BLOOD COLLECTION, LABORATORY INVESTIGATION AND QUALITY CONTROL

Five millilitre (5ml) venous blood was collected using sterile disposable syringe and needle from each DM patient following aseptic blood collection procedures. After one and half hour of complete blood clotting during the same day of collection, the serum was separated from the whole blood by centrifuging at 1200 revolution per minute for 10 min. Then, the separated serum was analyzed for determination of liver function test panel (AST, ALT, ALP, GGT, albumin, total bilirubin and direct bilirubin) by using HumaStar80 (Cat. No. 16880/1, Germany) automated clinical chemistry analyzer and also the analysis was done for HCV anti-body detection by using EUGENE® anti-HCV rapid test.

The interpretation of test results for liver function test panel was based on the reference range recommended by international federation of clinical chemistry (IFCC) for each analyte measured and the test result for HCV anti-body detection was interpreted strictly by following test principle, procedures and result interpretation as indicated by manufacturer`s on the leaflet of EUGENE Anti-HCV rapid test . The quality of test result was tried to be maintained strictly by following laboratory standard operating procedures (SOP) starting from the pre-analytic phase of blood collection up to post-analytical phase of result interpretation. The collected blood was extremely protected from direct sunlight during and after blood collection and the blood analysis was done during the same day of blood collection. The hemolyzed blood was excluded as it may falsely increases the test results of certain biomarkers like AST and ALT. We used humatrol P and humatrol N as internal quality control for laboratory investigation of liver function test.

DATA PROCESSING AND STATISTICAL ANALYSIS

All data from questionnaires were checked manually for their completeness, clarity and edited for inconsistencies. Anthropometric data was calculated by using body mass index (BMI) formula weight in kilograms /height in meter square. DM patients with BMI category <18 kg/m^2, 18-24.9kg/m^2, 25-29.9kg/m^2 and ⩾30kg/m^2 were considered as underweight, normal weight, overweight and obese, respectively. DM patients with systolic blood pressure ⩾130 mmHg and diastolic blood pressure ⩾ 85mmHg were considered as hypertensive. Statistical analysis was performed using Microsoft office excels for window 2008 and SPSS version 20. Bi-variate and multi-variate logistic regressions were done to assess the relationship between dependent and independent variables. P-value <0.05 was considered as statistically significant but for the sake of multi-variate analysis, P-value <0.25 was considered.

RESULTS

SOCIO-DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF DIABETIC MELLITUS PATIENTS

From 376 DM patients, 233 (62.0%) of them were males and the remaining 143 (38.0%) were females. The mean ages of diabetic patients was 46.4 (±14.2SD) ranging from 14-87 years. Out of 376 DM patients, 343 (91.2%) of them have T2DM, 218 (58.0%) of them were from rural and 186 (49.3%) of them had grade 1-8 educational status. Concerning duration of diabetes and mode of treatment, 219 (58.2%) of the DM patients had been following diabetic clinic for the duration of last 5 years or less and 305 (81.2%) of them had been following oral hypoglycemic agent. Concerning anthropometric data and blood pressure, 102 (27.1%) and 25 (6.6%) of DM patients had BMI between 25-29.9 kg/m^2 and ⩾30 kg/m^2, respectively and 215 (57.2%) of them had high blood pressure (systolic blood pressure⩾ 135mmHg and diastolic blood pressure ⩾ 85 mmHg) (Table 1).

Table 1. Socio-demographic and clinical characteristics of diabetic patients attending diabetes clinic of Jimma University Specialized Hospital, Jimma, Ethiopia.

Variables	Category	Frequency, n (%)
Age	<55	271(72.1)
	≥55	105(27.9)
Gender	Male	233(62.0)
	Female	143(38.0)
Types of diabetes	T1DM	33(8.8)
	T2DM	343(91.2)
Duration of diabetes	≤5years	219(58.2)
	6-10years	110(29.3)
	≥11years	47(12.5)

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Mode of treatment	Insulin OHA Both Insulin & OHA	50(13.3) 305(81.1) 21(5.6)
BMI	<18kg/m^2 18-24.9kg/m^2 25-29.9kg/m^2 ≥30kg/m^2	18(4.8) 231(61.4) 102(27.1) 25(6.6)
Hypertension	Yes	215(57.2)
	No	161(42.8)
History of ALC	yes	50(13.3)
	No	326(86.7)

Abbreviations: BMI, body mass index; T1DM, type 1 diabetic mellitus; T2DM, type 2 diabetic mellitus;OHA, oral hypoglycemic agent; ALC, alcohol consumption.

Out of 376 DM patients, 217(57.7%) of them were found to have one or more abnormal liver function tests while 26.9% of them had at least two abnormal liver function tests. The Mean ±SD of liver function tests for AST, ALT, ALP, GGT, total bilirubin, direct bilirubin andalbumin were 30±6.3, 34.3±2.9, 242.6±39.3, 25±10.4, 0.6±0.4, 0.18±0.3, 4.3± 0.6, respectively. Among 57.7% DM patients with one or more abnormal liver function tests, 23.9% and 20.5% had abnormal serum concentration for AST and for both ALT and ALP, respectively. Whereas the abnormal serum concentration of total bilirubin, albumin, direct bilirubin and GGT was indicated among 12.0%, 10.1%, 9.3% and 3.2% DM patients, respectively (Table 2). Out of 376 DM patients, 1.6% of them were positive for HCV and out of this, 16.0% of them had abnormal serum concentration for AST, ALT and ALP (Table 3).

Table 2. Mean values of the biochemical parameters in diabetic patients attending diabetes clinic of Jimma University Specialized Hospital, Jimma, Ethiopia.

Biochemical Parameters	Mean ±SD	Reference range	Diabetic patients with abnormal reference range (%)
AST	30±6.3	0-35U/L(M) 0-31U/l (F)	23.9%
ALT	34.3±2.9	0-45U/L(M) 0-35U/L(F)	20.5%
ALP	242.6±39.3	89-306U/L(M) 64-306U/L(F)	20.5%
GGT	25±10.4	0-55U/L	3.2%
Total bilirubin	0.6±0.4	0-0.25mg/dl	12.0%
Direct bilirubin	0.18±0.3	0-0.2mg/dl	9.3%
Albumin	4.3± 0.6	3.8-5.1mg/dl	10.1%

Notes: Values are expressed as the mean ± standard deviation (AST, ALT, ALP, GGT, Total bilirubin, Direct bilirubin and Albumin).
Abbreviations: AST, aspartate aminotransferase; ALT, alanine amino-transferase; ALP, alkaline phosphatase; GGT, gamma glutamyl-transferase; M, male; F, female.

Table 3. HCV Sero-status and liver function test profiles among diabetic patients attending diabetes clinic of Jimma University Specialized Hospital, Jimma, Ethiopia.

Liver Function Test Profiles and Status		HCV Sero-status	
Tests	Test Results Normal (N) or Abnormal (A)	HCV positive n (%)	HCV negative n (%)
AST	N	5(83.3)	283 (76.7)
	A	1(16.7)	87(23.3)
ALT	N	5(83.3)	295(79.7)
	A	1(16.7	75(20.3)

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ALP	N	5(83.3	294(78.2)
	A	1(16.7)	76(20.2)
GGT	N	6(100.0)	358(96.8)
	A	0(0.0)	12(3.2)
Total bilirubin	N	6(100.0)	325(87.8)
	A	0(0.0)	45(12.2)
Direct bilirubin	N	6(100.0)	335(90.5)
	A	0(0.0)	35(9.5)
Albumin	N	6(100.0)	332(89.7)
	A	0(0.0)	38(10.3)

Notes: Values are expressed as normal or abnormal based on the reference values.
Abbreviations: HCV, hepatitis C virus; AST, aspartate amino-transferase; ALT, alanine amino-transferase; N, normal value; A, abnormal value.

AST serum concentration was abnormal among 30.5% of DM patients with age group ⩾55 years and 31.9% of them with duration of diabetes ⩾11 years. Abnormal GGT serum concentration was found among 1.9% of DM patients with ⩾55 years of age. ALT serum concentration was found to be abnormal among 33.3% and 6 (31.6%) of DM patients with BMI between 25-29.9kg/m^2 and ⩾ 30kg/m^2, respectively with p-value <0.05 (Table 4).

Serum concentration for total bilirubin was found to be abnormal among 14.2% and 8.8% of DM patients with duration of diabetes ⩾5 years and BMI between 25-29.9 kg/m^2, respectively. Total bilirubin was also abnormal among 14.3% of DM patients following both oral hypoglycemic agent and insulin treatment. Abnormal serum concentration for direct bilirubin was found among 14.3% who were following both insulin and oral hypoglycemic agent treatment and among 11.4% with ⩾55 years age group, 10.9% of DM patients following oral hypoglycemic treatment and 11.0% with duration of diabetes ⩾5 years had abnormal albumin serum concentration (Table 5).

DISCUSSION

Overall, 217(57.7%) of DM patients had at least one or more abnormal liver function tests and 101(26.9%) them had at least two abnormal liver function tests. This result is in agreement with the study conducted in Finland by Salmela et al. (1984), in which 57.0% of the DM patients had at least one or more abnormal liver function tests and 27.0 % had at least two abnormal liver function tests[10]. It also agrees with the study conducted in Sudan by Hind M et al. (2013), in which 51.0% of the DM patients had at least one or more abnormal liver function tests and 24.0% had at least two abnormal liver function tests[11].

The most abnormal serum concentration observed in our study was AST; it was found to be elevated among 23.9 % of DM patients. Similar finding was found in Sudan by Idris et al. (2011) in which raised AST serum concentration was noted among 25.0% of DM patients[12]. In our study, ALT serum concentration was found to be elevated among 20.5% DM patients, which is similar to the study done in Myanmar (18.5%)[13]. In our study, ALP and ALT serum concentrations were found to be abnormal among 20.5% DM patients, which is in agreement with the study reported from Sudan (20.0%)[11].

In contrast to the study conducted in Finland and South Africa in which elevated serum GGT concentration was reported among 19.0% and 25.2% DM patients, respectively, the elevated GGT serum concentration was noted only among 3.2% in our study[10,14]. This variation may be attributed to the difference in living standard, medical care and knowledge of the patients on the risk factors.

DM patients with BMI between 25-29.9 kg/m^2 were 6.59 times (AOR=6.59, 95% CI: 2.2-19.6) more likely to have abnormal ALT serum concentration compared to DM patients with BMI <18-24.9kg/m^2. Moreover, DM patients with BMI ⩾30kg/m^2 were 3.6 times (AOR=3.6, 95% CI: 1.13-11.2) more likely to have elevated serum ALT concentration compared to DM patients with BMI 18-24.9kg/m^2.

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Table 4. Relationship between demographic, clinical characteristics and liver function tests (AST, ALT, and GGT) among diabetic patients attending diabetes clinic of Jimma University Specialized Hospital, Jimma, Ethiopia.

Variable	AST				ALT				GGT			
	N	A	AOR (95% CI)	P- value	N	A	AOR (95% CI)	P-value	N	A	AOR (95% CI)	P- value
Age												
<55	213(78.6)	58(21.4)			215(79.3)	56(20.7)	0.66(0.33,1.31)		261(96.3)	10(3.7)	0.60(0.11,3.22)	0.55
≥55	73(69.5)	32(30.5)	1.93(0.29,1.92)	0.54	84(80.0)	21(20.0)		0.43	103(98.1)	2(1.9)		
Gender												
Male	173(74.2)	60(24.8)			187(80.3)	46(19.7)	0.72(0.25,2.01)	0.53	229(98.3)	4(1.7)	0.90(0.07,11.00)	0.02
Female	113(79.0)	30(21.0)	0.75(0.29,1.92)	0.41	112(78.3)	31(21.7)			135(94.4)	8(5.6)		
Residence												
Rural	158(72.5)	60(27.5)		0.63	172(78.9)	46(21.1)	0.75(0.39,1.43)		209(95.9)	9(4.1)	0.56(0.11,2.40)	
Urban	128(81.0)	30(21.0)	0.86(0.48,1.57)		127(80.4)	31(19.6)		0.38	155(98.1)	3(1.9)		0.41
Type of DM												
T1DM	25(75.8)	8(24.2)			23(69.7)	10(30.3)	0.53(0.13,2.10)	0.36	33(100.0)	0(0.0)	0.00(0.000)	
T2DM	261(76.1)	82(23.9)	1.73(0.48,6.27)	0.39	276(80.5)	67(19.5)			331(96.5)	12(3.5)		0.99
Duration of DM												
≤5years	172(78.5	47(21.5)	0.61(0.29,1.29)	0.26	174(79.5)	45(20.5)	0.82(0.33,2.02)	0.66	211(96.3)	8(3.7)		
6-10years	82(74.5)	28(25.5)	0.76(0.33,1.72)		87(79.1)	23(20.9)	0.82(0.31,2.10)		106(96.4)	4(3.6)	1.00(0.000)	0.99
≥11years	32(68.1)	15(31.9)		0.51	38(80.9)	9(19.1)		0.70	47(100.0)	0(0.0)	1.00(0.000)	0.99
Type of Rx												
Insulin	42(84.3)	8(15.7)			44(86.3)	6(13.7)			49(98.0)	1(2.0)		
OHA	229(75.3)	76(24.7)	0.32(0.09,1.15)	0.08	239(78.6)	66(21.4)	0.42(0.10,1.72)	0.76	295(96.7)	10(3.3)	0.80(0.04.17.00)	0.89
Insulin & OHA	14(66.7)	7(33.3)	0.56(0.20,1.51)	0.51	16(76.2)	5(23.8)	0.83(0.26,2.60)	0.71	20(95.2)	1(4.8)	1.05(0.10,11.01)	0.96
BMI												
<18	18(100.0)	0(00.0)	1.30(0.73,2.33)	0.37	18(100.0)	0(00).0	4.80(2.57,9.00)	0.45	17(94.4)	1(5.6)	1.03(0.22,4.70)	0.9
18-24.9	203(88.9)	28(11.1)			216(93.6)	15(6.4)			225(92.4)	6(7.6)		
25-29.9	77(75.0)	25(25.0)	1.21(0.41,3.57)	0.72	68(66.7)	34(33.3)	6.59(2.2,19.60)	*0.001	98(96.1)	3(3.9)	1.61(0.14,19.10)	0.7
≥30	20(80.0)	5(20.0)		0.94	17(68.4)	8(31.6)	3.55(1.13,11.2)	*0.03	23(92.0)	2(8.0)	2.54(0.32,19.90)	0.37
Hypertension												
Yes	198(92.1)	17(7.9)	1.46(0.73,2.92)	0.28	203(94.4)	12(24.0)	1.15(0.53,2.60)	0.71	209(97.2)	6(2.8)	0.47(0.12,1.84)	
No	158(98.1)	3(1.9)			156(96.9)	5(3.1.)			155(96.3)	6(3.7)		0.47
Hx ALC												
Yes	33(66.0)	17(34.0)	1.46(0.73,2.92)	0.28	38(76.0)	12(24.0)	1.15(0.53,2.60)	0.71	41(82.0)	9(18.0)	0.85(0.37,1.93)	0.71
No	253(77.6)	73(22.4)			261(80.1)	65(19.9)			258(79.1)	68(20.9)		

Abbreviations: AST, aspartate amino-transferase; ALT, alanine amino-transferase; GGT, gamma glutamyl-transferase; N; normal ; A, abnormal ; CI, confidence interval ;DM, diabetes mellitus ; Rx , treatment; T1DM ,type 1 diabetes mellitus,T2DM, type 2 diabetes mellitus; OHA ,oral hypoglycemic agent; BMI, body mass index; Hx ALC, history of alcohol consumption.

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Table 5. Relationship between demographic, clinical characteristics and liver function tests (total bilirubin, direct bilirubin and albumin) among diabetic patients attending diabetes clinic of Jimma University Specialized Hospital, Jimma, Ethiopia.

Variable	Total bilirubin				Direct bilirubin				Albumin			
	N	A	AOR (95% CI)	P- value	N	A	AOR (95% CI)	P -value	N	A	AOR (95% CI)	P- value
Age												
<55	238(87)	33(12.2)	1.03(0.46,2.3)	0.79	241(88.9)	30(11.1)	0.41(0.15,1.14)	0.08	0.64	26(9.6)	1.12(0.49,2.6)	0.63
≥55	93(88.6)	12(11.4)			93(88.6)	12(11.4)			93(88.6)	12(11.4)		
Gender												
Male	208(89.3)	25(10.7)		0.94	206(88.4)	27(11.6)	1.66(0.64,4.29)	0.28	207(88.8)	26(11.2)		
Female	115(80.4)	28(19.6)	0.85(0.24,2.9)		135(94.4)	8(5.6)			131(91.6)	12(8.4)	0.91(0.26,3.2)	0.77
Residence												
Rural	192(88.1)	26(11.9)		0.82	197(90.4)	21(9.6)	1.66(0.64,4.29)	0.28	194(89.0)	24(11.0)		
Urban	139(88.0)	19(12.0)	0.91(0.41.2.0)		144(91.1)	14(8.9)			144(91.1)	14(8.9)	0.62(0.26,1.4)	0.29
Type of DM												
T1DM	24(72.7)	9(27.3)			30(90.9)	3(9.1)	0.80(0.12,5.6)		27(81.8)	6(18.2)		
T2DM	303(88.3)	40(11.7)	1.37(0.29,6.4)	0.68	311(90.7)	32(9.3)	0.45(0.08,2.3)	0.83	311(90.7)	32(9.3)	0.43(0.08,2.0)	0.28
Type of Rx												
Insulin	46(90.2)	4(9.8)			46(90.2)	4 (9.8)	0.32(0.07,1.3)		48(94.1)	2(5.9)		
OHA	268(87.8)	37(12.2)	0.57(0.10,2.9)	0.5	46(90.2)	5(9.8)	0.45(0.08,2.3)	0.34	272(89	33(10.9)	0.43(0.05,3.30	0.42
Insulin & OHA	18(85.7)	3(14.3)	0.79(0.21,3.0)	0.73	18(85.7)	3(14.3)	0.32(0.07,1.3)	0.11	19(90.5)	2(9.5)	0.96(0.19,4.6)	0.94
Duration of DM												
≤5 years	188(85.8)	31(14.2)	3.5(0.75,16.7)		202(92.2)	17(7.8)	1.31(0.27.6.35)	0.73	195(89.0)	24(11.0)	3.8(0.80,19.6)	
6-10 years	98(89.1)	12(10.9)	2.8(0.55-14.2)	0.10	94(85.5)	16(14.5)	3.23(0.65,16.0)	0.15	98(89.1)	12(10.9)	3.77(0.7,19.7)	0.9
≥11 years	45(98.7)	2(4.3)		0.21	45(95.7)	2(4.3)			45(95.7)	2(4.3)		0.11
BMI												
<18	17(94.4)	1(5.6)	0.7(0.29,1.57)	0.37	18(100.0)	0(0.0)	1.64(0.71,3.77)	0.23	17(94.4)	1(5.6)	1.15(0.51,2.6)	0.73
18-24.9	201(87.0)	30(13.0)			211(90.9)	21(9.1)			220(95.2)	11(4.8)	1.14(0.5,2.4)	0.72
25-29.9	93(91.2)	9(8.8)	1.63(0.46,5.8)	0.44	90(88.2)	12(11.8)	1.7(0.73,3.78)	0.24	96(94.1)	6(5.9)		
≥30	22(88.0)	3(12.0)	0.6(0.12,3.10)	0.55	25(100.0)	0(0.0)	0.61(0.18,2.0)	0.64	23(91.7)	2(8.3)	0.55(0.94,3.3)	0.51
Hypertension												
Yes	46(92.0)	4(8.0)	0.56(0.18,1.8)	0.35	191(88.8	24(11.2)	1.47(0.28,7.8)	0.64	196(91.2)	19(8.8)	0.76(0.4,1.61)	
No	2(85.4)	41(12.6)			150(93.2)	11(6.8)			142(88.2)	19(11.8)		0.49
Hx ALC												
Yes	46(92.0)	4(8.0)	0.56(0.18,1.8)	0.35	46(92.0)	4(8.0)	0.61(0.18,2.0)	0.41	47(94.0)	3(6.0)	281(89.3)	0.15
No	285(87.4)	41(12.6)			295(90.5)	31(9.5)			291(89.3)	35(10.7)		

Note: Abbreviations: N, normal; A, abnormal; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus; Rx, treatment; Hx of ALC, history of alcohol consumption; OHA, oral hypoglycemic agent; BMI, body mass index; DM, diabetes mellitus.

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There was statistically significant association between BMI and ALT abnormal serum concentration (p-value <0.05). This result is in agreement with study conducted in Mexico[15].

It also agrees with the study conducted in United States in which those obese and overweight were more likely to have elevated ALT level[16].

Concerning the type of treatment, DM patients following insulin treatment were 0.34 times (AOR=0.34, 95% CI=0.1-1.1) more likely to have abnormal AST serum concentration compared to those who were following both insulin and oral hypoglycemic treatment. In relation to the effect of duration of diabetes on the abnormal liver function tests, DM patients with duration of diabetes ⩽5 years were 2.34 times (AOR=2.34, 95% CI=0.9-6.1) more likely to have abnormal ALP serum concentration compared to diabetic patients with duration of diabetes ⩾11 years. This result is in agreement with the study conducted by Salmela et al.(1984) [10].

CONCLUSION

Based on the finding of this study, there was high prevalence of one or more abnormal liver function tests among DM patients in our study area. AST serum concentration was the most elevated liver function test followed by elevated serum concentration of both ALT and ALP. Abnormal ALT serum concentration was more frequently found among over weight (BMI between 25-29.9 kg/m^2) and obese (BMI ⩾30kg/m^2) DM patients. Diabetic patients following insulin treatment had more frequently abnormal AST serum concentration than DM patients following other mode of hypoglycemic treatment. DM patients with ⩽5years of duration of treatment had more frequently abnormal ALP serum concentration compared to those with >5years duration of diabetes. Assessment of liver function tests and associated factors among DM patients during early onset of diabetes and then follow up is necessary to control and properly manage liver diseases. Health education about the potential risk of liver diseases and way of prevention shall be provided to diabetic patients as well.

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AUTHOR CONTRIBUTIONS

Shiferaw Bekele, Zeleke Mekonnen and Waqtola Cheneke were involved in conception and design, and acquisition of data. Shiferaw Bekele took the lead in data generation, analysis and drafting the manuscript. Zeleke Mekonnen and Waqtola Cheneke revised the draft manuscript critically for important intellectual content. All authors were involved in analysis and interpretation of the data, as well as final approval of the version to be published.

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