

## Evaluation of biochemical parameters among diabetes patients and healthy participants in a Nigerian tertiary hospital

Felix Olaniyi Sanni<sup>1\*</sup>, Olusoji Adeyemi<sup>2</sup>, Paul Olaiya Abiodun<sup>3</sup>, Olumide Faith Ajani<sup>4</sup>, Freddy Rukema Kaniki<sup>5</sup>, Azeezat Abimbola Oyewande<sup>6</sup>, Andrew Nuhu Yashim<sup>7</sup>, Jubril Adeyinka Kareem<sup>8</sup>, Ajani Love Adeiye<sup>4</sup>, Sola Thomas Sunday<sup>9</sup>, Olakunle Daniel Olaniran<sup>10</sup>

<sup>1</sup>Department of Public Health, Triune Biblical University Global Extension, NY, USA

<sup>2</sup>Science Laboratory Department, Kogi State University, Ayingba, Nigeria

<sup>3</sup>Compliance and Quality control Department, Akesis, Abuja, Nigeria

<sup>4</sup>Logistics and Supply Chain Management Department, Malaysia University of Science and Technology, Malaysia

<sup>5</sup>Department of Public Health, Université Ebenezzer de Minembwe, D.R. Congo

<sup>6</sup>Family Medicine, Lagos State Health service commission, Alimosho, Lagos, Nigeria

<sup>7</sup>Haematology, and blood transfusion Department, National Hospital, Abuja, Nigeria

<sup>8</sup>Laboratory Services, Management Sciences for Health, Nigeria

<sup>9</sup>Surveillance department, Nigeria Center for Disease Control, Jabi Abuja, Nigeria

<sup>10</sup>Public Health Department, Texila American University, Guyana

### ABSTRACT

**Background:** Diabetes mellitus (DM) burden is one of the key concerns in developing countries like Nigeria. This study aimed to evaluate the biochemical parameters among diabetes patients and healthy persons in Abuja, Nigeria.

**Methodology:** The study was a prospective cross-sectional study that included 60 DM patients (case) and 48 healthy individuals (control) aged 19 to 80 years from April 1 and June 30, 2018. Five ml of venous fasting blood samples were obtained under aseptic precautions, and biochemical parameters were evaluated. Fasting blood glucose (FBS) and liver enzymes were determined using a fully automated biochemistry analyzer, while Haemoglobin A1c (HbA1c) was estimated by the High-performance liquid chromatography (HPLC) method. Data analysis was performed using IBM SPSS version 25, and a value of  $p < 0.05$  was taken as statistically significant.

**Results:** Mean FBS, HbA1c, AST, ALT, and LDH were significantly higher in DM than in control ( $P < 0.05$ ). Mean values of FBS and HbA1c in DM were 9.00mg/dl and 5.99%, respectively, while liver enzymes, ALT and AST, and ALP were 25.77U/L, 28.87U/L, and 214.35U/L, respectively. The mean values of cardiac enzymes, LDH, and CK-MB normal were 438.87U/L and 75.47U/L, respectively. The mean values of HbA1c, AST, ALT, ALP, LDH and CK-MB were higher than normal range in 48.3%, 16.0%, 15.0%, 23.3%, 26.6%, and 36.6% DM respectively.

**Conclusion:** Thus, these liver enzymes can be used as a biomarker for the assessment of diabetes. With a thorough study about the level of liver enzymes, it is possible to monitor complications of diabetes.

### KEYWORDS

diabetes mellitus;  
aspartate aminotransferase;  
alanine aminotransferase;  
lactate dehydrogenase;  
alkaline phosphatase

### CORRESPONDING AUTHOR

Dr. Felix Olaniyi Sanni

## INTRODUCTION

Diabetes mellitus (DM), also referred to as diabetes, is a category of metabolic conditions in which blood sugar levels are elevated over a long period<sup>[1]</sup>. Symptoms of diabetes include; constant hunger and thirst, weight loss, vision alterations, tiredness, weakness, and frequent urination<sup>[1,2]</sup>. If not treated, diabetics can result in acute and chronic complications such as diabetic ketoacidosis and non-ketotic hyperosmolar coma, stroke, liver injury, and fatty liver diseases<sup>[3]</sup>. Diabetes is most often caused by a lack of insulin or the body's insulin receptor<sup>[1]</sup>.

The morbidity and mortality of patients with type II diabetes have been significantly associated with liver disease<sup>[3-5]</sup>. The roles of the liver are significant during fasting and post-prandial cycles in the management of glucose homeostasis<sup>[6,7]</sup>. Liver disease also causes abnormal liver enzymes in type II diabetic patients, especially chronic transaminase elevation<sup>[6-8]</sup>. In a study by Kashinakunti et al.<sup>[7]</sup>, the liver enzymes AST, ALT, and ALP were substantially elevated relative to controls in Type II DM patients. In clinical practices, liver function tests (LFTs) are usually employed to study the advancement of known diseases and the effects of potentially hepatotoxic drugs<sup>[9]</sup>. Some of the LFTs are Aminotransferases (ALT and AST), which are markers of hepatocyte injury. At the same time, alkaline phosphatase (ALP) and  $\gamma$ -glutamyl transferase( $\gamma$ -GT) are markers of biliary function and cholestasis<sup>[9,10]</sup>. This study aimed to evaluate the biochemical parameters among diabetes patients and healthy persons in Abuja, Nigeria.

## MATERIAL AND METHODS

### Study design

The study was a prospective cross-sectional study and included diabetic patients confirmed to have the disease and a control group (apparently healthy individuals who are not suffering from diabetes.) The study was carried out between April 1 and June 30, 2018.

### Study area/population

The study area was the University of Abuja Teaching Hospital. Abuja is the capital city of Nigeria. It is located in centre latitude 90 4' 0' N 7 29' 0' E of Nigeria. Based on the 2006 census, the population of Abuja was estimated at 776,298<sup>[11]</sup>, which puts Abuja among the top ten cities with the highest population in Nigeria.

### Ethical consideration

Ethical approval was obtained from the Health Research Committee. Permission was obtained from the University of Abuja Teaching Hospital (UATH) Gwagwalada, FCT, and informed consent from the subjects before collecting samples.

### Sample size

There were 108 participants in the study, which comprised two groups. Group 1 (control group) consists of 48 healthy, non-diabetic patients who have met the inclusion criteria. Group 2 (test group) consists of 60 patients diagnosed with diabetes mellitus. A proportional representative sample of male and female participants and all age groups were selected in each study group. The sample size was calculated using an average population size of 500 patients attending clinics in UATH with an expected frequency of 10%, a confidence limit of 5%, and a cluster/design effect of 1.0. (Epi Info software was used).

### Laboratory analysis

Five millilitres of venous fasting blood were obtained under aseptic precautions, and biochemical parameters were determined: fasting blood glucose (FBS) and liver enzymes were determined using a Biosystems; A 25 fully automated biochemistry analyzer, whereas haemoglobin A1c (HbA1c) was estimated using a high-performance liquid chromatography (HPLC) method.

### Statistical analysis

All statistical analyses were performed using IBM SPSS version 25, and a value of  $p < 0.05$  was taken to indicate statistical significance. Results were presented as means  $\pm$  standard deviation (SD) or percentages for categorical variables according to diabetes.

**RESULT**

A total of 108 with 60 (55.6%) confirmed diabetic patients and 48 (44.4%) non-diabetic controls were enrolled in this study. The minimum and maximum ages of diabetic patients were 22 and 80 years, 38 (35.2%) males and 70 (64.8%) females. Among DM patients, the mean values of FBS and HBA1c were 9.00 mg/dl and 5.99%, respectively, while the mean values of liver enzymes, ALT, AST, and ALP were 25.77 U/L, 28.87 U/L, and 214.35 U/L, respectively. Moreover, cardiac enzymes, LDH, and CK-MB were also estimated for DM patients, and the mean values were 438.87 U/L and 75.47 U/L, respectively (Table 1).

**TABLE 1:** Mean value of biochemical parameters among diabetes patients

Variable (n=60)	Mean ± SD	Normal range	The number outside the normal range
FBS (mg/dl)	9.00 ± 4.69	3.8 – 6.4	33 (55.0%)
HBA <sub>1c</sub> (%)	5.99 ± 1.39	<6	29 (48.3%)
AST (U/L)	28.87 ± 12.45	<40	10 (16.0%)
ALT (U/L)	25.77 ± 12.49	<40	9 (15.0%)
ALP (U/L)	214.35 ± 99.84	M (<270) F (<240)	14 (23.3%)
LDH (U/L)	438.87 ± 312.36	230 – 460	16 (26.6%)
CK-MB (U/L)	75.47 ± 68.24	M (<80) F (<70)	22 (36.6%)

FBS = Fasting Blood Sugar, HBA<sub>1c</sub> = Glycosylated haemoglobin, AST = Aspartate Transaminase, ALT = Alanine Transaminase, ALP = Alkaline Phosphatase, LDH = Lactate Dehydrogenase, CK-MB = Cretine Kinase; M = male and F = female

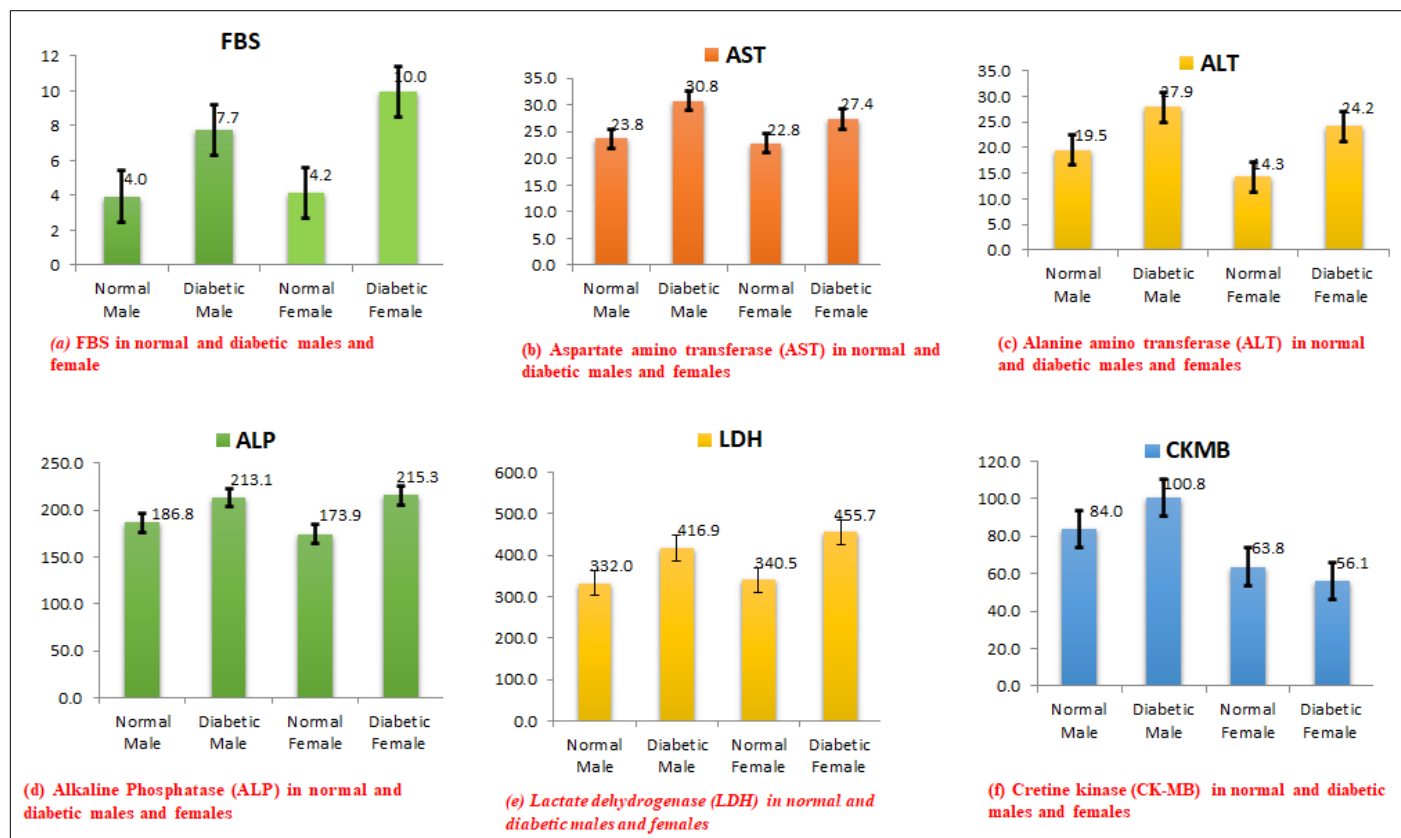
Five of 60 diabetic patients were CRP positive, while no CRP positive among non-diabetic patients. The mean values of FBS, HBA<sub>1c</sub>, AST, ALT, ALP, LDH, and CK-MB were significantly (p<0.05) higher among diabetic patients than the control (Table 2).

**TABLE 2:** Demographics, Inflammatory marker, Liver and Cardiac enzyme profiles in DM patients and healthy controls

Variable	Diabetes (n = 60)	Non-diabetes (n = 48)	P-value*
Sex (Male/Female)	26/34	12/36	0.047*
FBS (mg/dl)	9.00 ± 4.69	4.11 ± 0.55	0.000*
HBA <sub>1c</sub> (%)	5.99 ± 1.39	4.71 ± 0.76	0.000*
AST (U/L)	28.87 ± 12.45	23.06 ± 7.00	0.005*
ALT (U/L)	25.77 ± 12.49	15.56 ± 8.26	0.000*
ALP (U/L)	214.35 ± 99.84	177.13 ± 38.58	0.016*
LDH (U/L)	438.87 ± 312.36	338.38 ± 70.36	0.031*
CK-MB (U/L)	75.47 ± 68.24	68.81 ± 15.02	0.509
CRP (Positive/Negative)	5/55	0/48	0.041*

The biochemical parameters in normal and diabetic patients are expressed as Mean ± Standard Deviation.

Figure 1a shows the Full Blood Sugar (FBS) level in normal and diabetic patients. The mean FBS among DM patients was 10.0 mg/dl for females and 7.7 mg/dl for males ( $P = 0.000$  for both males and females). Figure 1b shows AST levels in both normal and DM patients. Mean AST was 30/8 U/L for diabetic males and 27.4 U/L for diabetic females, while 23.8 U/L and 22.8 U/L were seen for non-diabetic males and females ( $p = 0.051$  for males and  $p = 0.078$  for females). ALT was 19.5 U/L in normal males and 27.9 U/L in diabetic males, while it was 14.3 U/L and 24.2 U/L in normal and diabetic females, respectively ( $p = 0.044$  for males and  $0.000$  for males females) (Figure 1c). The mean ALP was 213.1 U/L and 215.3 U/L in diabetic males and females, while the values seen for normal males and females were 186.8 U/L and 173.9 U/L, respectively  $p = 0.471$  for males and  $0.008$  for females (Figure 1d). The mean LDH was 416.7 U/L in DM males and 455.7 U/L in DM females, while for normal males and females, the values recorded were 332.0 U/L and 340.5 U/L, respectively ( $p = 0.482$  for males and  $p = 0.004$  for females) as shown in Figure 1e. The mean CK-MB was 100.8 U/L for diabetic males and 84.0 U/L for non-diabetic males. In comparison, lower 63.8 U/L and 56.1 U/L values were seen for non-diabetic and diabetic females, respectively ( $p = 0.513$  for males and  $0.289$  for females) (Figure 1f).



**FIGURE 1:** Biochemical parameters in Normal individuals and Diabetic patient’s males and females

**DISCUSSION**

Although the overall mean values of HBA<sub>1c</sub>, AST, ALT, ALP, LDH, and CK-MB were within the normal range among diabetic patients, 55.0% had FBS values above the normal range. Also, the proportion of diabetic patients above the normal range of HBA<sub>1c</sub>, AST, ALT, ALP, LDH, and CK-MB was 48.3%, 16.0%, 15.0%, and 23.3%, 26.6%, and 36.6%, respectively. The mean values of FBS, HAB<sub>1c</sub>, liver enzymes as well as cardiac enzymes were also significantly higher in DM patients than in normal participants ( $p < 0.050$  except CK-MB, which was not statistically significantly higher in DM patients than in normal participants ( $p > 0.050$ ). This finding agrees with the literature [12-14].

Higher incidence of abnormal liver enzymes have been associated with Diabetes patients (type II) and elevated ALT being the most common abnormality [3,7,8,13,15]. The overall mean values of all biochemical parameters were within the normal range; however, high FBS, HBA<sub>1c</sub>, AST, ALT, ALP, LDH, and CK-MB were observed in 15.0% to 55.0% of the patients.

This finding is similar to what was observed in an over four-year cohort study of 959 diabetic patients in the United Kingdom; 15.7% had raised ALT, 10.4% had elevated alkaline phosphatase, whereas only 3.9% had hyperbilirubinemia<sup>[16]</sup>. A similar study conducted to evaluate abnormal liver function tests in diabetes patients in Myanmar, Malaysia reported a raised value of ALT and AST in 18.5% and 14.8% diabetic patients even though the mean values were within the normal range. In a similar study by Idris et al.<sup>[17]</sup>, 22% of diabetic patients had at least one abnormal liver function test. In Nepal, raised ALT and AST were reported in (57%) and (46%) diabetic patients, respectively<sup>[3]</sup>. Abnormal liver enzymes in diabetes patients can be attributed to several factors. The most common cause is that studies also associate diabetes and hepatitis C virus infection that causes deranged liver enzymes<sup>[5,6,18]</sup>. Though relatively infrequent, statin therapy can also contribute to abnormal liver enzymes<sup>[8]</sup>.

Glucose level was significantly higher ( $p < 0.01$ ) in male and female diabetic patients than in normal controls. Aspartate aminotransferase (AST) levels increased in male and female diabetic patients compared to normal controls. However, the increase was not statistically significant ( $p = 0.051$  for male and  $p = 0.078$  for female). The level of Alanine amino transferase (ALT) increased significantly ( $p < 0.05$ ) in both male and female diabetic patients as compared to normal controls. Alkaline phosphate (ALP) level was higher in both male and female diabetic patients than in controls. However, the differences were not significantly higher in DM males ( $p > 0.05$ ) but significantly higher in DM females than non-diabetic females ( $p < 0.05$ ). Lactate dehydrogenase (LDH) level was higher in male and female diabetic patients than normal control. However, the differences were not statistically significant in males ( $p > 0.05$ ) but statistically significant in females ( $p < 0.05$ ). Creatine kinase (CK-MB) level was higher in male diabetic patients than in normal control. On the other hand, CK-MB level was higher in normal control females than in diabetic patients. However, the differences were not statistically significant ( $p > 0.05$  for both males and females). In a comparable study conducted by Philip et al.<sup>[19]</sup>, ALT, AST, and GGT levels were shown to be significantly elevated ( $p < 0.01$ ) in diabetic individuals (males and females) when compared to normal controls. Ghimire *et al.*<sup>[3]</sup> found that, while not statistically significant, the values of both transaminases were higher in female diabetic patients than in male diabetic patients, which is consistent with the finding reported from Nigeria.<sup>[20]</sup> Similar studies, such as Bora et al.<sup>[21]</sup>, demonstrated substantial differences in transaminases levels between genders, although Ni et al.<sup>[22]</sup>, in contrast, this study demonstrated a significant difference in ALT levels between the two genders in diabetes subjects.

The fasting blood glucose (FBS), HbA1c, AST, ALT ALP, and LDH were raised significantly in diabetes mellitus patients compared to healthy controls ( $p < 0.05$ ), CK-MB also increased in DM cases than in controls, but it was not statistically significant ( $p = 0.509$ ). According to a study in Sudan by Idris et al.<sup>[17]</sup>, ALT, AST, total protein, and albumin were significantly higher among diabetes compared to the control. However, only ALT showed a statistically significant difference in this study, whereas AST did not.

A substantial increase in ALP was observed in this study among DM patients. Philip et al.<sup>[19]</sup>, in their study, showed a significant increase in AST and ALT ( $p < 0.01$ ) compared to healthy controls, findings of the present study are similar. Agrawal<sup>[23]</sup> in North India reported serum levels of AST, ALT, and ALP, and all were significantly elevated in diabetes mellitus patients as compared to controls ( $p < 0.05$ ). Ahmed<sup>[24]</sup> demonstrated that LDH and CK enzymes were highest in the study DM compared with control.

## CONCLUSION

This study found that the mean values of FBS, HbA<sub>1c</sub>, AST, ALT, ALP, and LDH were significantly higher in diabetic patients when compared to regular patients. Thorough checking of liver enzymes, ALT and AST, and LDH is advocated to screen the possibility of underlying fatty liver, which might need further evaluation and early intervention to prevent cirrhosis and chronic liver disease progression. Routine analysis of liver enzymes can help detect liver injury and cardiovascular accidents in diabetes mellitus patients. Timely diagnosis and management of the abnormal liver parameters may help minimize liver-related morbidity and mortality in the diabetic population.

**REFERENCES**

- [1] WHO. Global Report on Diabetes. Isbn 2016;978:6–86. Available from: [http://www.who.int/about/licensing/copyright\\_form/index.html](http://www.who.int/about/licensing/copyright_form/index.html)[http://www.who.int/about/licensing/copyright\\_form/index.html](http://www.who.int/about/licensing/copyright_form/index.html)<https://apps.who.int/iris/handle/10665/204871><http://www.who.int/about/licensing/>
- [2] Kilmer PD. Evaluation of Biochemical Parameters and Trace Elements in Type-2 Diabetic Patients. *Journal Theory, Pract Crit* 2010;11(3):369–73.
- [3] Ghimire S, Shakya S, Shakya J, Acharya P, Pardhe BD. Abnormal Liver Parameters among Individuals with Type 2 Diabetes Mellitus Nepalese Population. *Biochem Pharmacol Open Access* 2018;07(01):1–5.
- [4] Polat SB, Ugurlu N, Aslan N, Cuhaci N, Ersoy R, Cakir B. Evaluation of biochemical and clinical markers of endothelial dysfunction and their correlation with urinary albumin excretion in patients with type 1 diabetes mellitus. *Arch Endocrinol Metab* 2016;60(2):117–24.
- [5] Mandal A, Bhattarai B, Kafle P, Khalid M, Jonnadula SK, Lamicchane J, et al. Elevated Liver Enzymes in Patients with Type 2 Diabetes Mellitus and Non-alcoholic Fatty Liver Disease. *Cureus* 2018;92(Ci).
- [6] Shibabaw T, Dessie G, Molla MD, Zerihun MF, Ayelign B. Assessment of liver marker enzymes and its association with type 2 diabetes mellitus in Northwest Ethiopia. *BMC Res Notes* 2019;12(1):1–5. Available from: <https://doi.org/10.1186/s13104-019-4742-x>
- [7] Kashinakunti SV, Rangappa M, Kallaganada GS. Correlation between liver enzymes and lipid profile in type II diabetes mellitus. *IOSR J Biotechnol Biochem* 2017;3(5):1–5.
- [8] Harris EH. Elevated liver function tests in type 2 diabetes. *Clin Diabetes* 2005;23(3):115–9.
- [9] Legesse M. Comparison of Lipid Profile, Liver Enzymes, Creatine Kinase and Lactate Dehydrogenase of T2DM Patients who were on Statin Attending Diabetic Clinic of Tikur Anbesa Specialized Hospital. 2018;
- [10] Hall P, Cash J. What is the real function of the Liver “Function” tests? *Ulster Med J* 2012;81(1):30–6.
- [11] Eme OI, Idike A. Census Politics in Nigeria : An Examination of 2006 Population Census. *J Policy Dev Stud* 2015;9(3):47–72.
- [12] Wang YL, Koh WP, Yuan JM, Pan A. Association between liver enzymes and incident type 2 diabetes in Singapore Chinese men and women. *BMJ Open Diabetes Res Care* 2016;4(1):2–9.
- [13] Habte ML, Melka DS, Degen M, Menon MKC, Yifter H, Feyisa TO. Comparison of lipid profile, liver enzymes, creatine kinase and lactate dehydrogenase among type ii diabetes mellitus patients on statin therapy. *Diabetes, Metab Syndr Obes Targets Ther* 2020;13:763–73.
- [14] Lodgotra A, Verma P, Raj SS. Estimation of salivary and serum biomarkers in diabetic and non diabetic patients - A comparative study. *J Clin Diagnostic Res* 2016;10(6): ZC56–61.
- [15] Ahn HR, Shin MH, Nam HS, Park KS, Lee YH, Jeong SK, et al. The association between liver enzymes and risk of type 2 diabetes: The Namwon study. *Diabetol Metab Syndr* 2014;6(1):1–8. Available from: *Diabetology & Metabolic Syndrome*



- [16] Gonem, Sherif, Alan Wall and P De. Prevalence of abnormal liver function tests in patients with diabetes mellitus. *Soc Endocrinol Biosci* 2007;13(3).
- [17] Idris AS, Faisal K, Mekky H, Eldin B, Abdalla E, Ali KA. Liver function tests in type 2 Sudanese diabetic patients. *Int J Nutr Metab Vol* 2011;3(2):17–21.
- [18] Nazer RI, Abalhassan MF, Alburikan KA. Liver enzyme trends in patients taking uninterrupted metformin before and after coronary surgery. *Cardiovasc Diagn Ther* 2018;8(4):469–79.
- [19] Philip R, Mathias M, N. SK, M. DGK, K. JS. Evalation of Relationship Between Markers of Liver Function and the Onset of Type 2 Diabetes. *J Heal Allied Sci NU* 2014;04(02):090–3.
- [20] Et al. Liver Enzymes and Lipid Profile Among Type 2 Diabetic Patients in Osogbo, Nigeria. *Greener J Med Sci* 2013;3(5):174–8.
- [21] Bora K, Borah M, Chutia H, Nath CK, Das D, Ruram AA. Presence of Concurrent Derangements of Liver Function Tests in Type 2 Diabetes and Their Relationship with Glycemic Status: A Retrospective Observational Study from Meghalaya. *J Lab Physicians* 2016;8(01):030–5.
- [22] Ni H, Htoo Kyaw Soe H, Htet A. Determinants of Abnormal Liver Function Tests in Diabetes Patients in Myanmar. *Int J Diabetes Res* 2012;1(3):36–41.
- [23] Agrawal J. Prevalence of elevated hepatic enzymes among North Indian patients with type 2 diabetes mellitus. *Santosh Univ J Heal Sci* 2015;1(1):3–6.
- [24] Ahmed MAA. Correlation between Salivary Enzymes Levels CK and LDH with Severity of Chronic Periodontitis among Type 2 Diabetic Patients. *IOSR J Dent Med Sci* 2015;14(3):2279–861. Available from: [www.iosrjournals.org](http://www.iosrjournals.org)