

Study of Some Biochemical Parameters in Iraqi Type II Diabetics Patients

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ABSTRACT

Background: Diabetes mellitus is a metabolic disorder characterized by hyperglycemia due to impairment of insulin secretion, defective insulin action, or both.

Aim of study: The current study was planned to determine the serum levels of some biochemical parameters FSG, HbA1c, Lipid profile, and Renal functions in type 2 diabetics (T2D).

Methods: Twenty-one Iraqi T2D patients and 21 control subjects matched for age and ethnic background were also included randomly selected from those attending Diabetes Center for Treatment at Ramadi General Hospital for the period from beginning November 2017 to the end of May 2018.

Result: The mean levels of Blood pressure, FSG, HbA1c, Cholesterol, TG, LDL, VLDL, and S.Cr showed highly significant increase in group B Compared to A as well as the mean levels of HDL, T.P, Alb/Cr ratio and globulin showed highly significant decrease in group B compared to A. In contrast showed no statistical significant in mean levels of Age, WHr ratio, THr ratio, urea, UA, Albumin, Ca and Mg between group B and A. The receiver operator curve (ROC) investigation of the anticipated varieties uncovered the slipping request of HbA1c, FSG, TP, TG, VLDL, HDL, Cholesterol, LDL, Globulin, Alb/Cr ratio, Albumin, Cr, UA, Alb/Gratio, Urea, Ca, WHr ratio, THr ratio and Mg respectively that showed significant variation.

In conclusion, high level of HbA1c%, FSG, TG, VLDL, Total Cholesterol, LDL, S.Cr, SUA and low levels of T.P, HDL, S.Globulin, Alb/Cr ratio, and S.Albumin were associated with an increased risk of T2DM, especially in obese Iraqi diabetics.

Keywords: HbA1c, Lipid profile, Renal function, Type 2 Diabetics.

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INTRODUCTION

Diabetes is a metabolic disorder characterized by hyperglycemia when the pancreas cannot make insulin, or the body cannot make good use of the insulin it produces or both. The chronic hyperglycemia of diabetes is associated with relatively specific long-term microvascular complications affecting the eyes, kidneys, and nerves.¹

Type 2 diabetics (T2D) is a metabolic issue described by raised glucose with regards to fringe insulin opposition and relative insulin lack, T2D accounts for about 90–95 % of all diabetes cases.²

The hemoglobin A1C (HbA1c) is as often as possible utilized in individuals with T2D as a proportion of how their glucose is controlled. HbA1c midpoints an individual's glucose levels from the past 2–3 months, and usually utilized amid starting analysis, patients with T2D need to keep their HbA1c levels underneath 7% (essentially, at 6.5%),³ to decrease the long haul danger of microvascular difficulties, for example, diabetic retinopathy, nephropathy and neuropathy.^{3,4}

The lipid variations from the norm in patients with diabetes are assuming a critical job in the improvement of atherogenesis. These lipid issues incorporate quantitative as well as a subjective anomaly of possibly atherogenic lipoproteins.⁵ Quantitative irregularities incorporate expanded dimensions of absolute plasma cholesterol, TG, VLDL, and LDL-cholesterol and the diminished dimension of HDL-cholesterol, Qualitative variations from the norm incorporate change in the arrangement of LDL-cholesterol (little thick LDL-cholesterol, increment TG substance and increment electronegativity of LDL-cholesterol). These progressions make LDL-cholesterol vulnerable to oxidation and glycation with significant froth cell arrangement, endothelial brokenness, and atherosclerosis.⁶ Urea is an organic compound, and It is major nitrogenous end product resulting from the metabolic breakdown of protein and amino acids, Urea is incorporated in the liver by the catalysts of the urea cycle, It is en-emitted into the circulation system and sequestered by the kidneys for discharge in the urine.⁷ Creatinine (Cr) is a break-down product of creatine phosphate

in muscle and is typically delivered at a genuinely steady rate by the body (contingent upon bulk), It is an unexpectedly framed cyclic subordinate of creatine. Cr is essentially sifted through of the blood by the kidneys (glomerular filtration and proximal cylindrical discharge). If the sifting of the kidney is insufficient, Cr blood levels rise. In like manner, Cr levels in blood and urine may be used to figure the Cr slack, which reflects the glomerular filtration rate (GFR).⁸

Uric acid (UA) is the final result of purine digestion in people, overabundance serum gathering can prompt different sicknesses, and most quite UA is caused of gouty joint pain.⁹ Many investigations have recommended that hyperuricemia is related to an expanded danger of episode cardiovascular occasions and passing in both non-diabetic and T2D people.¹⁰

Albumin orchestrated in the liver from 585 amino acid units. It is very soluble protein is available in human plasma at typical fixations somewhere in the range of 35 and 50 g/l. It is transmitted metals, unsaturated fats, cholesterol, bile shades, and medications. It is a key component in the guideline of osmotic weight and conveyance of liquid between various compartments.¹¹

The total serum protein (T.P) test estimates the aggregate sum of protein in blood serum just as the measures of albumin and globulin, which are the primary two gatherings of protein. It can likewise check the measure of albumin Which have been contrasted with globulin, or what's called your "A/G proportion."¹²

Calcium (Ca) assumes critical jobs in auxiliary cell segments and biochemical working through motioning inside and outside to the cell, It is the most common cation in the body and is found in the skeleton, delicate tissue, and extracellular liquid, Ca exists in 2 unique structures, bound and free.¹³ Circulating Ca fixations are firmly constrained by the parathyroid hormone (PTH) and nutrient D to the detriment of the skeleton when dietary Ca admission are lacking.¹⁴

Magnesium (Mg) is a vital factor for compounds associated with carbohydrate metabolism, and proof recommends the nearness of a critical job for hypomagnesemia in Insulin Resistance and metabolic control.¹⁵ A chronic latent Mg deficit or overt clinical hypomagnesemia is common in patients with T2D.¹⁶

OBJECTIVES

The point of this investigation is to survey the dimension of some biochemical parameters in serum for Iraqi patients with type 2 diabetes (group B) by measuring the level of plasma glucose, lipid profile test and renal function test, measuring protein, albumin, and globulin ratio as well as measuring the proportion of calcium and magnesium and comparing them with healthy controls group A.

MATERIAL AND METHODS

The present examination was led at the Center of Diabetes for Treatment at Ramadi General Hospital for the period from

beginning November 2017 to the end of May 2018. The study included dealing with 42 people divided into two groups, the age range within 35 to 65 years.

The first group A is the healthy group and includes 21 healthy individuals without T2D, None of the healthy control was taking any medicine or dietary supplement; they were selected after a detailed physical examination and laboratory tests.

The second group B, the group of T2D patients includes 21 individuals.

Samples collection: Five mL of venous blood samples were drawn from both groups after fasting 12 hours, using. The blood test was partitioned into two aliquots; 1 and 4mL. The primary aliquot was moved in a test tube containing ethylene diamine tetraacetic acid (EDTA) (1.5 mg/mL). This blood was set up in less than three hours and was used for HbA1c estimation, while the second aliquot were moved into plain tube without anticoagulant, permitted to clump for thirty minutes following which examples were centrifuged for 15 minutes at 4000 xg. At that point, serum was isolated and put away promptly at (- 20°C) until used in the estimation of plasma glucose level, lipid profile, urea, creatinine, serum uric acid, Albumin, protein, Ca and Mg. Weight, height, Waist/Hip ratio, and Thoracic/Hip ratio.

The kits were used are available in the commercial markets and equipped by (LINER–Spain), and biochemical parameters was determined by using the colorimetric method.

STATISTICAL ANALYSIS

All information is displayed as middle; all factual investigation was performed utilizing SPSS measurable programming (version 24). Receiver operator curve (ROC) investigation was likewise utilized. The factual criticalness, bearing and nature of the straight association between's two quantitative elements, one of which being a non-regularly appropriated variable, was evaluated by Spearman's rank direct relationship coefficient, and a probability (P) regard not actually the 0.05 was considered statistically significant

RESULT

As shown in table 1, Forty-two of the control and diabetic subjects were interviewed. Twenty-Eight percent (28.6%: n=12) of them were female, with 71.4%: n = 30 being male. As shown in Table 1, although the gender differences in the two study groups were slightly higher among cases, the difference was not statistically significant.

As shown in Table 2, The mean levels of systolic blood pressure, diastolic blood pressure, mean blood pressure, pulse rate, FSG, HbA1c, cholesterol, TG, LDL and VLDL showed highly significantly increase ($p < 0.001$) in patients with T2D Group B compared to healthy control Group A. Also the mean of creatinine showed were significantly higher ($p = 0.012$) between cases with T2DM for group B compared to healthy

control group A. As well as the mean levels of HDL, S. total protein and albumin/creatinine ratio showed highly significant decrease ($p < 0.001$) in patients with group B compared to group A. Also the results of globulin showed were significantly lower ($p = 0.013$) in cases with Group B compared to Group A. In contrast showed no statistical significant in mean levels of Age, waist-hip ratio, Thoracic-hip ratio, urea, uric acid, albumin, Ca and Mg [$p = 0.92$ (NS), $p = 0.3$ (NS), $p = 0.32$ (NS), $p = 0.13$ (NS), $p = 0.05$ (NS), $p = 0.19$ (NS), $p = 1$ (NS), $p = 1$ (NS)] between group B and group A as shown in Table 2.

Table 3 shows the receiver operator curve (ROC) examination of the anticipated varieties uncovered the sliding request of HbA1c% (1.000), FPG (0.998), S.Total Protein

(0.964),S. Triglycerides (0.949), S. VLDL (0.948), S.HDL (0.934), S.Total Cholester(0.896), S.LDL (0.821), S. globulin (0.805), albumin/creatinine ratio (0.801) S.albumin (0.756), S.creatinine (0.731), S.uric acid (0.708).

Table 3 shows the validity parameters for selected indices when used as a test to predict the new cut-off values for diagnosis of T2DM differentiating it from healthy controls.

DISCUSSION

The frequency of dyslipidemia is more noteworthy in people with T2DM who are midway fat, expanded lipolysis makes the liver increment glucose and VLDL yield. This prompts an ascent in blood glucose and triglycerides, a drop in HDL cholesterol and an expansion in little, thick LDL particles.¹⁷

Table 1: Gender differences in two study groups.

Study groups		Control group (A)	Patients group (B)	Total
Gender	Male(N)	16	14	30
	%	76.2 %	66.7 %	71.4 %
	Female(N)	5	7	12
	%	23.8 %	33.3 %	28.6 %
Total	21	21	42	
P value	= 0.44[NS]			

Table 2: Parameters differences in the two study groups.

Parameters	Control group A Mean ± SD	Patients group B Mean ± SD	P Value
Age	49.6 ± 8.9	50.8 ± 8.2	= 0.92[NS]
waist-hip ratio	0.99	1.01	= 0.3[NS]
Thoracic-hip ratio	0.98	0.99	= 0.32[NS]
Systolic blood pressure	115.4 ± 5.7	142 ± 22.3	< 0.001
Diastolic blood pressure	76.9 ± 3.6	91.9 ± 12.9	< 0.001
Blood pressure (mmHg)	89.7 ± 4	108.6 ± 15.5	< 0.001
Pulse rate (beat/min)	71.6 ± 4.3	86 ± 6.9	< 0.001
FSG (mg/dL)	88	207	< 0.001
HbA1c %	4.8 ± 0.7	10.6 ± 1.6	< 0.001
Cholesterol (mg/dL)	172	204	< 0.001
TG (mg/dL)	95	181	< 0.001
HDL (mg/dL)	42	33	< 0.001
LDL mg/dL	109	141	< 0.001
VLDL (mg/dL)	19	36	< 0.001
Urea (mg/dL)	28	31	= 0.13[NS]
Creatinine (mg/dL)	0.66	0.79	= 0.012
Uric acid (mg/dL)	4.27 ± 0.62	5.5 ± 1.69	= 0.05[NS]
Albumin (g/dL)	4.34 ± 0.22	4.03 ± 0.33	= 0.19[NS]
S.Total protein (g/dL)	8.19 ± 0.41	7.21 ± 0.38	< 0.001
Globulin (g/dL)	3.85 ± 0.51	3.18 ± 0.48	= 0.013
Albumin/Creatinine ratio	6.46	5.34	< 0.001
Albumin/globulin ratio	1.14	1.31	= 0.037
Ca (mg/dL)	9.34 ± 0.78	9 ± 0.84	= 1[NS]
Mg (mg/dL)	1.95 ± 0.28	1.99 ± 0.17	= 1[NS]

T2D- Type 2 diabetics, BP-Blood pressure, FSG-Fasting serum glucose, TG-Triglyceride, VLDL-Very low density lipoprotein, HDL-high density lipoprotein, LDL-Low density lipoprotein, S.UA- Serum uric acid, T.P-Total protein, S.Cr-Serum Creatinine, ALB/CR-Albumin/Creatinine, ALB/G-Albumin/globulin, S.Ca-Serum Calcium, Mg-magnesium, WHr-Waist-hip ratio THr-Thoracic-hip ratio, NS-Non significantly, healthy controls.

An increase in the systolic and diastolic blood pressure is the major risk for macrovascular complications in T2DM.

Several possible factors are likely to be associated between T2DM and hypertension; there is evidence for both sodium retention and activation of the renin-angiotensin system (RAS), increased frequency of hypertension because of obesity and metabolic syndrome, diabetes accelerates the rise of blood pressure (BP) with age. Up to 75% of specific cardiovascular complications have been in diabetics can be attributed to hypertension.

This results agreed with other studies that demonstrated an elevated BP level in type 2 diabetic subjects compared to controls.¹⁹

Hypertension is known as a “quiet executioner” since it frequently has no undeniable indications and numerous individuals are uninformed they have it. A 2013 review by the American Diabetes Association (ADA) found that less than half of individuals in danger for coronary illness or type 2 diabetes revealed talking about biomarkers, including blood pressure, According to ADA, Having T2D and hypertension likewise builds your odds of creating different diabetes-related maladies, for example, kidney infection and retinopathy. Diabetic retinopathy may cause visual impairment²⁰

T2DM is portrayed by fasting hyperglycemia and an inordinate, delayed ascent in the plasma glucose focus after glucose or feast ingestion. The fasting hyperglycemia has been attributed to resulting mostly from an increased rate of glucose production, which could result from an increased rate of hepatic glycogenolysis and gluconeogenesis.²¹

The consequences of this investigation indicated huge increment of glucose in T2DM when contrasted and control subjects. The reasons of this state which typically shows up after the age of 40 years may incorporate shortcoming of β -cell, small amounts of insulin creation as well as capacity and expanding insulin obstruction.²²

Glucose is the major source of energy used by the cells. Notwithstanding, glucose can't enter the cell except if insulin is there. In a regularly working pancreas, a sufficient measure of

insulin is delivered to move glucose into cells. In an irregular pancreas, practically zero insulin is created, or the body cells don't react to the insulin that is delivered. Subsequently, glucose amasses in the blood and its focus is raised and causes diabetes mellitus.²³

HbA1c variability was associated with macrovascular disease in T2D patients, whereas short-term glucose variability was associated with both macrovascular and microvascular²⁴ The HbA1c has been utilized as a target marker of normal glycemic control in light of the fact that the dimensions of HbA1c in the blood mirror the glucose levels which erythrocyte has been uncovered amid its lifetime of the RBC, which is roughly 120 days.²⁵

The results of Lipid profile study agreed with other studies. The result indicates the presence of a significant increase ($p < 0.0001$) in serum TG, TC, LDL-C, and VLDL-C. Serum HDL-C levels were significantly decreased ($p < 0.0001$) in T2D patients.

Patients with T2DM frequently have an abnormal blood lipid profile which increases in Triglyceride (TG), cholesterol (LDL-C) and Very low-density lipoprotein -cholesterol (VLDL-C). High-density lipoprotein-cholesterol (HDL-C) showed a decrease in a patient with T2D compared to control.²⁶

In diabetes, numerous variables may influence blood lipid level, this is on the grounds that starch and lipid digestion systems are interrelated to one another if there is any confusion in sugar digestion, it additionally prompts lipid digestion issue, This result may because of these patients with T2D used a treatment to lower lipids in the blood. TG concentration showed a significant increase in a patient with T2D compared to control. This result is in agreement with (Shamsa, 2014).²⁷

TG level increment is ascribed to insulin lack causing hyperglycemia and activation of unsaturated fats from fat tissue, The unsaturated fats from fat tissue are assembled for vitality reason and abundance unsaturated fats are collected in liver and are changed over to triglyceride, the VLDL-C increment of patients with T2DM perhaps result from hyperinsulinemia and resultant increment in triglycerides, LDL-C and VLDL-C. It is realized that insulin and development hormone advance the generation of VLDL-C by invigorating lipolysis in the fat tissues and triglycerides in the liver, patients with T2DM showed altogether expanded plasma LDL-C cholesterol levels, could be ascribed to the way that, insulin builds the quantity of LDL-C receptors so unending insulin inadequacy, as found in T2DM, may be related with a lessened dimension of LDL-C receptor and resulting ascend in plasma LDL-C cholesterol levels.²⁸

The present study showed high urea levels was noted in patients with T2DM, compared to controls. However the difference was not statistically significant, the reason may be these patients maintained acceptable levels of blood sugar and thus didn't affect the function of the Kidney, thus the levels of urea didn't rise statistically significant.

Table 3: The area under ROC curve for selected quantitative variables when used as test to diagnose (predict) uncomplicated DM compared to

Parameters	ROC	P
HbA1c %	1.000	<0.001
Fasting Serum Glucose (mg/dL)	0.998	<0.001
Serum Total Protein (g/dL)	0.964	<0.001
Serum Triglycerides (mg/dL)	0.949	<0.001
Serum VLDL (mg/dL)	0.948	<0.001
Serum HDL (mg/dL)	0.934	<0.001
Serum Total Cholesterol(mg/dL)	0.896	<0.001
Serum LDL (mg/dL)	0.821	<0.001
Serum Globulin (g/dL)	0.805	<0.001
Albumin/creatinine ratio	0.801	0.001
Serum albumin (g/dL)	0.756	0.006
Serum Creatinine (mg/dL)	0.731	0.011
Serum uric acid (mg/dL)	0.708	0.022

Creatinine is the end product that is normally cleared from the blood and excreted with the urine it is the end product of creatinine clearance. An increase in creatinine concentration in diabetic patients may be related to disturbance of kidney function.⁵

The DM is a moderate dynamic malady portrayed by hyperglycemia. After some time, high glucose levels harm millions of nephrons-modest separating units within every kidney. Thus, kidneys can't keep up the liquid and electrolyte homeostasis. The glomerulus separates creatinine; along these lines, the serum creatinine level is utilized as a roundabout proportion of glomerular filtration. As the glomerular filtration rate (GFR) reduces, there is an ascent in a convergence of serum creatinine. Besides, the ascent demonstrates the movement of kidney ailment and estimation of serum creatinine has more prominent prognostic capacity contrasted and urea for anticipating the antagonistic results.²⁹ Serum uric acid (SUA) is produced by the metabolism of nitrogen bases(Purine), and it is considered as a risk factor for diabetes complication. In the study, there are significant differences in Iraqi patients with T2D. This result is the same as in the (Gawlik et al., 2015).³⁰

The result protein study showed decrease protein levels in patients with T2DM, compared to controls, Furthermore the reason for such decrease protein concentration, T2DM patients experience the ill effects of expanded urinary that outcome as a result of high glucose obsession, such augmentation leads to the cell siphoning the water (hydration) to the flow framework which causes extended urinary and besides debilitating of glucose center and protein obsession.³¹ Low albumin levels were noted in patients T2D, contrasted with controls. Anyway, the thing that matters was not measurably critical. The reason might be these patients kept up satisfactory dimensions of glucose, and along these lines didn't influence the capacity of the kidney, in this manner, the dimensions of albumin didn't rise factually critical.

Concentrate by Schmidt et al. propose brought down albumin levels in diabetics. When we examine albumin levels in our patients, we expect a noteworthy fall in albumin levels. In any case, despite what might be expected, mean albumin was in the typical reference go and there was no huge distinction between albumin evels in patients and control gathering. This finding can be credited to compensatory increment in albumin blend in diabetics with albuminuria.³²

Interestingly we observed positive correlations between urine Albumin to creatinine ratio, albumin globulin to ratio and plasma creatinine levels, which in consistence with patients with T2DM likely showing beginning periods of diabetic nephropathy.³³

The relationship between serum calcium levels and danger of occurrence T2D was not apparent, while higher dietary calcium admission was related with a diminished danger of episode T2D.

Past investigations on the connection between serum calcium levels and T2D have indicated clashing results. The reason behind the abnormality in the results isn't clear. In any case, differences in supplement D, parathyroid, and phosphorus

levels might be accountable for the abnormality.³⁴

The result magnesium study showed no association between serum magnesium levels and a risk of incident T2D in patients with T2DM, compared to controls.

CONCLUSION

Studies have appeared basic significance of, overweight and heftiness especially of long length, in the advancement of sort 2 diabetes and support the current public health recommendations to diminish the danger of T2DM by forestalling overweight.³⁵

REFRANCES

- 1 Punthakee, Z., Goldenberg, R. & Katz, P. (2018). Definition, Classification and Diagnosis of Diabetes, Prediabetes and Metabolic Syndrome. *Can J Diabetes*, 42 (1), S10-S15.
- 2 American Diabetes Association. (2018). 2. Classification and diagnosis of diabetes: standards of medical care in diabetes—2018. *Diabetes care*, 41(Supplement 1), S13-S27.
- 3 Sandoiu A. (2018). Type 2 diabetes: New guidelines lower blood sugar control levels. *Medical News Today*.
- 4 Qaseem, A., Wilt, T.J., et al. (2018). Hemoglobin A1c Targets for Glycemic Control With Pharmacologic Therapy for Nonpregnant Adults With Type 2 Diabetes Mellitus: A Guidance Statement Update From the American College of Physicians. *Ann Intern Med*, 168 (8), 569-576.
- 5 Ozmen, B., Ozmen, D., Turgan, N., et al. (2002). Association between homocysteinemia and renal function in patients with type 2 diabetes mellitus. *Annals of Clinical & Laboratory Science*, 32 (3), 279-286.
- 6 Hovind, P., Rossing, P., et al. (2009). Serum uric acid as a predictor for development of diabetic nephropathy in type 1 diabetes. *Diabetes*, 58(7), 1668-1671.
- 7 Nisha, R., Srinivasa Kannan, S.R., Thanga Mariappan, K., & Jagatha, P. (2017). Biochemical evaluation of creatinine and urea in patients with renal failure undergoing hemodialysis. *Journal of Clinical Pathology and Laboratory Medicine*, 1 (2), 1-5.
- 8 Gross, J.L., de Azevedo, M.J., Silveiro, S.P., et al. (2005). Diabetic nephropathy: diagnosis, prevention, and treatment. *Diabetes Care*. 28(1): 164-76.
- 9 Koenig, W., Meisinger, C. (2008). Uric acid, type 2 diabetes, and cardiovascular diseases: Fueling the common soil hypothesis? *Clin Chem* 54 (2): 231-233.
- 10 Zoppini, G., Targher, G., Negri, C., et al. (2009). Elevated serum uric acid concentrations. independently predict cardiovascular mortality in type 2 diabetic patients. *Diabetes Care*, 32 (9), 1716-1720.
- 11 Roche, M., Rondeau, P., Singh, N.R., Tarnus, E., and Bourdon, E. (2008). The antioxidant properties of serum albumin. *Fed. Eur. Biochem. Soc*, 582 (13), 1783-1787.
- 12 Abbass, S.A.R, & Defer, I.H. (2011). Some Biochemical Parameters in Iraqi Patients With Thalassemia and related with DM1. *Int. J. Chem. Res.*, 1 (5), 46-56.
- 13 Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (2012). *Tietz textbook of clinical chemistry and molecular diagnostics-e-book*. Elsevier Health Sciences.
- 14 Delage, B. (2017). Calcium, Online. Oregon State University available from <http://ipi.oregonstate.edu/mic/minerals/calcium>.
- 15 Dr.Alagavenkatesan, V.N., Dr.Anandhi, P.G., Dr. Balamurugan, P. V., et al., (2016). A study of serum magnesium level in patients with type 2 diabetes mellitus. *International Journal*

- of Information Research and Review; 3 (11), 2957-2959
- 16 Barbagallo, M. and Dominguez, L.J. (2015). Magnesium and type 2 diabetes. *World J Diabetes.*, 6 (10), 1152–1157.
 - 17 Krishnaswami, V. (2010). Treatment of dyslipidemia in patients with type 2 Diabetes. *L.H.D.*, 9 (144), 1-12
 - 18 Campbell, N.R.C., Gilbert, R.E., et al., (2011). Hypertension in people with type 2 diabetes. *Can Fam Physician*; 57 (9), 997–1002.
 - 19 Mohammed, A.A., Alderzi, N., Adeeb, S.S., et al., (2013). Correlation of Total Cholesterol and Glucose in Serum of Iraqi Patients with Atherosclerosis and Diabetes Mellitus Type 2. *Eng. & Tech. Journal*, 31 (6), 801-808.
 - 20 Marcin, J. (2018). Type 2 Diabetes and High Blood Pressure, What's the Connection. *Joann Jovinelly*
 - 21 Parker, J.C. (2004). Glucose-6-phosphatase inhibitors, *Drugs of the Future*, 29 (10), 1025-1033.
 - 22 Chang, A.M., & Halter, J.B. (2003). Aging and insulin secretion. *American Journal of Physiology-Endocrinology And Metabolism*, 284(1), E7-E12.
 - 23 Emanuele, N., Klein, R., Moritz, M., et al. (2008). Comparison of dilated fundus examinations with seven-field stereo fundus photographs in the Veterans Affairs Diabetes Trial. *Journal of diabetes and its complications*, 23(5), 323-329.
 - 24 Hirakawa Y, Arima H, Zoungas S, Ninomyia T, Cooper M, Hamet P, et al.,. (2014). Impact of visit-to-visit glycemic variability on the risks of macrovascular and microvascular events and all-cause mortality in type 2 diabetes: the Advance trial. *Diabetes Care*, 37, 2359–65.
 - 25 Mulani, M.R. and Gawali, P.S. (2016). Effect of Iron deficiency on glycation of hemoglobin in non-diabetics. *ACCLM*, 2 (2): 4-7.
 - 26 Aziz, S.B., Mohi aldeen S.K., & Chlimeran, S.K. (2013). Evaluation of lipid profile in patients with type II diabetes mellitus on different treatment. *Tikrit Journal of Pharmaceutical Sciences*, 9 (1), 253-261.
 - 27 Finch, W., Shamsa, K., & Lee, M.S. (2014). Cardiovascular complications of radiation exposure. *Rev Cardiovasc Med*, 15(3), 232-244.
 - 28 Majid, A. et al., (2018). Study of some biochemical parameters for patients with Type II Diabetes Mellitus in Thi-Qar Governorate, Iraq. *J. Pharm. Sci. & Res.*, 10 (11), 2938-2941.
 - 29 Al-Rawi, K.F., Taleab, S.F., Saif Allah P.H., & Al-Korwi, E.N. (2013). Evaluation of vitamin C, uric acid, urea and creatinine levels in the blood of Type 2 diabetic Iraqi females. *J. of University of Anbar for pure science*, 7 (2).
 - 30 Gawlik, K., Naskalski, J.W., Fedak, D., Pawlica-Gosiewska, D., Grudzień, U., Dumnicka, P., ... & Solnica, B. (2015). Markers of antioxidant defense in patients with type 2 diabetes. *Oxidative medicine and cellular longevity*, 2016.
 - 31 Hasan, H.R., & Abdulsattar, A. (2015). Influence of diabetes disease on concentration of total protein, albumin and globulins in saliva and serum: A comparative study. *Iraqi National Journal of Chemistry*, 15 (1), 1-11.
 - 32 Malawadi, BN., & Adiga, U. (2016). Plasma Proteins in Type 2 Diabetes Mellitus. *Journal of Biotechnology and Biochemistry*, 2 (5), PP 01-03
 - 33 Karar, T., Al Tamimi, W., Alanazi, A., et al.,. (2015). Assessment of microalbuminuria and albumin creatinine ratio in patients with type 2 diabetes mellitus. *J Nat Sci Biol Med.*, 6 (1): S89-S92.
 - 34 Kim, K.N., Oh, S.Y. and Hong YC. (2018). Associations of serum calcium levels and dietary calcium intake with incident type 2 diabetes over 10 years: the Korean Genome and Epidemiology Study (KoGES). *Diabetology & metabolic syndrome*, 10(1), 50.
 - 35 Powers, A.C. (2005). Diabetes Mellitus. In: Kasper DL (ed). *Harrison's Principles of Internal medicine*. 16th ed. Mc Graw-Hill companies. Inc.; Vol II: pp 2152-80.

