

Research Article

The Correlation Study Between Lipid Profile Parameters and Hba1c In Type 2 Diabetic Patients Compare with Healthy Persons in Babylon Province

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Abstract:

This study was aimed to evaluate the connection between lipid profile and glycated hemoglobin (Hba1c) parameters (LDL, HDL, VLDL, cholesterol and triglyceride) in the patients of type 2 diabetes mellitus compare with healthy person, also determine the significant differences between these parameters among healthy and diabetic patients, after assumed whole blood and serum specimens from laboratory of Diabetes and Endocrinology Center in Marjan hospital and private in the Babylon City between the period from October 2022 to February 2023.

The results revealed significant differences ($P < 0.05$) between study groups in the levels of Hba1c, also it was revealed significant increase ($P < 0.05$) in all lipid profile include: cholesterol, LDL, HDL, VLDL levels in diabetic group of study compare with control, the results showed significant positive correlation between VLDL and Hba1c in diabetic group, also it was revealed positive correlation between cholesterol and Hba1c in control and diabetic groups, and the results showed negative correlation between triglycerides and Hba1c in both control and diabetic groups, and the results revealed significant positive correlation between body mass index and glycated glucose (Hba1c) in diabetic group.

The research was concluded that the lipid profile level in diabetic patients is correlated with the HbA1c value and the significant positive correlation was conducted between HDL and Hba1c in diabetic group, also the study was concluded significant differences ($P < 0.05$) between diabetic and healthy group in the levels of Hba1c and other lipid profile parameters.

Keywords: Lipid profile, diabetes type 2, Hba1c.

Introduction

Persistent hyperglycemia is the main sign of a variety of metabolic disorders collectively referred to as diabetes mellitus. Either impaired insulin secretion, impaired insulin effect, or typically both are the root causes.[1].

The Federation Internationale Diabetes estimates that 382 million people worldwide are affected by diabetes. This will rise to twice as many as 592 million by 2035. One of the most important health issues in the world today is diabetes. The risk of long-term complications is higher in all forms of diabetes. These usually appear after several years (10–20), but in those who have not been diagnosed before then, they might be the first signs. [2].

There are two forms of diabetes mellitus: type 1 diabetes, which primarily affects children and is caused by a malfunction in the

way the body makes insulin and uses it. Adults with type 2 diabetes frequently develop the condition where the body does not produce enough insulin or cells [3].

The symptoms of polygenic disease include extreme thirst, frequent urination, perspiration, blurred vision, abrupt weight loss, exhaustion, and slowly healing sores. Patients with polygenic disease typically experience nephropathy, polyphagia, and thirst [4].

Adopting a healthy diet, exercising, abstaining from tobacco use, and maintaining a normal body weight are all part of prevention and treatment. For those who have the condition, controlling blood pressure and taking good care of their feet are also crucial. Insulin injections are the only way to treat type 1 diabetes. Insulin or pharmaceuticals combined with it is effective in treating type 2 diabetes.. Low blood sugar is a side

effect of some oral medications and insulin [5].

According to the clinical study that concluded, there was a significant positive correlation between lipid profiles and HbA1c level. Patients with diabetes mellitus had higher levels of TG, LDL/HDL, and TG/HDL and lipid ratios (TG/HDL, TC, and TG-C) than did healthy individuals [6]. These results demonstrate a relationship between lipid profiles and the glycemic index, as well as vice versa. This suggests a potential link between dyslipidemias and glycemic control in diabetes mellitus patients. The purpose of this study is to investigate the relationship between lipid profile and lipid ratio, and to use these lipid parameters as biochemical markers that can be used to predict glycemic index control in patients with type 2 diabetes [7].

Every nation has a high and growing diabetes-related disease burden, which is exacerbated by the increased prevalence of obesity and unhealthy lifestyles worldwide. According to the most recent estimates, the prevalence of diabetes in Northern America and the Caribbean region was 11.1% in 2019 and is predicted to increase to 13% by 2045. The Middle East and North Africa have the highest prevalence rates, with 13.9% more cases expected there by 2045. Africa has the lowest prevalence rate (4.7%), but by 2045, it is predicted to rise to 5.2%. South America and Southeast Asia are generally home to either high or intermediate incidences of [8].

Since each patient's etiology of the disease is unique, developing effective treatment strategies for diabetes is challenging due to its complex nature. In research on the genesis of diabetes, a universal cure is highly desirable because it is improbable [9].

Unlike type 1 diabetes, type 2 diabetes patients have difficulty developing treatment strategies because their cells are less able to absorb glucose from the blood. This can be caused by genetic mutations or desensitization of receptors. Regrettably, new research suggests that desensitization to insulin therapy in type 1 diabetics may result in the development of type 2 diabetes [10].

Materials and Methods

Patients or subjects

Serum and whole blood specimens were collected from laboratory of Diabetes and Endocrinology Center in Marjan hospital and private in the Babylon City during the period from October 2022 to February 2023. The study was included 50 samples, that composed from 30 samples from diabetic patients type 2 and 20 samples from healthy person.

The equipment's was used in the present study explained in the table 1.

Table 1 materials and method equipment's.

Equipments	Company/ origin
1- Plane Centrifuge	Hettic/ Germany
2-Micropipette, 100-1000 µl	Dragon lab/ china
3-refrigerator	Samsung / china
4-Micropipette, 10-100 µl	Dragon lab/ china
5- autophotoanalyzer	Spinreact / spanish
6- ichroma devise HbA1c test	Medlap/ Korean

Chemical materials

1- HbA1c kit uses to determine HbA1c levels in different samples, specific kit which manufactured by Ichromax: Biotech-medical / Korean company.

a- Principle of the method

The test makes use of a sandwich immune-detection technique, whereby the immobilized antibody on the test strip captures the detector antibody in the buffer after it binds to the antigen in the sample to form antigen-antibody complexes and migrates onto nitrocellulose matrix. The amount of antigen in the sample increases the amount of antigen-antibody complexes, which intensifies the fluorescence signal on the detector antibody. The glycated hemoglobin content in terms of percentage of total hemoglobin in blood is displayed by the Ichroma™ test instrument.

b- Procedure

- 1) The detection buffer tube was filled with (100 µL) of hemolysis buffer.
- 2) The blood sample (5 ml) was added into the detection buffer tube.
- 3) After closing the detection buffer tube's lid and giving the sample a good shake for around fifteen times, it was thoroughly mixed.
- 4) The cartridge half was removed from the i-Chamber slot.
- 5) The sample mixture (75 ml) was pipetted out and added to the test cartridge's sample well.
- 6) The windows display the flow of the sample mixture. (Roughly ten seconds)
- 7) The cartridge was placed inside the i-Chamber.
- 8) The cartridge was removed from the i-Chamber after being there for 12 minutes.
- 9) To scan, the sample-loaded cartridge was inserted into the cartridge holder of the ichroma™ test device. Prior to fully putting the cartridge into the cartridge holder, make sure it is oriented correctly. There's an arrow marked on the cartridge especially for this purpose.
- 10) the process was started after chose start in ichroma.
- 11) The test result was readed on the display screen of the instrument for ichroma™ tests.

Reference value

Instrument for ichroma™ tests calculates the test result automatically and displays HbA1c concentration of the test sample in terms of %

Normal range = 4.5-6.5 %

2- Determination of Lipid profile parameters

a- Triglycerides evaluation

Principle of the method:

Sample triglycerides incubated with lipoproteinlipase (LPL), liberate glycerol and free fatty acids. Glycerol is converted to glycerol-3-phosphate (G3P) and adenosine-5-diphosphate (ADP) by glycerol kinase and ATP. Glycerol3-phosphate (G3P) is then converted by glycerol phosphate dehydrogenase (GPO) to dihydroxyacetone phosphate (DAP) and hydrogen peroxide (H2O2). In the last reaction, hydrogen peroxide (H2O2) reacts with 4- aminophenazone (4-AP) and p-

chlorophenol in presence of peroxidase (POD) to give a red colored dye.

Reference values

Men 40 – 160 mg/dL Women 35 – 135 mg/dL.

b- Cholesterol evaluation

Principle of the method

The following reactions indicate that the sample's cholesterol causes the formation of a colored complex:

Cholesterol esters + H₂O → CHE Cholesterol + fatty acids

Cholesterol + O₂ → CHOD 4-Cholestenona + H₂O 2 H₂O₂

+ Phenol + 4-AP → POD

Quinonimine + 4H₂O

The amount of cholesterol present in the sample directly correlates with the color's intensity.

Reference value:

Less than 200 mg/dL.

c- High Density Lipoprotein Cholesterol evaluation (HDL)

Principle of the method

Directly determination of serum HDLc (high-density lipoprotein cholesterol) levels without requiring the sample to be centrifuged or subjected to any prior preparation.

The assay takes place in two steps.

- 1- Elimination of lipoprotein no-HDL Cholesterol esters → CHE Cholesterol + Fatty acids Cholesterol + O₂ → CHOD Cholestenone + H₂O 2 H₂O₂ → Catalase 2H₂O + O₂
- 2- Measurement of HDLc Cholesterol esters → CHE Cholesterol + Fatty acids Cholesterol + O₂ → CHOD Cholestenone + H₂O 2 H₂O₂ + HDAOS + 4-AA → POD Quinone Pigment + 4H₂O The intensity of the color formed is proportional to the HDLc concentration in the sample.

Reference value:

Men: 35 – 50 mg/dL Women: 45 – 60 mg/dL.

d- Low Density Lipoprotein Cholesterol (LDLc)

Principle of the method

Low-density lipoprotein cholesterol (LDLc) levels can be directly measured in the serum without the need for centrifugation or any prior preparation.

The assay takes place in two steps.

- 1-Elimination of lipoprotein no-LDL Cholesterol esters → CHE Cholesterol + Fatty acids Cholesterol + O₂ → CHOD 4-Cholestenone + H₂O 2 H₂O₂ → Catalase 2H₂O + O₂
- 2-Measurement of LDLc Cholesterol esters → CHE Cholesterol + Fatty acids Cholesterol + O₂ → CHOD 4-Cholestenone + H₂O 2 H₂O₂ + TODS + 4-AA → POD Quinonimine + 4H₂O The intensity of the color formed is proportional to the LDLc concentration in the sample.

Reference value:

100-129 mg/dL.

e- Very Low Density Lipoprotein (VLDL)

Principle of the method

It is the primary structural apolipoprotein in chylomicron, LDL (low density lipids), and VLDL (very low density lipids) lipoproteins.

Assay for measuring apolipoprotein B in human serum or plasma using turbidimetric methods. Insoluble complexes are formed when anti-Apo B antibodies are combined with Apo B-containing samples. These complexes alter the absorbance, which can be measured by comparing the patient sample's Apo B concentration to that of a calibrator with a known Apo B concentration.

Reference value:

Between 69 – 105 mg/dL.

3- Procedure of Lipid Profile Parameters:

All parameters in lipid profile participate in same procedure of spinreact devise:

- 1-The kits were calibrated according to the kit materials of the same company (SPINREACT)
- 2-According to the aforementioned parameters, it contains the calibration values for each test so that it is relied upon to extract the values for the tests to be measured.
- 3-The tests to be performed are determined from the list of tests.
- 4- Plotting the values obtained against the para concentration of each calibrator dilution allowed for the calculation of the absorbance difference at each point on the calibration curve.
- 5-Then the start icon was pressed to start the auto/photoanalyzer processing.

Body mass index calculation

Equilibrium was used to calculate the body mass index:

$$BMI = \frac{weight}{length^2}$$

[11].

Statistical Analysis

The Independent Sample T test experiment design, It uses linear equations to express these relationships and each relationship's correlation coefficient, was used to compare the quantity of lipid profile parameters in different groups and to infer the significance, mean, and standard error (SE) using the well-known statistical system, statistical package for social science (SPSS) (version 22.0). The extent of the two axes and the nature of the linear relations are reflected in these factors [12].

Results and Discussion

The results revealed non-significant differences (P>0.05) between diabetic and control groups in age, which refer to all persons in the same age, also it revealed significant differences (P < 0.05) between study groups in the levels of HbA1c, which may refer to disease effect on these patients and lead to elevation in HbA1c in diabetic group, Because it gives details regarding the average blood glucose levels during the previous few months, the HbA1c is a helpful diabetes biomarker [2]. A

number of factors, such as sugar consumption, exercise, and medication adherence, can affect HbA1c levels. In some studies, HbA1c may be a reliable indicator of dyslipidemia and CVD [13], Nowadays, HbA1c is a reliable indicator of hyperglycemia because it shows sugar buildup on the Hb [14].

Table 2 significant differences (P<0.05) between control and diabetic group (type 1and 2) in the parameters of study

Parameters	Diabetic patients Mean ± SE	Control Mean ± SE	SIG	P value
Age	38.65 ± 2.63	35.22 ± 5.43	0.38	0.05
HbA1c	7.83 ± 0.36	4.662 ± 0.123	0.02	
Cholesterol	203.4 ± 49.55	168.54 ± 30.15	0.0038	
LDL	109.65 ± 33.45	98.45 ± 25.6	0.010	
HDL	50.16 ± 11.35	23.54 ± 0.33	0.002	
VLDL	43.33 ± 16.54	23.14 ± 9.55	0.012	
BMI	88.349 ± 21.87	67.33 ± 13.47	0.02	

Also it was revealed significant increase (P<0.05) in all lipid profile include: cholesterol, LDL, HDL, VLDL levels in diabetic group of study compare with control, which may refer diabetic dyslipidemia is associated with multiple factors, such as the impact of insulin on apoprotein production in the liver, lipoprotein lipase regulation, the activities of cholesteryl ester transfer protein (CETP), and peripheral effects of insulin on muscle and adipose tissue [15].

Diabetic dyslipidemia, a term used to describe lipid abnormalities in patients with diabetes, is commonly associated with elevated levels of small dense LDL particles, low levels of high density lipoprotein cholesterol (HDL-C), high

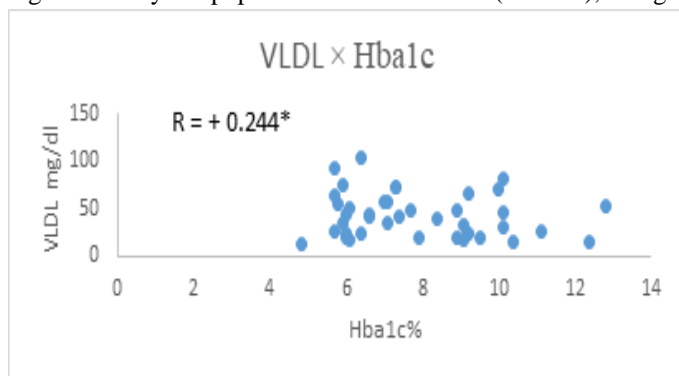


Figure 1 positive correlation between VLDL and Hba1c in control group

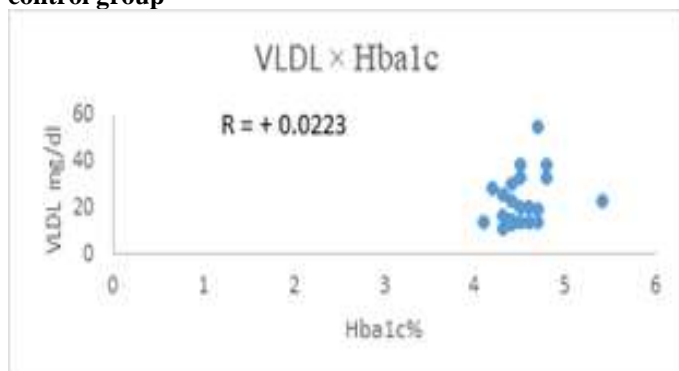


Figure 2 significant positive correlation between VLDL and Hba1c in diabetic group

triglycerides (Tg), and high total cholesterol (T-Chol). LDL-C, or low density lipoprotein cholesterol, levels can be either normal or slightly elevated. People with prediabetes and type 2 diabetes frequently have abnormal lipid levels [16], According to abnormal levels of the recently published meta-analysis, which aforementioned lipid parameters are somewhat indicative of the risk of type 2 diabetes (T2DM). Additionally, research in individuals with T2DM has revealed a stronger correlation between CAD and low HDL-C and high Tg when the two lipid parameters are evaluated separately [17].

Other study revealed a robust correlation between T2DM and prediabetes and serum lipids, it is still unknown whether insulin resistance causes dyslipidemia despite a wealth of evidence pointing to a strong correlation between IR and dyslipidemia. The concept that insulin resistance's clinical and metabolic phenotypes may vary depending on a person's diabetes status further muddies the sequence of this relationship [18].

Insulin resistant is also linked to elevated levels of hepatic triglyceride lipase, which may cause HDL to decrease and be cleared more quickly. A crucial element an accelerated rate of lipolysis of stored TG-derived free fatty acids (FFA) from adipose tissue is involved in the mechanism of both increased VLDL-TG production and IR, with subsequent increases in FFA flux to the liver. [19].

Furthermore, even though insulin is a significant adipose lipoprotein lipase stimulant. Insulin resistance, then, may decrease the breakdown of VLDL and thereby raise hypertriglyceridemia. Moreover, TG-rich lipoprotein TG clearance may be lowered in T2DM as a result of decreases in skeletal muscle LPL. Indeed, it has been suggested that the lipoprotein lipase gene may be a potential gene for insulin resistance [20].

The results showed significant positive correlation between VLDL and Hba1c in diabetic group (figure 2), also that appeared in control group, which may be refer to Hypertriglyceridemia is another common finding in type 2 diabetic patients. The pathophysiology of hypertriglyceridemia has been suggested to involve increased VLDL production and decreased serum lipoprotein lipase activity [21]. Other studies have found a significant positive correlation between VLDL secretion and serum insulin level. In contrast, a number of other studies have demonstrated that acute hyperinsulinemia reduced the synthesis of VLDL in the liver of non-diabetic individuals (in our study, there was a very clear correlation between rising levels of HbA1c, s.triglyceride, and VLDL),[14].

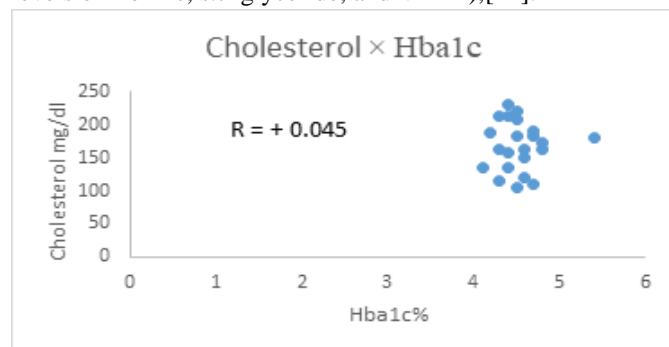


Figure 3 positive correlation between cholesterol and Hba1c in control group

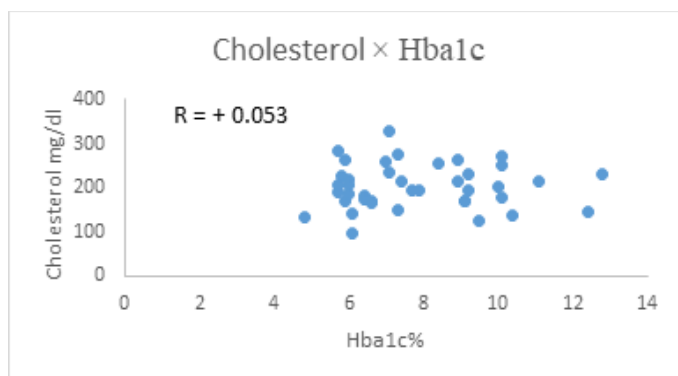


Figure 4 positive correlation between cholesterol and Hba1c in diabetic group

Also, it was revealed positive correlation between cholesterol and Hba1c in control and diabetic groups, in figures (3-3) and (3-4) consequently, which may refer to normal state and balanced between glycated glucose and cholesterol improved control of hyperglycemia does mitigate diabetes-associated dyslipidaemia, and lipid abnormalities may be the consequence of the unbalanced metabolic state of diabetes (hyperglycemia and insulin resistance) [22].

Diabetes causes damage to the artery lining. Those with diabetes, who generally higher levels of LDL/non-HDL (bad) cholesterol and lower levels of HDL (good) cholesterol, are therefore more likely to have cholesterol adhere to them, narrowing or even blocking them. This condition, which is commonly referred to as "dyslipidemia," increases the risk of artery narrowing or blockage [23].

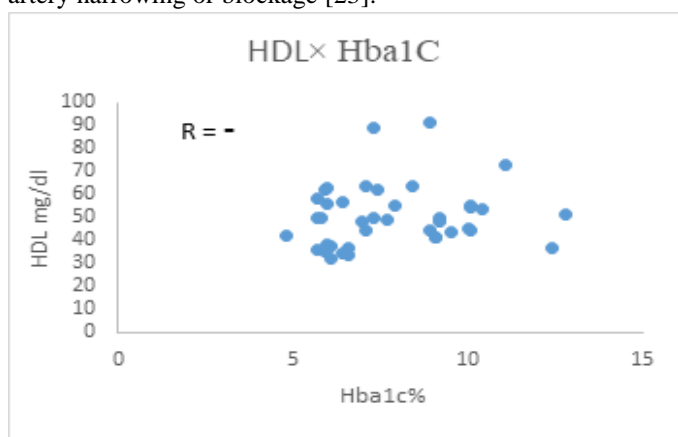


Figure 5 negative correlation between HDL and Hba1c in control group

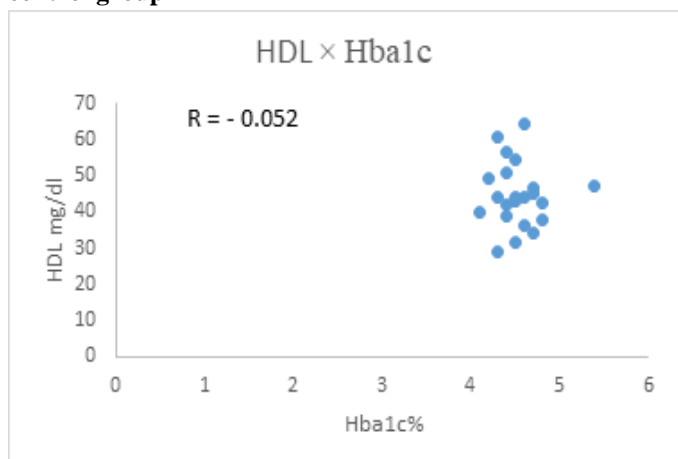


Figure 6 negative correlation between HDL and Hba1c in diabetic group

The results showed negative correlation between triglycerides and Hba1c in both control and diabetic groups figures (5) and (6) which may due to poor glycemic management, Nevertheless, given that elevated triglyceride and decreased HDL cholesterol levels are thought to be hallmarks of insulin resistance and diabetes, these associations should be interpreted cautiously. According to recent research, aberrant glucose metabolism may be made worse by low HDL-C levels [24]. In patients with diabetes, blood sugar regulation may have an impact on triglyceride and HDL cholesterol levels because insulin resistance is thought to alter triglyceride and HDL C levels [25].

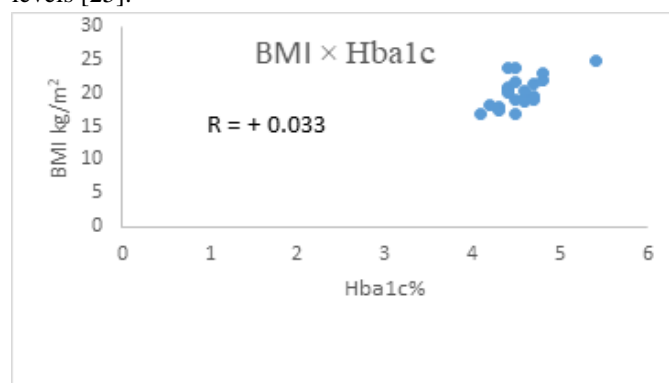


Figure 7 positive correlation between BMI and Hba1c in control group

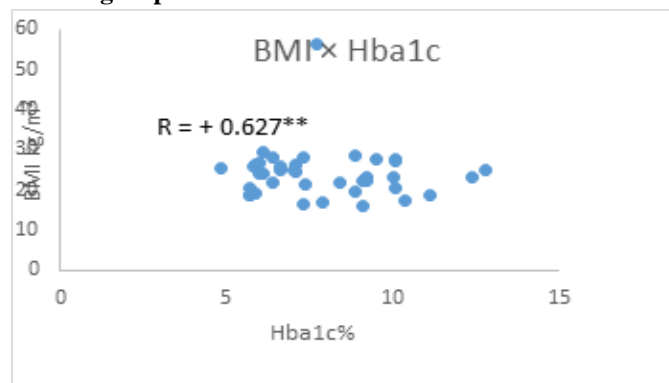


Figure 8 significant positive correlation between HDL and Hba1c in diabetic group

The results revealed there is a strong positive relationship between body mass index and glycated glucose (Hba1c) in diabetic group figure (8) compare with control also that has positive correlation between it figure (7), which may be refer to The proportion of patients classified as having glycemic control declined while mean BMI increased. These findings are in line with earlier studies that found a positive correlation between higher BMI and higher HbA1c [26]. Therapies that lower BMI and HbA1c may have a substantial effect on the management of T2D, given the rise in BMI and declining proportion of T2D adults who were able to control their blood sugar levels during the study period. The increasing percentage of younger adults with higher mean BMIs could continue to be a significant target subgroup [27].

Conclusions and Recommendations

Conclusions

1-The research was concluded that the lipid profile level in

diabetic patients is correlated with the HbA1c value.

2- The significant positive correlation was conducted between HDL and Hba1c in diabetic group,

3- The study was concluded significant differences ($P < 0.05$) between diabetic and healthy group in the levels of Hba1c and other lipid profile parameters.

Recommendations

1-Repeat the study in large number of samples in cohort study instead of case control study.

2-Study the relationship between Hba1c and other parameters such as lactate dehydrogenase (LDH) and alkaline phosphatase (ALP) in diabetic patients.

3- Comparison study the Hba1c and lipid profile levels in different type of diabetes mellitus.

Authors' contributions

All authors had 1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND 2. Drafting the work or revising it critically for important intellectual content; AND 3. Final approval of the version to be published; AND 4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethical approval:

The human study was approved by the Al-Qasim Green University, Babylon Province, Iraq Review Board.

Conflicts of Interest:

The authors declare no conflict of interest.

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