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Impact of Different Diabetes Treatments on Lipid and Carbohydrate Metabolism

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This paper aims to investigate lipid and carbohydrate metabolism changes in diabetic individuals undergoing various therapies compared to clinically healthy individuals. Given that carbohydrate metabolism disorders often lead to lipid and lipoprotein metabolism disorders, the study measures biochemical parameters such as glucose, triglycerides, total cholesterol, HDL-cholesterol, and LDL-cholesterol to achieve its aim. 166 individuals between the ages of 30 and 49 participated in the study and were split into four groups: clinically healthy controls, diabetics receiving diet therapy, diabetics receiving oral antidiabetics, and diabetics receiving insulin. Following a 12- to 14-hour fast, blood samples were examined for glucose, triglycerides, total cholesterol, HDL, and LDL cholesterol. The study found significant differences in the concentrations of biochemical parameters between diabetic patients and healthy controls. Diabetic patients treated with insulin exhibited the highest levels of glucose, triglycerides, and total cholesterol, followed by those treated with diet, oral antidiabetics, and the control group. HDL and LDL cholesterol levels were lower in diabetics compared to controls, except for those treated with insulin, who had higher LDL cholesterol levels. In contrast to the 30-39 age group, the 40-49 age group showed the highest parameter values. The findings highlight that different diabetes treatments significantly impact lipid and carbohydrate metabolism, with insulin treatment showing the most pronounced effects. These results suggest the need for personalized treatment strategies to manage diabetes effectively, particularly in mitigating cardiovascular disease risks associated with lipid metabolism disturbances.

Keywords: Biochemical Parameters, Carbohydrate Metabolism, Cardiovascular Disease, Diabetes, Lipid Metabolism.

Diabetes is a complex health problem primarily caused by a lack of insulin[1], which is why it leads to disorders of carbohydrate metabolism, as well as lipid and protein metabolism. Chronic pathologically elevated blood glucose levels are a clinical symptom of this condition.

The absence of insulin results in a number of pathophysiological alterations that raise blood glucose levels[2]. The production of ketone bodies as a result of these metabolic alterations lowers the levels of cholesterol, triglycerides, and free fatty acids.

Secondary diabetes[3] is the result of some other disease, which leads to the disruption of the production of hormones that initiate hyperglycemia. This is how secondary diabetes occurs in pancreatic carcinoma[4]. Consuming regular meals. is crucial for regulating blood sugar levels because it provides

the body with glucose, galactose, and fructose hexoses and other carbs that swiftly enter the liver through the portal circulation. Because it provides a source for the synthesis of glucose from metabolic byproducts including lactic and pyruvic acids, glycerol, and certain amino acids, glycogenesis is extremely significant.

This way of supplying glucose is used by the body, especially in conditions when it is not supplied with carbohydrates in sufficient quantities, then the liver plays an important role because it synthesizes sufficient amounts of glucose from the substances highlighted through gluconeogenesis, which serves the renewal of reserve glycogen in the liver respectively for the maintenance of glycaemia in the body[5].

The main objective of this study is to examine and elucidate the effects of different diabetes treatments on lipid and carbohydrate metabolism and to compare these metabolic changes with those observed in clinically healthy individuals [6]. Specifically, the study aims to evaluate metabolic changes from different therapeutic approaches to diabetes management – such as dietary therapy, oral antidiabetic therapy, and insulin therapy and the impact on metabolic processes in patients with diabetes.

It also aims to identify risk factors for complications, and how these metabolic changes are related to the risk of developing diabetes-related complications, especially cardiovascular diseases, which are greatly influenced by lipid and glucose metabolism.

The study aims to highlight the specific metabolic disturbances caused by diabetes and its treatments by comparing the metabolic profiles of diabetic patients under various treatment regimens with those of clinically healthy individuals. Additionally, the study will educate and support clinicians and health professionals in creating personalized diabetes treatment plans based on individual metabolic responses to various therapies, which will improve treatment efficacy and overall patient outcomes.

This study will advance our knowledge of diabetes as a metabolic condition and offer insights that might result in more focused and efficient treatment approaches.

MATERIALS AND METHODS

The qualitative research approach is the foundation of this study. The study was conducted at the ENDDILAB, a private laboratory in Gjakova-Kosova, as well as the Biochemical Laboratory of the National Center of Occupational Medicine in Gjakova.

166 individuals between the ages of 30 and 39 and 40 and 49 were examined. As a control group, we used patients who donated blood for transfusions, who were clinically healthy in terms of their lipid and carbohydrate metabolism, as well as patients at the Biochemical Institute who had their cholesterol, triglycerides, and glucose levels measured in addition to other testing. The experimental group consisted of diabetic patients.

The serums of diabetic patients and the serum of control group patients were analyzed. For the performance of this work, blood donor serums were divided into 4 groups:

1. Control group with normal glucose and normal lipemia, no. patients (persons): 33, age 30-49 years from both sexes.
2. Diabetics treated with diet: number of persons -42, age 30-49 years from both sexes.
3. Diabetics treated with oral antidiabetics, no. of 43 persons, of both sexes, age 30-49.
4. Diabetics treated with insulin: no. of 48 persons, age 30 - 49 years, both sexes.

Procedure

Twelve to fourteen hours after the last meal, in the morning, the analyses were carried out. A kinetic-spectrophotometric approach is used to measure the amount of glucose in solution in order to estimate glycemia. At 400 nm, measurements were made; the negative peak was produced by subtracting the myoglobin (Mb) absorption spectra before and after oxidation. This approach involves adding glucose to a combination of glucose oxidase and MG. Glucose oxidase converts glucose to gluconate, which is then converted to hydrogen peroxide. The heme Mb (Fe2+) is oxidized to Fe3+ by the produced hydrogen peroxide. The more glucose is added, the more H2O2 is produced and the more Mb is oxidized (Fe2+ to Fe3+), which raises the absorbance at 400 nm (negative point, lower absorption value).

One aqueous reagent was used for the enzymatic measurement of cholesterol. Pretreatment of the sample is not required for the method, and the calibration curve is linear at 600 mg/dl. To release cholesterol, cholesterol esters are hydrolyzed by cholesterol ester hydrolase (EC 3.1.1.13). Cholesterol oxidase produces hydrogen peroxide and changes free cholesterol into cholest-4-en-3-one. When peroxidase is present, this hydrogen peroxide forms an oxidative bond with phenol and 4-amino antipyrine to produce a chromogen that The enzymatic breakdown of serum or plasma triglycerides by lipoprotein lipase (LPL), which produces glycerol and free fatty acids (FFA), is the basis for the triglyceride measurement method. Adenosine triphosphate (ATP) phosphorylates glycerol in the presence of glycerol kinase (GK), resulting in the production of glycerol-3-phosphate (G-3-P) and adenosine diphosphate (ADP). Glycerophosphate oxidase (GPO) oxidizes G-3-P to produce hydrogen peroxide and dihydroxyacetone phosphate (DHAP). Peroxidase (POD) catalyzes the coupling of 4-aminoantipyrine (4-AA) and phenol with hydrogen peroxide (H2O2), resulting in the production of a red chromogen proportional to the sample's triglyceride content.

Differential precipitation and additional sedimentation of the remaining lipoproteins and chylomicrons are avoided in the direct method, which is a homogeneous enzymatic test used for the quantitative measurement of cholesterol in low density lipoproteins (LDL). The process is divided into two stages. Together, cholesterol oxidase (CO) and cholesterol esterase (CE) break down the cholesterol in the test sample's lipoproteins other than LDL at a pH of 7.0. Hydrogen peroxide and cholesterolestenone are the final products, which catalase subsequently converts to oxygen and water. The second step is adding a surfactant that specifically acts on LDL cholesterol to the reaction's product. This is done using a Trinder-type reaction, where the aniline derivative HDAOS* and 4-aminoantipyrine (4-AA) as a coupling reagent are condensed by H2O2 in the presence of peroxidase (POD) to form a quinoneimine red color proportional to the concentration of LDL cholesterol present in the mixture.

A selective separation method was employed to measure HDL (high density lipoprotein). Phosphotungstic acid/MgCl2 precipitated lipoproteins containing apoprotein B (VLDL, LDL, and (a)Lpa), sedimented the precipitant by centrifugation, and then analyzed the residual cholesterol in the clear supernatant to determine HDL.

RESULTS

As we pointed out in the material and methods chapter, since age affects the level of metabolism, the patients were divided into two age groups (Gr. I: 30-39 years; and Gr. II: 40-49 years). Using the serum of the control and the test groups we have measured: a) the glucose values (Table 1), with reference values for glucose are 4.0-6.0 mmol / L, b) the triglyceride values (Table 2) with reference values of 0.8-2.0 mmol/L. c) cholesterol values (Table 3) with referential (normal) value of 3.6-5.7 mmol / L., d) values of HDL-cholesterol (Table 4) with reference (normal) value of - 0.9-1.2 mmol / L and e) the LDL-cholesterol values.

Tables 1, 2, and 3 demonstrate that the concentrations of glucose, triglycerides, and total cholesterol are greater in diabetics of both ages who are receiving diet, oral antidiabetic, and insulin treatment than in the control group. The data in question also suggest that when these biochemical markers are examined between the two age groups, the 40–49 age group has a larger concentration of them than the 30-39 age group. Insulin-treated diabetics had greater levels of glucose, triglycerides, and total cholesterol when these parameters are compared across diabetics receiving various therapy.

Additionally, our study demonstrated that, when compared to the control group of individuals of both ages, the variation in HDL and LDL cholesterol concentrations does not follow a similar pattern to the concentrations of other biochemical parameters (glucose, triglycerides, and total cholesterol) in diabetics treated as previously mentioned. For instance, table 4 shows that the control group of adults had greater HDL cholesterol levels than diabetics do.

In contrast to HDL cholesterol, LDL cholesterol values are higher in diabetics compared to the control group of people. The exception here was LDL cholesterol in diabetics treated with oral

antidiabetics, in the age group of 30-39 years, where the concentration of LDL cholesterol is higher (4.8 + 0.13 mmol / L), compared to the control group of the same age group (3.5 + 0.16 mmol / L), tab. No. 5.

The statistical processing of the results and the comparison of the concentration of these biochemical parameters (glucose, triglycerides, total cholesterol, HDI. and LDL cholesterol) not only with the control group, but also among themselves, is given in the tables. 6,7,8,9 and summary tables 0 and 11.

In compared to the similar values observed in the control group of individuals, Tables 6 and 7 demonstrate that the concentrations of glucose ($P < 0.01$), triglycerides ($P < 0.01$), and total cholesterol ($P < 0.01$) are considerably greater in both age groups of diabetics receiving oral antidiabetic treatment. According to the tables, diabetics have lower HDL and LDL cholesterol levels than the control group, which consists of individuals in both age categories, albeit not significantly ($P > 0.05$). Here, there was an exception: the concentration

Table 1. Glucose values (mmol/1) in the serum of control group people and diabetics with different therapies

Group	30 – 39 years old	40 – 49 years old
Control group	5.23 ± 0.7 mmol / L	5.35 ± 0.86 mmol / L
Diabetics on a diet	8.85 ± 1.05 mmol / L	9.06 ± 0.45 mmol / L
Diabetics with oral therapy	11.8 ± 1.04 mmol / L	12.4 ± 0.98 mmol / L
Diabetics with insulin	15.4 ± 1.14 mmol / L	16.7 ± 1.50 mmol / L

Table 2. Triglyceride values analyzed (mmol/l)

GROUP	30 - 39 years old	40 - 49 years old
Control group	1.43 ± 0.74 mmol / L	1.62 ± 0.93 mmol / L
Diabetics on a diet	1.9 ± 0.76 mmol / L	2.2 ± 1.12 mmol / L
Diabetics with oral therapy	2.4 ± 0.75 mmol / L	2.5 ± 0.93 mmol / L
Diabetics with insulin	2.8 ± 0.68 mmol / L	3.1 ± 1.45 mmol / L

Table 3. Cholesterol values analyzed (mmol/l) in the serum of people of the control group and diabetics treated with different therapies in the age group 30-39, 40-49 years old.

	30 - 39 years old	40 - 49 years old
Control group	5.0 ± 1.0 mmol / L	5.23 ± 0.98 mmol / L
Diabetics on diet	5.4 ± 0.75 mmol / L	6.0 ± 0.82 mmol / L
Diabetics with oral therapy	6.4 ± 0.7 mmol / L	6.9 ± 0.78 mmol / L
Diabetics with insulin	7.2 ± 1.1 mmol / L	7.8 ± 1.14 mmol / L

Table 4. The values of HDL-cholesterol analyzed (mmol/I)

Control group	30 - 39 years old	40 - 49 years old
Diabetics on a diet	1.15 ± 0.32 mmol / L	1.13 ± 0.42 mmol / L
Diabetics with oral antidiabetics	1.10 ± 0.65 mmol / L	1.10 ± 0.60 mmol / L
Diabetics with insulin	0.62 ± 0.24 mmol / L	0.7 ± 0.34 mmol / L
Normal values for LDL- cholesterol	0.6 ± 0.34 mmol / L	0.6 ± 0.38 mmol / L
Control group	3.9 - 4.9 mmol / L	

of LDL cholesterol was greater in the 40–49 age group (7.1 ± 0.31 mmol/L) than in the control group (6.p ± 0.22 mmol/L). (tab. 8, 9.) The difference is substantial (P < 0.01).

The statistical analysis of the data showed that compared to diabetics treated with oral antidiabetics, those treated with insulin had substantially higher levels of glucose (P < 001), total cholesterol (P < 0.01), and LDL cholesterol (P < 0.01) in all age categories. In neither age group were there any appreciable differences in the levels of HDL cholesterol and triglycerides between the previously described groups.

The average values of triglycerides, cholesterol, glucose, HDL, and LDL cholesterol are shown in Table 10 for the control group and diabetics receiving diet, oral antidiabetics, and insulin, respectively, in the 30-39 and 40-49 age

Table 5. Values of LDL-cholesterol analyzed: mmol / 1 in the serum

GROUP	30 - 39 years old	40 - 49 years old
Control group	3.5 ± 0.16 mmol / L	3.8 ± 0.23 mmol / L
Diabetics on a diet	3.2 ± 0.30 mmol / L	4.2 ± 0.40 mmol / L
Diabetics with oral antidiabetics	4.8 ± 0.13 mmol / L	6.0 ± 0.22 mmol / L
Diabetics with insulin	5.2 ± 0.40 mmol / L	7.1 ± 0.31 mmol / L

Table 6. The concentration of some biochemical parameters (mmol/l) in the serum of people of the control group and diabetics with a diet in the age group of 30-39 years

Age group 30-39 years	Glucose	Triglycerides	Cholesterol – total	HDL - chol.	LDL – chol.
GR. of control	5.23 ± 0.7	1.2 ± 0.74	5.10 ± 1.0	1.15 ± 0.31	3.5 ± 0.16
Diet diabetics 30-39 years old	8.95 ± 1.05	1.9 ± 0.76	5.4 ± 0.75	1.10 ± 0.65	3.2 ± 0.30
t	15.37	4.12	1.5	0.43	1.12
P significance	P<0.1	P<0.01	P>0.05	P>0.05	P>0.05
%	1.71%	1.58%	1.58%	0.95%	0.91%

Table 7. The concentration of some biochemical parameters (mmol / L) in the serum of people of the control group and diabetics with a diet in the age group of 40-49 years

Age group	Glucose	Triglycerides	Cholesterol	HDL - chol.	LDL - chol.
Gr. of control	5.35 ± 0.86	1.62 ± 0.92	5.23 ± 0.98	1.13 ± 0.42	3.8 ± 0.23
Diet diabetics 40-49 years old	9.60 ± 0.46	2.2 ± 1.12	6.0 ± 0.82	1.12 ± 0.60	4.2 ± 0.40
t	24.7	3.06	3.45	0.23	3.13
P significance	P<0.01	P<0.01	P<0.01	9<0.05	P<0.01
%	1.79%	1.35%	1.15%	0.99%	1.10%

Table 8. Concentrations of some biochemical parameters (mmol/l) in the serum of people in the group of diabetics treated with oral antidiabetics and those treated with insulin in the age group of 30-39 years

Age group	Glucose	Triglycerides	Cholesterol	HDL - chol.	LDL - chol.
Oral antidiabetic 30-39 years	11.8 ± 1.04	2.4 ± 0.75	6.4 ± 0.7	0.62 ± 0.24	4.8 ± 0.13
Diabetics with insulin 30-39 years old	15.0 ± 1.14	2.8 ± 0.68	7.2 ± 1.1	0.6 ± 0.34	5.2 ± 0.40
t	12.85	2.19	3.47	0.27	3.1
P significance	P<0.01	p>0.05	P<0.01	p>0.05	P<0.01
%	1.27%	1.16%	1.12%	0.96%	1.1%

Table 9. The concentration of some biochemical parameters (mmol/l) in the serum of people in the group treated with oral antidiabetics and those treated with insulin in the age group 40-49 years old

Age group	Glucose	Triglycerides	Cholesterol	HDL - chol.	LDL - chol.
Oral antidiabetic 40-49 years old	12.4 ± 0.98	2.5 ± 0.93	6.9 ± 0.78	0.7 ± 0.34	6.0 ± 0.22
Diabetics with insulin	16.7 ± 1.50	3.1 ± 1.45	7.8 ± 1.14	0.61 ± 0.38	7.1 ± 0.31
t	13.0	1.88	3.6	1.05	3.3
P significance	P<0.01	P>0.05	P<0.01	p>0.05	P<0.05
%	1.34%	1.24%	1.13%	0.87%	1.187%

groups. The table also shows the percentage of increase, respectively decrease in the concentration of these analyzed parameters in diabetics, compared to the control group.

DISCUSSION

Diabetes mellitus, often known as diabetes illness, is a metabolic endocrinological condition. The cause is the pancreatic hypofunction, specifically the problem with the B-Lagerhans island cells' inability to synthesize and secrete insulin. This hormone controls how proteins, lipoids, lipoproteins, and carbs are metabolized. In the human body, diseases of protein and lipid metabolism are linked to abnormalities of glucose metabolism. Serial alterations in blood and serum biochemical markers are linked to this metabolic disease. In this manner, the body uses lipids, namely triglycerides, as an energy source instead of glucose. Because of the potential for ketone bodies to develop and metabolic acidosis to ensue, this can seriously harm the body. Biochemical parameters such as measurement of glucose, triglycerides, total cholesterol, HDL-cholesterol, and LDL-cholesterol are standard practice in assessing metabolic control in patients with diabetes. These parameters are critical indicators of cardiovascular risk and are influenced by both lifestyle factors and therapeutic interventions. The observed differences in biochemical parameters between different age groups in our study highlight the importance of age-specific management strategies in diabetes care. Regarding our research's findings regarding the fluctuations in the levels of various biochemical blood parameters, specifically serum (glucose, triglycerides, total cholesterol, HDL cholesterol, and LDL cholesterol), in diabetic patients of various ages following treatment with diets, oral antidiabetic medications, and insulin, it should be mentioned that, based on the literature we had access to and our limited Internet usage, we did not find any papers that took this approach. For this reason, we shall try our best to avoid commenting on these findings.

In this context, we are only emphasizing (that compared to the control group), the most pronounced changes in these parameters (it is about concentration) in diabetics are in order: insulin > oral antidiabetic therapy > diet > control.

This study also revealed that the 30- to 39-year-old age group differs in terms of these parameters' concentrations. as well as 40–49 years old. The age group of 40–49 has the greatest values of these characteristics. Exceptions were HDL and LDL cholesterol. Otherwise, it is known that arteriosclerosis can be caused by diabetes and hyperlipemia. Arteriosclerosis increases the likelihood of ischemic diseases of the brain, heart, etc.

According to statistics from the literature, HDL cholesterol seems to be the "good cholesterol" that shields the body from ischemia disorders whereas LDL cholesterol is the harmful "bad cholesterol" that causes heart, arteriosclerosis, and ischemic diseases. The HDL percentage is essential for preventing heart attacks, coronary heart disease, and other vascular disorders. Conversely, LDL—the fraction—has an influence on the development of new blood vessels. However, total cholesterol does not provide a comprehensive picture of how arteriosclerosis develops. Because of this, HDL cholesterol completes the picture; low levels cause arteriosclerosis, while high levels prevent it from developing. A balanced diet, regular physical activity, abstaining from tobacco and excessive

Table 10. Summary presentation of the behaviour of different biochemical parameters in patients treated with diet, oral antidiabetics and insulin

Age group 30-39 years			Settings		
A Gr. of control	Glucose 5.23 ± 0.7	Triglycerides 1.43 ± 0.74	Cholesterol 5.0+ 1.0	HDL – chol. 1.15 ± 0.31	LDL – chol. 3.80.16
B Diabetics on a diet	8.95 ± 1.05	1.9 ± 0.76	5.4 ± 0.74	1.10 ± 0.65	4.2 ± 0.30
C Diabetics with antidiabetics	11.8 ± 1.04	2.4 ± 0.75	6.4 ± 0.7	0.62 ± 0.24	5.8 ± 0.13
D Diabetics with insulin	15 ± 1.14	2.8 ± 0.68	7.2 ± 1.1	0.60 ± 0.34	6.6 ± 0.40
%	A:B = 1.71%	A:B = 1.32%	A:B = 1.05%	A:B = 0.95%	A:B = 1.1%
	A:C = 2.25%	A:C = 1.67%	A:C = 1.25%	A:C = 0.53	A:C 1.5%
	A:D = 2.85%	A:D = 1.95%	A:D = 1.41%	A:D = 0.52%	A:D = 1.7%
	B:C = 1.31%	B:C = 1.26%	B:C = 1.18%	B:C = 0.56%	B:C = 1.3 %
	C:B = 0.76%	C:B = 0.79%	C:B = 0.84%	C:B = 1.77%	C:B = 0.73%
Age group 40-49	GLUCOSE	Triglycerides	Settings Cholesterol	HDL - chol.	LDL – chol.
A Gr. audit	5.35 ± 0.86	1.62 ± 0.92	5.23 ± 0.89	1.13 ± 0.42	3.5 ± 0.23
B Diabetics on a diet	9.60 ± 0.46	2.2 ± 11.2	2.2 ± 11.2	1.12 ± 0.60	3.2 ± 0.40
C Diabetics with oral antidiabetics	12.4 ± 0.98	2.5 ± 0.93	2.5 ± 0.93	0.7 ± 0.34	6.2 ± 0.22
D Diabetics with insulin	16.7 ± 1.50	3.1 ± 1.45	3.1 ± 1.45	0.61 ± 0.38	7.2 ± 0.31
%	A:B = 2.27%	A:B = 31.35%	A:B = 31.14%	A:B = 0.99%	A:B = 0.91%
	A:C = 2.31%	A:C = 1.54%	A:C = 131%	A:C = 0.62%	A:C = 1.77%
	A:D = 3.12%	A:D = 1.91%	A:D = 1.49%	A:D = 0.54%	A:D = 2%
	B:C = 1.29%	B:C = 1.13%	B:C = 1.15%	B:C = 0.62%	B:C = 1.9%
	C:D: 0.27%	C:D = 0.88%	C:D =0.87%	C:D =1.6%	C:D =0.51%

alcohol, and maintaining a healthy lifestyle are all important ways to improve lipid profiles (triglycerides, total cholesterol, HDL, and LDL) and reduce cardiovascular risks, according to the World Health Organization's Global Report on Diabetes and the Global Action Plan for the Prevention and Control of Noncommunicable Diseases (2013–2020). Interventions that specifically target these parameters can raise healthy HDL cholesterol levels while drastically lowering LDL cholesterol and triglycerides. These suggestions are consistent with the results of our investigation, which showed that the most noticeable lipid changes were seen in diabetic patients receiving insulin therapy. This emphasizes the significance of lifestyle changes in addition to medication to avoid complications. w

CONCLUSION

Based on the results of our research, we can conclude the following:

1. The age group and the control group itself differ in terms of these biochemical parameters' concentrations. For instance, the 40–49 age group had greater levels of glucose, triglycerides, total cholesterol, HDL, and LDL cholesterol than the 30-39 age group.

2. When comparing the 40–49 age group to the 30-39 age group, these metrics reveal a comparable trend among diabetics treated with diet, oral antidiabetics, and insulin.

3. Higher levels of glucose, triglycerides, and total cholesterol were seen in diabetics using antidiabetic medication (diet, oral antidiabetic, and insulin) in comparison to the control group in both age groups (30–39 and 40–49 years old).

4. Compared to the control group, in diabetics of both age groups (despite glucose, triglycerides and total cholesterol) the average values of HDL and LDL cholesterol are lower. The one exception was LDL cholesterol, which had a greater concentration in insulin-treated diabetics than in the control group.

5. The degree of concentrate of these parameters in the serum goes according to this order: **insulin > with diet > oral antidiabetics > control.** This arrangement is characteristic of two age groups and both genders (F and M). These findings highlight the need for personalized therapeutic and lifestyle interventions in managing lipid and glucose metabolism disturbances in diabetics, as supported by global health recommendations.

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Conflict of Interest

The author(s) do not have any conflict of interest.

Data Availability Statement

This statement does not apply to this article.

Ethics Statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval.

Informed Consent Statement

This study did not involve human participants, and therefore, informed consent was not required.

Clinical Trial Registration

This research does not involve any clinical trials

Author Contributions

Laura Binxhija Qeska: Conceptualization, Methodology, Writing – Original Draft. Visualization, Supervision, Project Administration; Greta Qeska: Data Collection, Analysis, Writing – Review & Editing. Funding Acquisition, Resources, Supervision

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