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Original Article

The effect of diet with administration of glycemic index and glycemic load on triglyceride levels of type 2 diabetes mellitus patients

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Abstract

In patients with diabetes mellitus, a carbohydrate metabolism disorder causes an increase in insulin to convert acetyl CoA into fat stores in adipose tissue and triglycerides in the liver. The glycemic load (GL) is the development of the glycemic index (GI), which can show the quality and quantity of carbohydrates consumed. Foods with a high glycemic load can increase blood sugar levels quickly so that they have the potential to accumulate body fat and trigger an increase in blood triglyceride levels. This shows a relationship between a glycemic load intake and an increase in triglyceride levels. The purpose was to analyze the effect of diet with the administration of glycemic index and glycemic load on triglyceride levels of type 2 diabetes mellitus patients. Quasi experiential study on 56 subjects who were given diet treatment with high GI, high GL (T-T), low GI with high GL (R-T), high GI, low GL (T-R), and low GI with low GL (R-R). Triglyceride levels were analyzed before and after the intervention. The results of the one-way ANOVA test showed a significant difference in triglyceride levels between the four groups ($p<0.05$). In conclusion, a glycemic load diet and low glycemic index reduce triglyceride levels.

Keywords: triglycerides, glycemic load, glycemic index.

Introduction

Diabetes Mellitus (DM) is a metabolic disease with an increase in blood glucose levels above normal caused by diet, unhealthy behavior, and stress. According to the World Health Organization [1], at least 171 million people worldwide suffer from DM, which caused the death of 3.2 million people. WHO predicts that by 2030 the number will increase to 366 million people [1]. In uncontrolled type 2 diabetes, the levels of triglycerides and chylomicrons and plasma-free fatty acids increase. This increase was mainly due to a decrease in the transport of triglycerides into fat depots [2].

If uncontrolled, diabetes mellitus can cause various damages or complications such as damage to nerves, eyes, kidneys, heart and blood vessels. Diabetes can be controlled for a longer time. One way to control diabetes mellitus is by diet or food intake, which is associated with one of the symptoms of diabetes mellitus, eating a lot. The success of complying with dietary recommendations depends on the patient's discipline [3].

Diet is an important part of the management of type 2 DM, in addition to exercise, anti-diabetic drugs and education. Choosing foods (carbohydrates) that do not drastically raise blood sugar levels is an effort to maintain blood sugar levels at normal levels [4, 5]. The effect of carbohydrates on blood sugar levels and insulin response can be used as a reference in determining the right amount and type of carbohydrate source food to improve and maintain health [6]. Carbohydrate consumption directly affects the glycemic load, where glycemic load can reflect the insulin response to food.

The glycemic index helps diabetics determine the type of carbohydrate food that can control blood glucose levels. By knowing food's glycemic index, diabetics can choose foods that do not raise blood glucose levels drastically so that blood glucose levels can be controlled at a safe level [7, 8].

A research on the relationship between consumption of foods containing the glycemic index and blood sugar levels in patients with type 2 diabetes conducted at Abdul Moeloek General Hospital has shown that there is a significant relationship between the glycemic index of foods consumed and blood sugar levels in patients with type 2 diabetes mellitus. When consumed, foods with a high glycemic index will increase blood sugar levels quickly. Conversely, people who eat foods with a low glycemic index slowly increase their blood sugar levels and their blood sugar levels [8].

Lipoprotein lipase is the main enzyme responsible for the clearance of lipoprotein-containing triglycerides from the circulation, whereas lipoprotein lipase activation is strongly influenced by insulin resistance [9]. Liver lipase is also responsible for blocking HDL particles from the circulation, showing increased activity when insulin resistance occurs and causing HDL levels to decrease. Therefore, due to insulin resistance, patients with diabetes mellitus will experience an increase in triglyceride levels and a decrease in HDL levels [10].

Material and methods

Study design and patients

This research is a quasi-experimental research. The study was conducted on patients with type 2 diabetes mellitus at the Gondangrejo Community Health Center, Indonesia, in 2020. This research was declared to have passed the health research ethics committee at the Kusuma Husada University, Surakarta, Indonesia, with No. 78/UKH.L.02/EC/IX/2020. Sampling by simple random sampling method. The population of this study was all type 2 DM patients at the Gondangrejo Public Health Center. The sample used in this study was 56 people without dropping out, with inclusion criteria including 45–60 years old, not having dementia or mental disorders, being able to communicate well, and not being on a specific diet. The independent variable in this study was the provision of a diet with a glycemic index setting and glycemic load, with the dependent variable being triglyceride levels. Triglyceride levels were taken through a vein carried out by laboratory personnel. Examination of triglyceride levels was carried out twice, pre- and post-intervention. Plasma triglycerides were measured using the calorimetric method with the enzymatic hydrolysis lipase technique.

Intervention

Diet with GI and GL settings is given as an interlude for lunch and afternoon. The groups were divided into four, high glycemic index with high glycemic load (H-H), low glycemic index with high glycemic load (L-H), high glycemic index with low glycemic load (H-L) and low glycemic index with low glycemic load (L-L). The H-H diet consists of 100 grams of glutinous rice, 10 grams of sweetened condensed milk, 15 grams of cheese, and 200 grams of watermelon with a GI value of 89 GL 35. The L-H diet consists of 15 grams of roasted peanuts, 175 grams of boiled potatoes, and 200 grams of pears with a GI value of 50 BG 27. The H-L diet consists of 115 grams of watermelon, 120 grams of boiled cassava, and 45 grams of cheese with a GI value of 70 GL 10. The L-L diet consists of 30 grams of roasted peanuts and 200 grams of boiled taro with a GI of 34 GL 6. The four diet groups had the same calories, ±350 kcal and fluid administration of about 500 ml of water.

This dietary intervention was administered for 4 weeks. Subjects were asked to consume the same food for three days before the intervention to minimize variations in intake and additional snacks of ±500 kcal/day to meet their supposed needs. Subjects were instructed to consume 500 ml of water and fast for at least 8 hours the night before the intervention. Subject compliance is monitored directly so that the subject consumes all the food given. Blood triglyceride levels were measured twice before and after the intervention and analyzed using the enzymatic method.

The first procedure of this research is to provide an explanation of the research procedures to be carried out and fill out the informed consent as an agreement to participate in the study, the screening process to select subjects according to the inclusion criteria before the study. Food intake was obtained by interviewing 3×24 hours of food recall before the intervention and analyzed using nutrisurvey software.

Statistical analysis

Data processing and analysis were carried out using a computer program. Univariate analysis was used to describe the frequency distribution of data on age,

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Table 1: Distribution of the characteristics of research respondents.

Subject characteristics	P1 (L-L)		P2 (L-H)		P3 (H-L)		P4 (H-H)	
	n	%	n	%	n	%	n	%
Age (year)								
35–45	0	0	2	14.3	3	21.5	0	0
46–55	14	100	12	85.7	11	78.5	14	100
Sex								
Male	0	0	3	21.4	2	14.2	2	14.2
Female	14	100	11	78.6	12	85.8	12	85.8
Occupation								
Entrepreneur	13	92.3	14	100	13	92.8	12	85.8
Government employees	1	7.1	0	0	0	0	0	0
Doesn't work	0	0	0	0	1	7.2	2	14.2
P*	0.864		0.884		0.360		0.456	

Note: *One-way Analysis of Variance (ANOVA).

gender, and occupation; normality test using Shapiro-Wilk test. Differences in triglyceride levels between groups were analyzed using the one-way analysis of variance (ANOVA) test because the data were normally distributed.

Results

Table 1 shows that the mean age, gender and occupation between groups did not have a significant difference and had the same variance (p>0.05). This shows that the three groups have the same characteristics. Table 2 shows no significant differences in energy, protein, fat and carbohydrate intakes between groups (p>0.05).

Table 3 shows that there was a decrease in triglyceride levels in each group, both L-L, L-H, H-L and H-H. In the L-L group, there were many who experienced a decrease in triglyceride levels compared to the other groups. The results of the analysis showed a significant difference in reducing triglyceride levels (p<0.05).

Discussion

This study used 56 subjects divided into four diet groups, including the high glycemic index diet group with high glycemic load (H-H), low glycemic index with high glycemic load (L-H), high glycemic index with low glycemic load (H-L) and low glycemic index with low glycemic load (L-L). Each group consisted of 14 subjects. The results of the different tests showed no difference in age, gender and occupation (p>0.05). This shows that the four groups were in the same condition at the time of the study.

The average food intake of the subjects for 3 days before the intervention was 2,159–2,332 kcal of energy;

Table 2: Differences in intake of energy, protein, fat and carbohydrates before dieting.

Intake variable	Average±SD				P*
	H-H	L-H	H-L	L-L	
Energy (kkal/day)	2.305±241.4	2.183±290.3	2.332±337.3	2.159±334.3	0.346
Protein (gram/day)	71,9±9.8	67.7±9.6	69.4±10.6	61.3±13.7	0.080
Fat (gram/day)	87.2±10.9	79.5±14.2	86.4±12.2	82.9±17.9	0.456
Carbohydrate (gram/day)	306.7±39.6	295.5±38.4	314.8±50.5	289±40.4	0.389

Note: *One-way Analysis of Variance (ANOVA).

Table 3: Changes in triglyceride levels.

Subject characteristics	P1 (L-L)		P2 (L-H)		P3 (H-L)		P4 (H-H)		P*
	n	%	n	%	n	%	n	%	
Triglycerides									
Increase	1	7.1	1	7.1	2	14.3	11	78.6	
Does not change	2	14.3	4	28.6	4	28.5	2	14.3	0.018
Decrease	11	78.6	9	64.3	8	57.2	1	7.1	

Note: *One-way Analysis of Variance (ANOVA).

61.3–71.9 grams of protein; 79.5–87.2 grams of fat; and 289-314.8 grams of carbohydrates.

The results of the analysis showed no statistically significant differences in the intake of energy, protein, fat, and carbohydrates. This indicates that the intake conditions of the subjects before the intervention were the same.

Measurement of triglyceride levels was carried out 2 times, before and after the diet. Based on the measurement results, average triglyceride levels increased, remained unchanged, and decreased. The L-L group experienced more decrease in triglyceride levels when compared to the L-H, H-L and H-H groups. Based on the different test results, there was a significant difference ($p<0.05$).

The difference in triglyceride levels in this study was influenced by the glycemic index's value and the food's glycemic load. A low glycemic index can reduce insulin resistance and insulin levels, causing a decrease in free fatty acids, which can prevent the accumulation of triglycerides in the blood [11].

Consumption of foods with a high GI and high GL will cause a rapid increase in blood glucose levels, triggering an increased insulin response and inhibiting the release of glucagon. This high insulin-glucagon ratio will interfere with the normal anabolic response of food [11].

This will increase glucose absorption, glycogenesis in muscle and liver, lipogenesis in adipose tissue, suppress lipolysis, gluconeogenesis and glucose expenditure by the liver. This causes hypoglycemia and will automatically trigger the release of counter-regulatory hormones to restore glycemic levels, activate lipolysis and release free fatty acids by adipose tissue, causing accumulation of free fatty acids. High levels of free fatty acids will result in the accumulation of lipids in the liver and skeletal muscle, which contributes to insulin resistance and dyslipidemia by increasing triacylglycerol-rich lipoproteins [12].

A low glycemic index has slow glucose absorption characteristics, while a high glycemic index has fast glucose absorption in the upper small intestine [13].

However, the relationship between glycemic index and glycemic load is not always directly proportional. Low glycemic index consumed in large quantities can increase blood glucose levels drastically. Conversely, a high glycemic index consumed in small amounts can increase blood glucose levels relatively small [14]. Therefore, in this study, the high glycemic load diet (T-T and R-T) showed high fluctuations in triglyceride levels, while the low glycemic load diet (T-R and R-R) had lower fluctuations. An increase in high blood glucose levels stimulates the formation of glycogen from glucose, the synthesis of fatty acids and cholesterol levels from glucose. High blood glucose levels can accelerate the formation of triglycerides [15]. The results of this study are in accordance with previous studies, which showed that a low GI and low carbohydrate diet did not affect HDL cholesterol and LDL cholesterol but significantly reduced triglyceride levels [16].

Conclusion

The high glycemic load diet showed high fluctuations in triglyceride levels, while the low glycemic load diet had lower fluctuations in our study. Increased high blood glucose levels stimulates the formation of glycogen from glucose, the synthesis of fatty acids and cholesterol levels from glucose while high blood glucose levels can accelerate the formation of triglycerides. In this study, it was shown that a glycemic load diet and low glycemic index have an effect on reducing triglyceride levels.

Conflict of interest

The authors declare no conflict of interest.

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